

Converging (Pragmatist)

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

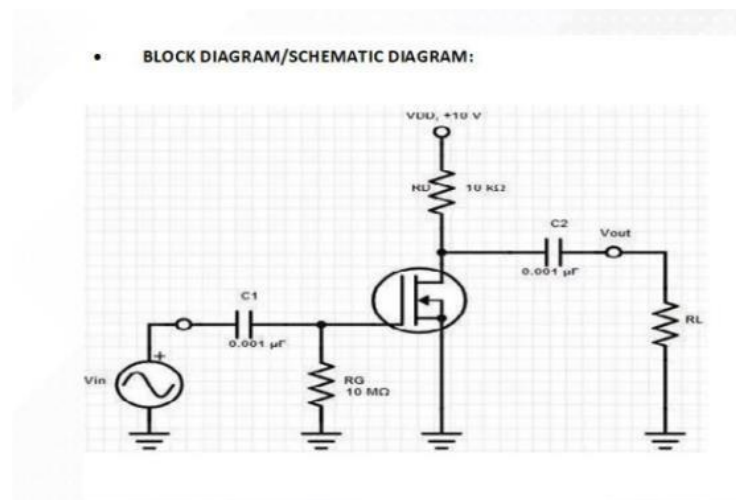
A. Beginner

I. Main Objective:

To explore and understand the basics of a FET amplifier by connecting theory to real-life scenarios. Learners will build the circuit using guided tools, identify components, and focus on familiarizing themselves with the layout and function of each part in a real-world context.

II. Procedure:

1. Imagine the FET amplifier is used in a microphone to make a speaker's voice louder — your goal is to amplify weak audio signals.
2. Study a simplified datasheet (cheat sheet provided) to learn the symbol, function, and orientation of each component.
3. Assemble the circuit using a labeled schematic. Drag-and-drop tools in VR show where each part goes.
4. Identify the function generator, FET, resistors, capacitors, and power supply in the lab setup.
5. Explore different FET package types and labeling conventions.
6. Use the VR interface to highlight each component in the assembled circuit and read its description. Then, complete a matching activity in the worksheet to pair component names with their roles (e.g., "This capacitor passes AC signals"). (e.g., "This capacitor passes AC signals").



EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

I. OBJECTIVES

A. Content Standards

- Understand the basic function and purpose of a FET amplifier
- Recognize the components and layout of a simple FET amplifier circuit.

B. Performance Standards

- Assemble a basic FET amplifier using a guided schematic
- Measure voltage signals accurately and interpret phase relationships.
- Compute and compare voltage gain effectively.

C. Learning Competencies/Objectives

- Identify key components (FET, resistors, capacitors, power source) and their functions in the amplifier.
- Describe the flow of the input signal through the circuit and how amplification occurs.
- Accurately measure input/output voltages.
- Draw diagrams

II. CONTENT (Experiment 6: Field Effect Transistor Amplifier)

III. LEARNING RESOURCES

A. References

- ECEN 30034 Experiments Module 9
- ECEN 30034 Instructional Material
- Field Effect Transistor by Robert Bolyestad

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.

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.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

B. Discussion of Concepts

INTRODUCTION

Welcome back to another experiment! In this activity, you will learn how to use a Field Effect Transistor (FET) to build something really useful — an amplifier. An amplifier is a device that makes a small signal bigger. For example, it takes a quiet sound or a weak signal and increases its strength so we can use it better.

This time, we're using a type of amplifier called a Common-Source Amplifier. It's a popular circuit in electronics because it gives a strong output and is easy to understand once you build and test it.

Since this is a hands-on experiment, your job is not just to read about it — you'll actually see the signal grow and change.

PART 1: WHAT IS A FET AND WHAT DOES IT DO?

A **Field Effect Transistor (FET)** is like an electronic valve. It controls the flow of current using a small voltage signal. It has three parts:

- **Gate** - like a control switch
- **Drain** - where the current flows out
- **Source** - where the current comes in

In a **common-source amplifier**, we send a small signal to the **gate**, and the amplified signal comes out at the **drain**. It's called "common-source" because the **source** is shared by both the input and output parts of the circuit.

PART 2: MEET THE COMPONENTS

Here are the main parts of the circuit and what they do:

- **Resistors** - control how much current flows
- **Capacitors** - let AC signals pass but block DC
- **The FET** - amplifies the signal
- **Power Supply** - gives the circuit energy to work

Each part has a job, just like players in a band. Together, they make the signal louder — just like amplifying a guitar or voice.

PART 3: WHAT WILL YOU SEE?

In the VR lab, you'll:

- Build the circuit by dragging and dropping components
- Highlight each part to read its name and role
- See how the signal flows from input to output
- Measure how much the signal was amplified

This helps you understand how everything connects without needing to use real wires yet.

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PART 4: BASIC FORMULA

To check how well your amplifier works, use this formula:

- Voltage Gain (A_v) = Output Voltage \div Input Voltage

Example: If $V_{in} = 0.2V$ and $V_{out} = 1V$, then Gain = 5

You can compare your measured gain with this calculation later.

PART 5: CONCLUSION

Now that you've explored the circuit and its parts in a fun and interactive way, you've taken your first step toward understanding how electronic amplifiers work. You've seen how a FET can take a small signal and make it stronger, and you've connected each component to a real-life purpose.

Even though this is just the beginning, you've already learned something that's used in devices all around you. Keep asking questions, keep exploring — and soon, you'll be building more complex systems with confidence!

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

B. Intermediate

I. Main Objective:

To apply practical knowledge of FET amplifiers by assembling circuits, identifying and describing key components, and comparing variations in design across real-world examples.

II. Procedure:

1. Begin with a real-life demo: Explore how a guitar amp uses similar circuits.
2. Use the "Quick Reference Guide" to check transistor pinouts and common resistor codes.
3. Build the circuit using a guided schematic and component layout in VR.
4. Identify each component's role in the circuit: biasing resistors, coupling capacitors, and the FET.
5. Use the VR circuit view to explore the complete layout and reference each part. In the worksheet, match components with their descriptions and explain their function in the system.
6. Complete a concept-matching activity that connects each component with a familiar device or analogy to reinforce understanding.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

I. OBJECTIVES

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- Recognize the components and layout of a simple FET amplifier circuit.

B. Performance Standards

- Assemble a basic FET amplifier using a guided schematic
- Measure voltage signals accurately and interpret phase relationships.
- Compute and compare voltage gain effectively.

C. Learning Competencies/Objectives

- Identify key components (FET, resistors, capacitors, power source) and their functions in the amplifier.
- Describe the flow of the input signal through the circuit and how amplification occurs.
- Accurately measure input/output voltages.
- Draw diagrams

II. CONTENT (Experiment 6: Field Effect Transistor Amplifier)

III. LEARNING RESOURCES

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IV. PROCEDURES

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Knowledge Level Assessment

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Assignment of Tracks

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

- 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

Welcome to the Electrosphere! In this session, you're not just observing a FET amplifier—you're building, exploring, and analyzing it in action. The FET (Field Effect Transistor) is a core component in signal amplification.

As a converging learner, you'll benefit from seeing how the circuit behaves under real-world conditions. You'll measure actual input and output waveforms, test your gain calculations, and make adjustments if needed. Your goal isn't just to follow instructions — it's to understand the system and optimize it.

Let's get started.

PART 1: WHY USE A COMMON-SOURCE AMPLIFIER?

The common-source amplifier is one of the most widely used amplifier designs. It's popular because it provides:

- **Voltage Amplification:** It can take a tiny signal and make it stronger.
- **Phase Inversion:** The output signal is flipped 180° relative to the input.
- **Simplicity:** A straightforward structure that's easy to trace and analyze.

PART 2: COMPONENTS AND THEIR FUNCTIONS

To understand how the amplifier works, you need to know the role of each component. In VR, you'll see these clearly labeled and described.

