इलेक्ट्रॉनिक्स सर्किट प्रयोगशाला

Electronics Circuit Lab

(EC 217)

(बी टेक III सेमेस्टर / **B Tech III Semester**)

(प्रयोगशाला मैनुअल)

Lab Manual

(2024-25)

इलेक्ट्रॉनिक्स एवं संचार अभियांत्रिकी विभाग

Department of Electronics and Communication Engineering

मौलाना आजाद राष्ट्रीय प्रौद्योगिकी संस्थान, भोपाल- 462003
Maulana Azad National Institute of Technology Bhopal-462003

इलेक्ट्रॉनिक्स सर्किट प्रयोगशाला

Electronics Circuit Lab

(प्रयोगशाला मैनुअल)

Lab Manual

कार्यक्रम	:	प्रौद्योगिकी में स्नातक
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विशेषज्ञता	:	इलेक्ट्रॉनिक्स और संचार अभियांत्रिकी
Specialization	:	**Electronics and Communication Engineering**
सेमेस्टर	:	III
Semester	:	**III**
पाठ्यक्रम कोड	:	EC 217
Course Code	:	**EC 217**

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Department of Electronics and Communication Engineering

इलेक्ट्रॉनिक सर्किट प्रयोगशाला (EC-217)

Electronic Circuits Lab (EC-217)

प्रयोगों की सूची

List of Experiments

क्रमांक S.N.	प्रयोग Experiment	पृष्ठ संख्या Page No.
1	मल्टी-मीटर, डीएसओ (DSO), फ़ंक्शन जनरेटर और विद्युत आपूर्ति जैसे विभिन्न इलेक्ट्रॉनिक उपकरणों का अध्ययन Study of various electronic instruments such as multi-meter, DSO, function generator and power supply	
2	डीएसओ (DSO) पर साइन तरंग, वर्ग तरंग और त्रिकोणीय तरंग रूपों का निरीक्षण करना और तरंग रूपों के आयाम और आवृत्ति को मापना To observe sine wave, square wave and triangular waveforms on DSO and to measure amplitude and frequency of the waveforms	
3	PN संगम डायोड की अग्रिम और प्रतिलोम विशेषताओं का अध्ययन करें और कट-इन विद्युत दाब, ब्रेकडाउन विद्युत दाब और स्थैतिक प्रतिरोध तथा गतिशील प्रतिरोध का पता लगाएं Study the forward and reverse characteristics of the PN junction diode and find cut-in, voltage, breakdown voltage, and static and dynamic resistance	
4	अर्ध तरंग दिष्टकारी (हाफ-वेव रेक्टिफायर) परिपथ का अध्ययन करना और इसके तरंग कारक और दक्षता की गणना करना To study the half-wave rectifier circuit and calculate its ripple factor and efficiency	
5	पूर्ण तरंग दिष्टकारी (फुल वेव रेक्टिफायर) परिपथ का अध्ययन करना और इसके तरंग कारक और दक्षता की गणना करना To study the full wave rectifier circuit and calculate its ripple factor and efficiency	
6	जेनर डायोड की VI विशेषताएँ प्लॉट करें, तथा नीचे लिखे मापदंडों को मापें (i) प्रतिलोम पूर्वाग्रह स्थितियों में ब्रेकडाउन विद्युत दाब | (ii) अग्रिम और प्रतिलोम पूर्वाग्रह स्थितियों में स्थैतिक प्रतिरोध और गतिशील प्रतिरोध की गणना करें To plot VI characteristics of the Zener diode and determine (i) Breakdown voltage in reverse biased condition (ii) Calculate static resistance and dynamic resistance in both forward and reverse bias condition	
7	प्रयोविद्युत दाब नियामक के रूप में जेनर डायोड के संचालन का अध्ययन और निष्पादन करें Study and perform the operation of the Zener Diode as a voltage Regulator	
8	कॉमन एमिटर और कॉमन बेस मोड में ट्रांजिस्टर प्रवर्धक का अध्ययन करें Study of Transistor Amplifier in Common Emitter and Common Base mode	

9	विभिन्न पूर्वाग्रह तकनीक द्वारा बाइपोलर जंक्शन ट्रांजिस्टर (BJT) के विद्युत दाब के लाभ की गणना करें Calculate the voltage gain of the Bipolar Junction Transistor (BJT) by different biasing techniques	
10	प्रवर्धक के रूप में ट्रांजिस्टर की विशेषताओं का अध्ययन और प्रदर्शन करें Study and perform the characteristics of a Transistor as an Amplifier	
11	फ़ील्ड इफ़ेक्ट ट्रांजिस्टर (FET) की विशेषताओं का अध्ययन और आलेखन करें Study and plot the characteristics of the Field Effect Transistor	
12	फ