Here's what to focus on:

Component	Function
FET (Transistor)	Core amplifying device; controls current from drain to source.
Biasing Resistors	Set the correct DC operating point (putting FET into saturation mode).
Coupling Capacitors	Allow AC signals to pass while blocking DC (for signal isolation).
Drain Resistor	Converts amplified current variations into a voltage output.
Power Supply	Provides the necessary voltage for transistor operation.

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PART 3: WHAT HAPPENS DURING AMPLIFICATION?

When the circuit is powered and the FET is correctly biased, a small **AC input signal** at the gate results in a **larger, inverted output** at the drain.

- How the waveform grows in amplitude from input to output.
- The **inversion** of the signal (you'll notice the peaks and valleys are flipped).
- Any **distortion** when signals are too strong (hint: that's a sign of clipping).

PART 4: WHAT TO MEASURE?

You'll focus on three main things:

1. **V_{in}** (AC input from function generator)
2. **V_{out}** (amplified signal across the drain resistor)
3. **Voltage Gain** – calculated and measured

Use the formula:

$$A_V = \frac{V_{out}}{V_{in}}$$

Then compare this result with your theoretical expectations from the small-signal model:

$$A_V = -g_m \cdot R_D$$

PART 5: PRACTICAL TIPS FOR PRAGMATISTS

- Double-check transistor orientation and resistor placement – a small mistake can affect results.
- Watch for distortion — if the output is clipped, the transistor might be leaving the active region.
- Try adjusting V_{in} or load resistance to see how gain changes – experiment and optimize.
- Take multiple readings. Don't settle for one result — compare and test again to improve confidence.

PART 6: CONCLUSION

This experiment gives you the chance to connect theory to actual performance. You'll not only measure waveforms, but also evaluate how component values influence amplification. With each adjustment, you'll be learning through action — which is exactly how converging learners thrive.

You've got the tools, the formulas, and the circuit. Now test it, measure it, and make it work better.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

C. Difficult

I. Main Objective:

To investigate advanced amplifier circuits by focusing on real-world design techniques, component selection, and troubleshooting methods. Learners will deepen their understanding of amplifier structure without relying on measurements.

II. Procedure:

1. Use component datasheets and cheat sheets to review specifications such as FET types, resistor wattage, and capacitor ratings.
2. Build the circuit in VR using components.
3. Observe the interaction between the power supply, signal input, and load resistor.
4. Identify potential component mismatches or layout issues through guided exploration.
5. Reflect on how design choices affect reliability, size, and application of the amplifier in real-life devices.
6. Use an interactive concept discussion board to explain component functions and participate in a comparison activity to evaluate different amplifier topologies.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

I. OBJECTIVES

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B. Performance Standards

- Assemble a basic FET amplifier using a guided schematic
- Measure voltage signals accurately and interpret phase relationships.
- Compute and compare voltage gain effectively.

C. Learning Competencies/Objectives

- Identify key components (FET, resistors, capacitors, power source) and their functions in the amplifier.
- Describe the flow of the input signal through the circuit and how amplification occurs.
- Accurately measure input/output voltages.
- Draw diagrams

II. CONTENT (Experiment 6: Field Effect Transistor Amplifier)

III. LEARNING RESOURCES

A. References

- ECEN 30034 Experiments Module 9
- ECEN 30034 Instructional Material
- Field Effect Transistor by Robert Bolyestad
- Manufacturer Datasheets
- Simulation Tools

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:

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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.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

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

Welcome to the Electrosphere! Today, we're not just learning about amplifiers – we're going to build one, test it, and analyze how it performs. In this experiment, you'll apply what you already know about FETs to practically explore how they amplify AC signals using a common-source amplifier configuration.

As a converging learner, you'll benefit from seeing how the circuit behaves under real-world conditions. You'll measure actual input and output waveforms, test your gain calculations, and make adjustments if needed. Your goal isn't just to follow instructions – it's to understand the system and optimize it.

Let's get started.

PART 1: WHY USE A COMMON-SOURCE AMPLIFIER?

The common-source amplifier is fundamentally governed by small-signal analysis, where the FET is modeled as a voltage-controlled current source with transconductance g_m . The voltage gain of the amplifier is given by:

$$A_V = -g_m \cdot R_D$$

Where:

- $g_m = \frac{2I_D}{|V_{GS} - V_{th}|}$ (for a MOSFET in saturation)
- R_D is the drain resistor
- The negative sign indicates a 180° phase inversion

The amplifier relies on proper **DC biasing** to place the FET in its saturation region — a prerequisite for linear amplification. The small AC signal superimposed on the DC gate bias modulates the drain current, resulting in an amplified and inverted output voltage.

PART 2: PRACTICAL IMPLICATIONS AND SIGNAL BEHAVIOR

While theory predicts a clean gain and phase inversion, real circuits introduce several deviations:

- Gate leakage and input capacitance may affect high-frequency response.
- Bypass capacitors and load impedance can influence the mid-band gain.
- The cutoff frequency is determined by the RC time constants formed by input/output capacitors and resistances.
- Gain compression or distortion may appear when the input signal drives the FET out of the linear region.

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These factors explain why measured gain often diverges from ideal predictions – especially under varying frequency or amplitude.

PART 3: ANALYZING NON-IDEALITIES

Advanced learners are expected to critically assess performance issues, such as:

- Clipping due to limited output swing
- Thermal drift affecting bias stability
- Parasitic capacitances impacting high-frequency operation

By identifying these factors in waveform observations (e.g., distorted sine waves, phase lag), you can trace back to their origin in the physical layout, component tolerances, or power supply limitations.

PART 4: SYNTHESIZING THEORETICAL AND EXPERIMENTAL RESULTS

After conducting measurements, learners compare theoretical gain to observed values using:

$$A_V = \frac{V_{out}}{V_{in}}$$

Reflection questions include:

- Is the gain lower than expected? Why?
- Is there noticeable phase shift or distortion?
- What component or design factor might be the cause?

Such reflection encourages deeper understanding and promotes **analytical troubleshooting**.

Parameters	V1 out 2 Cycles Measure d value.	V2 out 2 Cycles Compute d values.	Voltage Gain	
			Measure d values	Compute d values
5Vpp/20HZ				
10Vpp/500HZ				
12Vpp/1KHZ				
15Vpp/1.5KH Z				
20Vpp/20KHZ				
20VPP/200KH Z				
25Vpp/1MHZ				

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PART 5: CONCLUSION

This experiment goes beyond basic circuit assembly — it challenges you to think critically about how theoretical models hold up in real environments. You've applied formulas, measured actual signals, and identified sources of deviation.

More importantly, you've seen how factors like biasing, component values, and non-ideal device behavior shape the amplifier's performance. This analysis isn't just about numbers — it's about understanding limitations, making informed design decisions, and refining your engineering intuition.

Diverging (Reflector)

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

A. Beginner

I. Main Objective:

To understand how a common-source Field Effect Transistor (FET) amplifier works by observing and reflecting on the purpose and function of each circuit component. In this experiment, learners will take time to explore how each part contributes to the circuit's behavior, identify real-life examples of its use, and build a strong conceptual foundation through observation.

II. Procedure:

1. Begin in the virtual lab by watching a guided demonstration of the FET amplifier setup. Focus on the purpose of each component.
2. Observe the arrangement of the function generator, FET, resistors, capacitors, and power supply in the amplifier layout.
3. Use visual aids or diagrams provided to reflect on how these components might affect signal flow in theory.
4. Take notes or sketch the setup before starting your own circuit. Think about how the input signal will behave at the output.
5. Reflect on how the signal is likely processed based on your understanding of each component.
6. Create a block diagram showing the full connection

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

I. OBJECTIVES

A. Content Standards

- Understand the basic function and purpose of a FET amplifier
- Recognize the components and layout of a simple FET amplifier circuit.

B. Performance Standards

- Assemble a basic FET amplifier using a guided schematic
- Measure voltage signals accurately and interpret phase relationships.
- Compute and compare voltage gain effectively.

C. Learning Competencies/Objectives

- Identify key components (FET, resistors, capacitors, power source) and their functions in the amplifier.
- Describe the flow of the input signal through the circuit and how amplification occurs.
- Accurately measure input/output voltages.
- Draw diagrams

II. CONTENT (Experiment 6: Field Effect Transistor Amplifier)

III. LEARNING RESOURCES

A. References

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IV. PROCEDURES

A. Pre- Activity Preparation

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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

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

- 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

Hello, everyone! I'm glad to welcome you to another exciting learning session in the Electrosphere! Today, we'll gently explore the idea of amplification using a Field Effect Transistor (FET). This may sound complex at first, but don't worry — we will observe how the circuit behaves, take time to think about it, and understand how the FET helps make small signals bigger.

As Reflectors, your strength is in careful observation and deep thinking. You don't need to rush. This experiment is your opportunity to watch, take notes, and reflect before building. When you're ready, you'll get to apply what you've observed by building your own version of the circuit.

PART 1: STARTING WITH OBSERVATION

Before jumping into building or testing, begin by watching a step-by-step demonstration of the FET amplifier in the VR lab. As a Reflector, take time to absorb the details: How are the components placed? What connections matter most? Watch the input signal flow from the function generator to the output terminal. You'll be guided to pause and reflect at key points.

PART 2: WHAT EACH COMPONENT DOES?

The FET amplifier works like a translator: it takes a small signal and makes it big enough to be useful. Each part plays a role:

- **Function Generator:** Think of it like a soft voice trying to speak.
- **Gate (FET Input):** Acts like a control switch that senses the voice.
- **Drain Resistor:** Helps the FET translate the voice into a louder output.
- **Coupling Capacitor:** Like a door that only lets AC signals through, blocking DC.
- **Biasing Resistors:** Keep the FET "awake" and ready to work — like setting the right posture before starting a job.

PART 3: BUILDING MENTAL CONNECTIONS

Before assembly, reflect on where you've seen this kind of amplification. Have you used a microphone, radio, or guitar amp? These devices use similar circuits! Think of how a whisper becomes a loud sound in a speaker — the FET circuit is behind that transformation.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

PART 4: CONCLUSION

In this activity, you didn't just learn by doing — you learned by watching, thinking, and connecting ideas. You explored how a common-source FET amplifier works by focusing on each component's role, watching the circuit behavior, and connecting the setup.

By reflecting on how signals move and change, you built a solid foundation for understanding amplifiers. You didn't need numbers — just your eyes, your mind, and your ability to make sense of what you saw.

This is how Reflectors learn best: by taking in information thoughtfully and connecting the parts to the whole. You'll understand how an amplifier works by carefully watching how each part behaves, and reflecting on why the signal changes. Once you feel confident in what you've seen, you'll be able to build and test the circuit yourself — and see the amplifier come to life.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

B. Intermediate

I. Main Objective:

To explore and understand the structure and behavior of a common-source Field Effect Transistor (FET) amplifier by observing its layout and reflecting on the function of its individual components. This experiment encourages thoughtful consideration of how the design and arrangement of elements such as resistors, capacitors, and transistors contribute to circuit operation

II. Procedure:

1. Begin by watching a guided demonstration of a complete FET amplifier setup and note how each component is introduced and placed.
2. Take notes on each key component's role (gate, source, drain, resistors, capacitors) and their positions in the circuit.
3. Once ready, assemble the FET amplifier on the virtual breadboard by following the guided example.
4. Participate in a discussion where learners hypothesize the impact of changing or removing components.
5. Reflect on how each component supports the function of the amplifier, particularly how biasing and layout impact signal handling.
6. Review multiple example circuits with slight differences and identify how the purpose and behavior of the amplifier might change.
7. Write a short reflection summarizing how different component configurations could influence signal behavior, supported by your observations.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

I. OBJECTIVES

A. Content Standards

- Understand the basic function and purpose of a FET amplifier
- Recognize the components and layout of a simple FET amplifier circuit.

B. Performance Standards

- Assemble a basic FET amplifier using a guided schematic
- Measure voltage signals accurately and interpret phase relationships.
- Compute and compare voltage gain effectively.

C. Learning Competencies/Objectives

- Identify key components (FET, resistors, capacitors, power source) and their functions in the amplifier.
- Describe the flow of the input signal through the circuit and how amplification occurs.
- Accurately measure input/output voltages.
- Draw diagrams

II. CONTENT (Experiment 6: Field Effect Transistor Amplifier)

III. LEARNING RESOURCES

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IV. PROCEDURES

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B. Discussion of Concepts

INTRODUCTION

Hello, everyone! I'm glad to welcome you to an exciting learning session in the Electrosphere! In this experiment, we'll dive deeper into understanding how FETs amplify AC signals in a common-source amplifier configuration. You'll not only build the circuit — you'll first observe, analyze, and reflect on how it behaves before making conclusions.

As Reflectors, your strength lies in watching carefully, connecting ideas, and thinking before acting. In this lab, take your time to analyze what happens at each point in the circuit. Watch how the signal transforms, reflect on the voltage gain, and identify patterns between theory and real-world behavior.

PART 1: WHY STUDY A COMMON-SOURCE AMPLIFIER?

The common-source amplifier is a standard FET amplifier configuration used in many analog systems. It takes a small AC signal at the gate and outputs a larger, inverted signal at the drain.

By studying this circuit, you'll understand:

- How the amplification occurs through transconductance
- Why the output is 180 degrees out of phase with the input
- How component values affect gain and signal shape

You may already be familiar with these ideas from theory — now you'll get to see them in action.

PART 2: THE CIRCUIT AS A LIVING SYSTEM

Imagine the amplifier like a team, where every part plays a role:

- The **FET** controls the flow like a faucet responding to small pressure (voltage) changes at the gate.
- **Biasing resistors** are like tension springs that set the transistor in the right operating mode.
- **Coupling capacitors** allow the signal to move forward without letting in unwanted noise or DC levels.
- The **drain resistor** helps create the amplified output by converting changes in current into changes in voltage.

PART 3: REFLECTING ON VARIATIONS AND OUTCOMES

Now examine **multiple amplifier examples** with slight differences:

- One has a larger resistor.
- One is missing a capacitor.
- One has biasing shifted.

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Ask yourself: *How might the signal change in each case?* Would it distort? Lose volume? Flip upside down?

These aren't puzzles to solve — they're questions to ponder. In the discussion, share your thoughts. Reflect on *why* a circuit behaves differently, not just *how* it works.

PART 4: FORMULAS TO APPLY (AND THINK ABOUT)

As you reflect on your measurements, apply these key formulas:

- **Voltage**

Gain:

$$A_V = \frac{V_{out}}{V_{in}}$$

- **Theoretical**

Gain

(using

transconductance):

$$A_V = -g_m \cdot R_D$$

Think about:

- Do your measured results agree with theory?
- What factors may cause small differences? (e.g., tolerance, signal frequency, loading)

PART 5: CONCLUSION

This activity allowed you to experience the amplifier as a system — not by crunching numbers, but by watching, comparing, and reflecting. You learned that each component has a distinct role and that its placement and value influence how the signal flows and changes.

By thoughtfully considering different circuit layouts, you've deepened your understanding of how biasing, coupling, and component interactions shape the performance of an amplifier. As a Reflector, you build knowledge not by rushing — but by seeing patterns, analyzing examples, and making meaningful connections.

Remember: Every circuit tells a story. The more you observe and reflect, the clearer that story becomes.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

C. Difficult

I. Main Objective:

To build a foundational understanding of how a common-source Field Effect Transistor (FET) amplifier works by observing its behavior in action, reflecting on how different parts of the circuit affect the signal, and comparing what is seen with basic expected outcomes. This approach encourages curiosity, careful observation, and thoughtful discussion rather than technical analysis.

II. Procedure:

1. Begin by watching the full demonstration of the common-source amplifier circuit in the virtual or physical lab. Observe how the AC input is applied, how the circuit is built, and how measurements are taken.
2. Take notes on each key component's role (gate, source, drain, resistors, capacitors) and how they influence the signal path.
3. Assemble a basic version of the FET amplifier on a breadboard using guided steps. Focus on recognizing the components and making proper connections, rather than worrying about precise values.
4. Connect a basic output indicator and observe how the input changes the output in real time. Focus on patterns—is the output stronger, reversed, or distorted?
5. Try using different types of input signals and observe how the output changes. Note what happens when the signal gets too loud or too soft.
6. Reflect on what you've learned

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

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- Draw diagrams

II. CONTENT (Experiment 6: Field Effect Transistor Amplifier)

III. LEARNING RESOURCES

A. References

- ECEN 30034 Experiments Module 9
- ECEN 30034 Instructional Material
- Field Effect Transistor by Robert Bolyestad

IV. PROCEDURES

B. 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.

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

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

- Based on learning style and knowledge level results, students are assigned the appropriate version of the VR presentation and activity procedure.

C. Discussion of Concepts

INTRODUCTION

Welcome to the Electrosphere. In this advanced exploration of FET amplifiers, our goal isn't just to build a circuit — it's to understand the nuanced behavior of a common-source amplifier and to reflect on what the results teach us about real-world electronics.

As Reflectors, your learning strength lies in careful observation, deep analysis, and drawing connections between ideas. This experiment is designed to support those strengths: you'll have the opportunity to observe the amplifier's behavior under varying signal conditions, study waveform changes, and compare your data with theoretical models — all before forming final conclusions.

PART 1: SEEING THE CIRCUIT

The common-source amplifier is fundamental in analog electronics due to its simplicity and effectiveness in providing voltage gain. However, real-world performance rarely matches textbook theory. In this experiment, you will explore how design assumptions hold up under actual testing conditions.

You already know that an AC signal at the gate of a FET, once properly biased, will produce an amplified, 180° out-of-phase signal at the drain. But now, you will go further — monitor how changes in frequency, amplitude, and load affect performance, and observe phenomena like signal distortion, gain compression, or clipping.

Ask yourself:

- How do component values shape performance?
- Why does distortion occur at certain input levels?
- How does biasing stabilize or destabilize the signal?

PART 2: OBSERVATION BEFORE ACTION

Before diving into construction, take time to observe the full system:

- The function generator's input waveform
- The FET's role as a transconductive element
- The output waveform under both ideal and stressed conditions

Sketch the setup. Predict how a change in frequency might affect the gain. Ask:

- Where are the limits of linear amplification?
- Does phase shift remain consistent across signal amplitudes?

Reflective learners gain the most from detailed analysis, not quick action — let observation guide your hypothesis.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

PART 3: THEORETICAL INSIGHT VS. PRACTICAL RESULTS

This amplifier should theoretically follow:

$$A_V = -g_m \cdot R_D$$

But in practice, you may observe:

- Gain drop-off at higher frequencies (due to parasitic capacitance)
- Output clipping from insufficient biasing
- Phase distortion or waveform asymmetry

Use your oscilloscope readings and measurement tools to capture this data. Then reflect:

- How does the measured gain compare to theoretical?
- Are discrepancies consistent or condition-dependent?
- What real-world factors are at play that models often ignore?

PART 4: CRITICAL THINKING THROUGH COMPARISON

Throughout the experiment, maintain a reflective journal or sketchpad. Log what you expected and what you observed. Ask:

- Did the FET operate in the saturation region the whole time?
- At what point did the output distort, and why?
- If this were part of a real device (e.g., audio amp), would the distortion be acceptable?

PART 5: CONCLUSION

This is not just a lab—it's a reflective study in how theory, design, and behavior align (or don't). By watching first, then measuring, then thinking critically, you'll build a deeper understanding of amplification and transistor behavior — not just in circuits, but in real systems.

You will walk away with not only data, but with insight — insight gained through careful reflection, thoughtful comparison, and analytical patience.

You are not just building a circuit. You are building understanding.

Assimilating (Theorist)

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

A. Beginner

I. Main Objective:

To develop a clear, logical understanding of how a common-source Field Effect Transistor (FET) amplifier works, by connecting basic transistor theory with real circuit behavior. This experiment helps build foundational knowledge by identifying circuit components, understanding signal flow, and observing cause-and-effect in a guided, structured way.

II. Procedure:

1. Begin by reviewing the theory of FET operation, including the function of the gate, drain, and source terminals in a common-source configuration.
2. Study the basic amplifier schematic and identify the purpose of each component (e.g., load resistor, coupling capacitors, biasing resistors).
3. Watch the VR/lab demonstration carefully, focusing on how the input signal travels through the circuit and how the FET modulates the output.
4. With guidance, follow a step-by-step layout to assemble the circuit using a breadboard or simulation. Focus on getting familiar with the structure, not measuring performance.
5. Record voltage values and calculate the voltage gain
6. Observe and Reflect

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

I. OBJECTIVES

A. Content Standards

- Understand the basic function and purpose of a FET amplifier
- Recognize the components and layout of a simple FET amplifier circuit.

B. Performance Standards

- Assemble a basic FET amplifier using a guided schematic
- Measure voltage signals accurately and interpret phase relationships.
- Compute and compare voltage gain effectively.

D. Learning Competencies/Objectives

- Identify key components (FET, resistors, capacitors, power source) and their functions in the amplifier.
- Describe the flow of the input signal through the circuit and how amplification occurs.
- Accurately measure input/output voltages.
- Draw diagrams

II. CONTENT (Experiment 6: Field Effect Transistor Amplifier)

III. LEARNING RESOURCES

A. References

- ECEN 30034 Experiments Module 9
- ECEN 30034 Instructional Material
- Field Effect Transistor by Robert Bolyestad

IV. PROCEDURES

A. Pre- Activity Preparation

Navigation of Virtual Laboratory:

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EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

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

Welcome to today's experiment. Before we begin building the circuit, it's important to understand the theory behind what we're doing. This experiment focuses on a simple but powerful application of the Field Effect Transistor (FET): the common-source amplifier.

As theorists, you'll find that this activity allows you to analyze a real-life electronic system using concepts from circuit theory. You will study the behavior of AC signals in transistor circuits and validate how theoretical models apply to real-world circuits.

PART 1: UNDERSTANDING THE FET

A Field Effect Transistor (FET) is a voltage-controlled device. It operates by controlling the flow of current from drain to source through the voltage applied between the gate and source (VGS). In this experiment, we will use a common-source configuration, which means the source is common to both the input and output sides of the amplifier.

The transistor must be biased correctly to operate in the saturation region, where it can act as an effective amplifier. Without proper biasing, the transistor won't behave linearly, and signal distortion may occur.

PART 2: THE ROLE OF THE COMMON-SOURCE AMPLIFIER

In a common-source amplifier, a small AC signal is applied at the gate, and an amplified version appears at the drain. One important feature of this configuration is that the output is inverted—meaning it has a 180° phase shift compared to the input.

The voltage gain of the amplifier depends on two things:

- The transconductance (g_m) of the transistor, which relates how much drain current changes for a given change in gate-source voltage.
- The drain resistor (R_D), which develops the amplified output voltage.

The theoretical voltage gain is given by:

$$A_V = -g_m \cdot R_D$$

But in this beginner version, we'll use a simplified formula based on actual voltage readings:

$$A_V = \frac{V_{out}}{V_{in}}$$

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

PART 3: WHAT YOU WILL OBSERVE AND ANALYZE

Using a function generator, you'll apply a sinusoidal signal to the gate of the FET. Using an oscilloscope, you will observe both the input and output waveforms. You should see that:

- The output waveform has a greater amplitude than the input.
- The output is inverted compared to the input.
- The difference in size (amplitude) shows the voltage gain of the amplifier.

You will measure, record, and analyze these values, then use them to calculate gain and confirm if the amplifier behaves as predicted.

PART 5: CONCLUSION

This experiment gives you the opportunity to apply FET theory to a real-world amplifier circuit. By observing input/output behavior, applying formulas, and calculating gain, you will see how theoretical concepts like biasing, gain, and signal inversion translate directly into circuit performance.

Understanding this connection between theory and function is essential for developing strong circuit analysis skills — and that's exactly what today's experiment is designed to reinforce.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

B. Intermediate

I. Main Objective:

To develop a clear, theory-driven understanding of how a common-source FET amplifier works—by analyzing signal flow, component roles, and functional behavior in a guided virtual environment. Learners will connect structured theoretical concepts with visual, immersive representations of the circuit in action.

II. Procedure:

1. Begin by reviewing the theory of FETs and the small-signal model of a common-source amplifier. Understand key terms such as transconductance (g_m), voltage gain (A_v), and phase inversion.
2. Analyze the circuit schematic, identifying the role of each component (biasing resistors, drain resistor, coupling capacitors, and FET).
3. Observe the circuit demonstration (simulation or guided setup) to see how AC signals behave at different points in the amplifier.
4. Record the peak-to-peak values of both signals, noting any distortion or phase shift.
5. Calculate the measured gain using:

$$A_v = \frac{V_{out(pp)}}{V_{in(pp)}}$$

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

6. Compare your results with theoretical expectations using:

$$A_V = -g_m \cdot R_D$$

Use approximate values for g , or derive from the transistor datasheet.

7. Summarize your analysis, reflecting on differences between expected and observed values and explaining possible causes (e.g., non-ideal components, frequency effects).

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

I. OBJECTIVES

A. Content Standards

- Understand the basic function and purpose of a FET amplifier
- Recognize the components and layout of a simple FET amplifier circuit.

B. Performance Standards

- Assemble a basic FET amplifier using a guided schematic
- Measure voltage signals accurately and interpret phase relationships.
- Compute and compare voltage gain effectively.

C. Learning Competencies/Objectives

- Identify key components (FET, resistors, capacitors, power source) and their functions in the amplifier.
- Describe the flow of the input signal through the circuit and how amplification occurs.
- Accurately measure input/output voltages.
- Draw diagrams

II. CONTENT (Experiment 6: Field Effect Transistor Amplifier)

III. LEARNING RESOURCES

A. References

- ECEN 30034 Experiments Module 9
- ECEN 30034 Instructional Material
- Field Effect Transistor by Robert Bolyestad

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

IV. PROCEDURES

A. Pre- Activity Preparation

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- 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.

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

In this experiment, you will investigate how a Field Effect Transistor (FET) functions in a common-source amplifier configuration. Before building the circuit, it is essential to understand the theoretical principles that govern its behavior.

Amplifiers are used to increase the amplitude of signals, and the common-source amplifier is one of the most basic and widely used configurations in analog electronics. It is known for producing moderate voltage gain and a 180-degree phase shift between the input and output signals.

As an assimilating learner, your focus should be on understanding how each component contributes to circuit function, how voltage gain is derived mathematically, and how this gain is affected by the FET's characteristics and surrounding elements.

PART 1: FET OPERATION IN AMPLIFICATION

A FET is a voltage-controlled device. When used as an amplifier, it converts small voltage changes at the gate into larger current changes from drain to source. In the saturation (active) region, the drain current becomes relatively constant for a given gate voltage, allowing the FET to amplify AC signals effectively.

The common-source configuration places the source terminal at ground, with the input applied to the gate and the output taken from the drain. This setup is known for:

- Voltage gain
- Phase inversion
- Relatively high input impedance

To amplify properly, the transistor must be biased so that it remains in its linear operating region during the entire AC input cycle.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

PART 2: THEORETICAL GAIN AND SMALL-SIGNAL MODEL

In a common-source amplifier, a small AC signal is applied at the gate, and an amplified version appears at the drain. One important feature of this configuration is that the output is inverted—meaning it has a 180° phase shift compared to the input.

The voltage gain of the amplifier depends on two things:

- The transconductance (g_m) of the transistor, which relates how much drain current changes for a given change in gate-source voltage.
- The drain resistor (R_D), which develops the amplified output voltage.

The theoretical voltage gain is given by:

$$A_V = -g_m \cdot R_D$$

But in this beginner version, we'll use a simplified formula based on actual voltage readings:

$$A_V = \frac{V_{out}}{V_{in}}$$

PART 3: WHAT YOU WILL OBSERVE AND ANALYZE

Using a function generator, you'll apply a sinusoidal signal to the gate of the FET. Using an oscilloscope, you will observe both the input and output waveforms. You should see that:

- The output waveform has a greater amplitude than the input.
- The output is inverted compared to the input.
- The difference in size (amplitude) shows the voltage gain of the amplifier.

You will measure, record, and analyze these values, then use them to calculate gain and confirm if the amplifier behaves as predicted.

PART 5: CONCLUSION

This experiment gives you the opportunity to apply FET theory to a real-world amplifier circuit. By observing input/output behavior, applying formulas, and calculating gain, you will see how theoretical concepts like biasing, gain, and signal inversion translate directly into circuit performance.

Understanding this connection between theory and function is essential for developing strong circuit analysis skills — and that's exactly what today's experiment is designed to reinforce.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

C. Difficult

I. Main Objective:

To critically analyze the performance of a Field Effect Transistor (FET) amplifier by constructing a complete AC amplifier circuit, measuring its input and output response, and evaluating voltage gain through theoretical derivation and experimental verification. The objective is to strengthen the learner's ability to interpret amplifier behavior through small-signal models, understand the interaction of component values, and apply mathematical analysis to assess circuit accuracy and limitations.

II. Procedure:

1. Review the theoretical background of FET amplifiers, including small-signal models, transconductance (g_m), and voltage gain expressions. Focus on the relationship between I_D , V_{GS} , and R_D .
2. Analyze the schematic provided for the FET amplifier circuit. Identify all AC and DC paths, and determine the expected biasing point (Q-point) using the transfer characteristics of the FET.
3. Calculate theoretical voltage gain using:

$$A_V = -g_m \cdot R_D$$

where g_m is obtained either from the datasheet or derived using:

$$g_m = \frac{2I_{DSS}}{|V_{GS(off)}|} \left(1 - \frac{V_{GS}}{V_{GS(off)}}\right)$$

4. Assemble the circuit precisely according to the schematic. Confirm resistor and capacitor values and ensure correct FET orientation.
5. Apply an AC signal (e.g., 1 kHz sine wave, 100-200 mV peak) through a function generator to the input.
6. Use a dual-trace oscilloscope to display both input and output waveforms. Measure peak-to-peak voltage, phase relationship, and any signal distortion.
7. Record and tabulate values for $V_{in(pp)}$, $V_{out(pp)}$, and calculate experimental gain:

$$A_V = \frac{V_{out(pp)}}{V_{in(pp)}}$$

8. Compare measured gain to theoretical gain, and identify possible causes of deviation: loading effects, parasitic capacitance, nonlinearities, or measurement error.
9. Reflect on the overall system behavior, documenting strengths and limitations of the amplifier in real-world performance.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

I. OBJECTIVES

A. Content Standards

- Understand the basic function and purpose of a FET amplifier
- Recognize the components and layout of a simple FET amplifier circuit.

B. Performance Standards

- Assemble a basic FET amplifier using a guided schematic
- Measure voltage signals accurately and interpret phase relationships.
- Compute and compare voltage gain effectively.

C. Learning Competencies/Objectives

- Identify key components (FET, resistors, capacitors, power source) and their functions in the amplifier.
- Describe the flow of the input signal through the circuit and how amplification occurs.
- Accurately measure input/output voltages.
- Draw diagrams

II. CONTENT (Experiment 6: Field Effect Transistor Amplifier)

III. LEARNING RESOURCES

A. References

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- ECEN 30034 Instructional Material
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IV. PROCEDURES

A. Pre- Activity Preparation

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EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

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

In this experiment, you will investigate how a Field Effect Transistor (FET) functions in a common-source amplifier configuration. Before building the circuit, it is essential to understand the theoretical principles that govern its behavior.

Amplifiers are used to increase the amplitude of signals, and the common-source amplifier is one of the most basic and widely used configurations in analog electronics. It is known for producing moderate voltage gain and a 180-degree phase shift between the input and output signals.

As an assimilating learner, your focus should be on understanding how each component contributes to circuit function, how voltage gain is derived mathematically, and how this gain is affected by the FET's characteristics and surrounding elements.

PART 1: WHAT IS A FET AMPLIFIER?

A Field Effect Transistor (FET) operates as a voltage-controlled current source. In amplifier applications, a small AC signal at the gate changes the drain current, producing a larger voltage across the drain resistor (R_D). This voltage becomes the amplified output signal.

In this experiment, we typically use a common-source amplifier setup, which has three important features:

- Voltage gain (the output signal is stronger than the input)
- High input impedance (important for signal sources with weak output)
- 180° phase shift between input and output signals

Theoretically, the voltage gain is given by:

$$A_V = -g_m \cdot R_D$$

Where:

- A_V is the voltage gain
- g_m is the transistor's **transconductance**
- R_D is the **drain resistor**

This model is part of the **small-signal analysis**, which assumes linear operation around the transistor's quiescent point.

PART 2: WHAT SHOULD YOU LOOK FOR?

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

As a Theorist, before building or measuring anything, it's important to think analytically. Ask yourself:

- What is the expected gain of the circuit based on the values of R_D and g_m ?
- How does the waveform behave at different points?
- Does the output waveform match the model – in shape, phase, and amplitude?

You'll also consider the DC biasing that positions the FET in the saturation region, allowing linear amplification to occur.

PART 3: FORMULAS YOU WILL USE

To calculate and compare values in this experiment, use the following:

1. Voltage Gain (Measured)

$$A_V = \frac{V_{out(pp)}}{V_{in(pp)}}$$

2. Voltage Gain (Theoretical)

$$A_V = -g_m \cdot R_D$$

3. Transconductance (if not given in the datasheet):

$$g_m = \frac{2I_{DSS}}{|V_{GS(off)}|} \left(1 - \frac{V_{GS}}{V_{GS(off)}}\right)$$

You will compare the measured gain with the calculated one and reflect on any differences.

PART 4: WHAT TO EXPECT?

When done correctly, you should observe:

- A **larger output waveform** than the input
- A clear **180° phase shift** (signal inversion)
- A **voltage gain** that closely matches your theoretical estimate — though it may vary due to non-ideal factors like parasitic capacitance or measurement loading

If your measured gain is too low or distorted, reflect on possible causes:

- Is the FET properly biased?
- Is the signal too large, pushing the FET out of linear operation?
- Are parasitics or load resistance affecting performance?

PART 5: CONCLUSION

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

This experiment is designed to help you connect theory with reality. You're not just amplifying a signal — you're applying mathematical models, predicting results, and then testing those predictions in a real circuit. As a theorist, this approach helps reinforce your analytical skills and gives you confidence that the principles you've studied truly apply to working systems.

So, dive into the analysis, verify your models, and refine your understanding of transistor amplifiers!

Accommodating (Activist)

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

A. Beginner

I. Main Objective:

To build and test a basic Field Effect Transistor (FET) amplifier circuit by applying an input signal and observing how it changes at the output. This experiment allows learners to explore how a transistor can increase signal strength through practical hands-on assembly, immediate measurement, and real-time analysis of waveforms.

II. Procedure:

1. Jump into the virtual or physical lab and begin by gathering your materials: FET, resistors, capacitors, signal generator, and oscilloscope.
2. Quickly review the circuit diagram and follow the step-by-step instructions to assemble the FET amplifier on a breadboard or simulator.
3. Connect the function generator to the input terminal and set it to a sine wave (e.g., 1 kHz, 100 mV peak).
4. Use the oscilloscope to view both the input and output waveforms. Try adjusting the input amplitude and note how the output changes.
5. Sketch or capture two waveforms showing how the output signal looks compared to the input.
6. Measure the peak-to-peak voltage of both signals (V_{in} and V_{out}).
7. Calculate voltage gain using the basic formula:

$$A_V = \frac{V_{out(pp)}}{V_{in(pp)}}$$

8. Try a few quick variations — like changing the input frequency or resistor values — and see how the output changes.
9. Record your observations and reflect on what changes gave better amplification.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

I. OBJECTIVES

A. Content Standards

- Understand how a FET can act as an amplifier by increasing signal strength.
- Recognize the basic behavior of input and output signals in a working amplifier.

B. Performance Standards

- Assemble a basic FET amplifier using simple instructions.
- Observe how an input signal is amplified using real-time tools like oscilloscopes.
- Make quick changes to the circuit and explore how they affect performance.

C. Learning Competencies/Objectives

- Build and test a functioning FET amplifier circuit.
- Use instruments to explore input and output behavior hands-on.
- Try out changes and immediately observe results to improve performance.
- Calculate voltage gain using measured signals.
- Reflect briefly on what worked well and what could be improved next time.

II. CONTENT (Experiment 6: Field Effect Transistor Amplifier)

III. LEARNING RESOURCES

A. References

- ECEN 30034 Experiments Module 9
- ECEN 30034 Instructional Material
- Field Effect Transistor by Robert Bolyestad

IV. PROCEDURES

A. Pre- Activity Preparation

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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.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

B. Discussion of Concepts

INTRODUCTION

Welcome back to the Electrosphere! Ready to jump in and build something real? In this experiment, you're going to build a working amplifier using a Field Effect Transistor — also called a FET.

If you like learning by trying things out and seeing what happens (instead of reading pages of theory), this activity is made for you. You'll set up the circuit, send a signal through it, and see how the signal grows right in front of your eyes!

PART 1: WHAT DOES A FET AMPLIFIER DO?

A FET amplifier is a circuit that takes a small signal and makes it bigger. That's called amplification. You send in a tiny wave, and the transistor uses its power source to boost it up.

You'll connect a function generator (which makes the wave) to the input, and then see a bigger version of that wave at the output using an oscilloscope.

And here's the cool part: The output wave is not just bigger — it's flipped upside down! That's called a phase shift.

PART 2: WHAT WILL YOU DO?

- You'll build the circuit on a breadboard.
- You'll send in a test signal and see what comes out.
- You'll try changing the input or resistor values and watch the results change.
- You'll measure both waves and calculate how much bigger the output is.
- You'll test, tweak, and discover — all while learning how transistors work as amplifiers.

PART 3: WHAT SHOULD YOU LOOK FOR?

When your circuit is running:

- Is the output wave bigger than the input?
- Is it flipped (inverted)?
- What happens if you turn up the input signal?
- Does the output get distorted if it's too big?

Try things out! Play with the circuit and see what affects the gain.

PART 4: BASIC FORMULA TO USE

Once you've measured the wave sizes (peak-to-peak voltages), use this easy formula:

$$A_V = \frac{V_{out(pp)}}{V_{in(pp)}}$$

That tells you how much the signal was amplified.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

PART 5: CONCLUSION

This experiment is about getting your hands dirty and learning through action. You don't need to memorize everything — just build the circuit, try different things, and watch what happens. The more you experiment, the more you'll understand how FETs control signals and make them stronger.

Now it's your turn to take control of the signal and bring your amplifier to life!

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

B. Intermediate

I. Main Objective:

To explore how a Field Effect Transistor (FET) amplifies signals by constructing an amplifier circuit, applying a dynamic input signal, and analyzing output behavior through real-time testing and adjustment. This experiment allows learners to discover how different components and signal conditions affect amplification by learning through trial, observation, and active experimentation.

II. Procedure:

1. Start by gathering your components: FET, resistors, capacitors.
2. Follow the diagram to build the FET amplifier circuit on a breadboard.
3. Apply an AC input signal from a function generator (e.g., 1 kHz sine wave, 100 mV). Watch how the input behaves.
4. Observe the signal behavior and note differences in amplitude, shape, and timing between input and output.
5. Make small changes to the circuit (e.g., try another resistor, increase input amplitude, or change frequency). Watch how each change affects the output.
6. Measure the voltage gain after each change using:

$$A_V = \frac{V_{out(pp)}}{V_{in(pp)}}$$

7. Record and compare results, noting what improved or reduced the amplification.
8. Compute and do a block diagram.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

I. OBJECTIVES

A. Content Standards

- Understand the basic function and purpose of a FET amplifier
- Recognize the components and layout of a simple FET amplifier circuit.

B. Performance Standards

- Assemble a basic FET amplifier using a guided schematic
- Measure voltage signals accurately and interpret phase relationships.
- Compute and compare voltage gain effectively.

C. Learning Competencies/Objectives

- Identify key components (FET, resistors, capacitors, power source) and their functions in the amplifier.
- Describe the flow of the input signal through the circuit and how amplification occurs.
- Accurately measure input/output voltages.
- Draw diagrams

II. CONTENT (Experiment 6: Field Effect Transistor Amplifier)

III. LEARNING RESOURCES

A. References

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- ECEN 30034 Instructional Material
- Field Effect Transistor by Robert Bolyestad

IV. PROCEDURES

A. Pre- Activity Preparation

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- 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.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

B. Discussion of Concepts

INTRODUCTION

Welcome back to the Electrosphere! Get ready to roll up your sleeves and experiment. In this lab, you'll build a real amplifier using a Field Effect Transistor (FET) — and more importantly, you'll see what happens when you power it on, adjust the input, and test the output in real time.

This experiment isn't just about following steps. It's about trying things, making mistakes, and learning what works best through action. You'll explore how FETs boost weak signals, and discover how changing parts or signal levels changes performance.

PART 1: WHAT ARE YOU WORKING WITH?

A Field Effect Transistor (FET) acts like a valve that controls the flow of current. When a small voltage is applied at the gate, it controls the current between the drain and source — kind of like turning a knob.

In an amplifier circuit, this means a tiny signal at the gate gets turned into a bigger signal at the drain. That's amplification! You'll test this by feeding in a small wave (from the function generator) and watching what comes out using an oscilloscope.

PART 2: WHAT ARE YOU LOOKING FOR?

As you build and test, look for the following:

- Is the output signal bigger than the input?
- Is it flipped (inverted)?
- How does the gain change when you:
 - Increase or decrease the input voltage?
 - Change a resistor value?
 - Switch the FET?

This is where the fun begins — trying new setups, observing results, and figuring out what each change does to the amplifier's performance.

PART 3: WHAT'S THE FORMULA?

After playing around with the circuit, measure the input and output using the oscilloscope, and calculate the voltage gain:

$$A_V = \frac{V_{out(pp)}}{V_{in(pp)}}$$

Don't worry about being perfect at first — try, test, and tweak.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

PART 4: HOW TO EXPLORE MORE

Try these ideas:

- Swap the input signal to a different frequency. Does the output still follow?
- Change the drain resistor. Does it make the amplifier stronger or weaker?
- Observe if the signal starts to distort – what might be causing it?

Each change is a chance to see cause and effect in action – no textbook required.

PART 5: CONCLUSION

This experiment is about learning by doing, testing, and observing. You're not just building a FET amplifier — you're exploring how signal strength, component values, and transistor behavior all connect in a real, working system.

So take the lead, dive into the circuit, and let your curiosity drive the results. Mistakes are just part of the experiment — and that's where the best discoveries happen.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

C. Difficult

I. Main Objective:

To investigate and optimize the performance of a Field Effect Transistor (FET) amplifier by building, modifying, and analyzing a high-sensitivity analog circuit. This experiment encourages students to engage in deep exploration of amplifier behavior by testing different component values, observing signal distortion and gain limits, and reflecting on how real-world performance compares to theoretical expectations.

II. Procedure:

1. Begin by reviewing the FET amplifier schematic, then immediately start building the circuit on a breadboard or simulation environment. Don't worry about perfection—start testing and learn through adjustments.
2. Connect the AC input source using a function generator. Set a baseline input (e.g., 1 kHz, 100 mV sine wave).
3. Observe the output waveform using a dual-trace oscilloscope. Compare input and output signals in terms of amplitude, shape, and timing.
4. Calculate the initial voltage gain using:

$$A_V = \frac{V_{out(pp)}}{V_{in(pp)}}$$

5. Begin experimenting:
 - Increase or decrease the input amplitude.
 - Replace or adjust the drain resistor (RD).
 - Change the input frequency.
 - Try biasing the FET differently to move the Q-point.
6. Record the changes in output behavior — look for gain increase, signal distortion, clipping, or phase changes.
7. Repeat tests with different configurations, keeping track of which changes improve or reduce amplifier performance.
8. Sketch or capture waveforms to visualize performance differences across test cases.
9. Reflect on what changes had the biggest effect, and try to optimize the circuit for clean, high-gain performance.
10. Wrap up by comparing your best configuration with theoretical gain expectations and explain what worked best and why.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

I. OBJECTIVES

A. Content Standards

- Understand the basic function and purpose of a FET amplifier
- Recognize the components and layout of a simple FET amplifier circuit.

B. Performance Standards

- Assemble a basic FET amplifier using a guided schematic
- Measure voltage signals accurately and interpret phase relationships.
- Compute and compare voltage gain effectively.

C. Learning Competencies/Objectives

- Identify key components (FET, resistors, capacitors, power source) and their functions in the amplifier.
- Describe the flow of the input signal through the circuit and how amplification occurs.
- Accurately measure input/output voltages.
- Draw diagrams

III. LEARNING RESOURCES

A. References

- ECEN 30034 Experiments Module 9
- ECEN 30034 Instructional Material
- Field Effect Transistor by Robert Bolyestad

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.

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.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

B. Discussion of Concepts

INTRODUCTION

Welcome to your next hands-on engineering challenge in the Electrosphere! In this advanced experiment, you won't just be building a Field Effect Transistor (FET) amplifier — you'll be pushing it, tweaking it, breaking it (on purpose), and fixing it again.

This is where engineering meets experimentation. You'll explore how a FET handles real signal conditions: how it responds to increased input levels, what happens when biasing shifts, and how distortion creeps in. You'll try things, get unexpected results, and figure out why — because that's how real discovery works.

PART 1: WHAT ARE YOU EXPLORING?

You already know that a FET amplifier can boost small signals using a high-impedance input at the gate and a controlled current at the drain. But in this experiment, we go deeper.

You'll explore:

- How signal distortion appears when the FET is pushed out of its linear range
- How drain resistor values affect gain
- How biasing shifts the Q-point and changes everything
- How small adjustments can make or break circuit performance

And most importantly, you'll test all of this live, using your oscilloscope and function generator to learn from real-time data.

PART 2: WHAT TO TRY OUT

Once you've built your basic amplifier circuit, don't stop there. Try things like:

- Increasing the **input signal amplitude** until the output starts to clip
- Changing the **frequency** to see where gain drops off
- Adjusting the **bias voltage** and watching the waveform shift
- Swapping resistor values to **maximize gain** without distortion

Each change teaches you something — if the output distorts, you've found the limit. If the gain drops, maybe parasitic effects are kicking in. You're not just observing — you're **interacting with the circuit** like an engineer in the field.

PART 3: WHAT TO WATCH FOR?

As you test and modify, watch for:

- **Clipping** at the peaks of the output wave
- **Phase inversion** (output is flipped compared to input)
- **Signal compression** when the transistor leaves the linear region
- **Gain variation** when component values are changed

These effects show you where the theory ends and the real world begins.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

PART 4: CALCULATE, THEN ADJUST

Yes, there's still math — but here, it's part of your toolkit:

- Measure gain:

$$A_V = \frac{V_{out(pp)}}{V_{in(pp)}}$$

- Predict theoretical gain:

$$A_V = -g_m \cdot R_D$$

Now compare! If the output gain doesn't match theory, that's your cue to experiment: is it loading? Is biasing off? Are parasitics distorting the signal?

Don't just solve — **explore, adapt, and refine.**

PART 5: CONCLUSION

This experiment is not about memorizing — it's about engaging, experimenting, and evolving. You are in control of the amplifier's performance, and every change you make teaches you something new.

As an activist learner, this is your space to learn by doing. Trust your instincts, challenge the limits, and let curiosity drive you. The theory is there to support you — but the discovery is yours to make.

Now, grab the probes, fire up the signal, and let's see what this amplifier can really do.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

LESSON PLAN

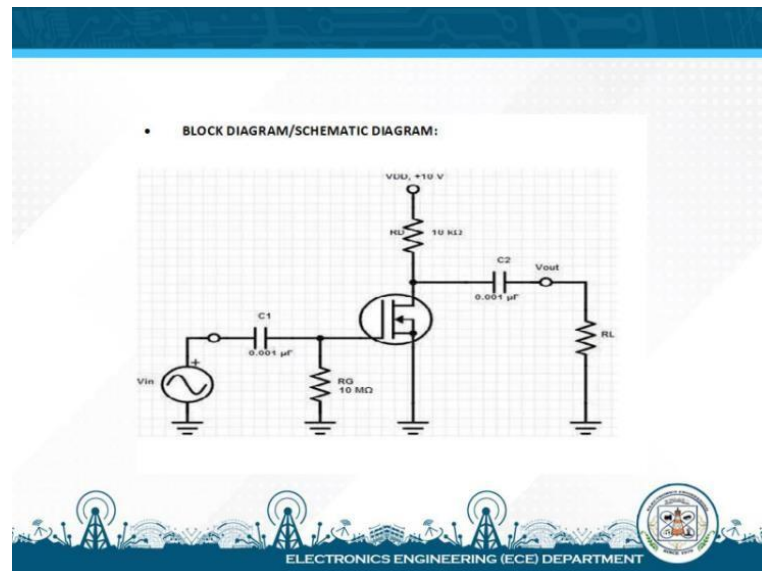
[Insert Module Basis/Pictures here/Reference Images/Lesson Plan]

EXPERIMENT NO:	6
EXPERIMENT TITLE:	Field Effect Transistor Amplifier

- OBJECTIVES:**
 1. To assemble a Field Effect Transistor Amplifier.
 2. To design a simple FET amplifier circuit.
 3. To know the effect Instantaneous Signal Voltage applied in the circuit.
 4. To compare measured values voltages and currents in terms of Gain with the computed gain using formulas based on theories.
 5. To draw a block diagram of measuring instruments connected to the circuits.
- Discussions:**

Field Effect Transistor (FET) is an amplifying device in which the output current depends on the input voltage. The FET Pre Amplifier described here is a sensitive and stable Preamp circuit using an N-Channel FET and a PNP Bipolar transistor. This combination gives high input impedance and low output impedance with stabilized gain. The three (3) FET Amplifier configurations are Common Source Amplifier Configuration, Common Gate Amplifier Configuration and Common Drain Amplifier Configuration.

ELECTRONICS ENGINEERING (ECE) DEPARTMENT



EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

MATERIALS:

- Transistor Trainer ITF05/Breadboard
- Field Effect Transistor
- Resistors
- Single Polarity Power Supply
- Oscilloscope
- Function Generator
- Connecting Wires

PROCEDURES:

1. Arbitrarily choose a sample Field Effect Transistor using Specification Sheet/ Transistor Manual based your analysis with given voltage of the circuit.
2. Assemble the given schematic diagram applying your chosen transistor.
3. Apply an AC signal from Function Generator to the input terminal of transistor.
4. Measure the input and output voltages using Oscilloscope.
5. Draw the waveform produced having two cycles that is Input versus Output Voltage. Take note of the Phase shift.
6. Compute the Voltage Gain using formulas learned from theory.
7. Compare the computed and measured gain.
8. Record on table.

ELECTRONICS ENGINEERING (ECE) DEPARTMENT

TABLES:

Parameters Vin Sine wave	V1 out 2 Cycles Measure d value.	V2 out 2 Cycles Compute d values.	Voltage Gain	
			Measure d values	Compute d values
5Vpp/20HZ				
10Vpp/500HZ				
12Vpp/1KHZ				
15Vpp/1.5KH Z				
20Vpp/20KHZ				
20VPP/200KH Z				
25Vpp/1MHZ				

Computations:

GRAPHS/Sketches:

OBSERVATION:

CONCLUSION:

ELECTRONICS ENGINEERING (ECE) DEPARTMENT

- **Converging (Pragmatist)**

- Pragmatists learn best through practical application of concepts and enjoy experimenting with new ideas to see if they work in real-life situations.
- Each objective and procedure is structured to allow learners to directly implement theoretical knowledge into hands-on activities. By assembling the circuit and observing results, pragmatists connect concept to outcome.

- **Diverging (Reflector)**

- Reflectors prefer to observe, gather information, and thoughtfully consider multiple perspectives before reaching conclusions.
- Objectives focus on observation and reflection, encouraging learners to analyze waveform changes and draw conclusions based on comparison and visualization. Procedures are designed to let them process data quietly and creatively.

EXPERIMENT 6: FIELD EFFECT TRANSISTOR AMPLIFIER

- **Assimilating (Theorist)**
 - Theorists thrive on understanding underlying principles and models. They prefer structured learning with logical explanations.
 - The objectives emphasize understanding the theory behind FET operation and amplifier design. Procedures involve formula derivation, simulation, and conceptual analysis, aligning with their preference for abstract and systematic learning.
- **Accommodating (Activist)**
 - Activists learn by doing. They enjoy new experiences, hands-on tasks, and challenges that allow active engagement.
 - Objectives promote direct involvement in the assembly and testing of circuits. The procedures offer open-ended exploration, allowing activists to tweak circuits, gather data, and immediately see the outcomes of their actions.

Additional References:

[1] Maam Noriega Module

[2] Vemuri, V. R., & Rao, K. A. (2024). Assessment of Learning Styles Using Kolb's Learning Style Inventory among Medical College Students: A Cross-sectional Study. JOURNAL OF CLINICAL AND DIAGNOSTIC RESEARCH. <https://doi.org/10.7860/jcdr/2024/67440.18987>

[3] Kolb, A. Y., & Kolb, D. A. (n.d.). THE KOLB LEARNING STYLE INVENTORY 4.0 A Comprehensive Guide to the Theory, Psychometrics, Research on Validity and Educational Applications. www.learningfromexperience.com

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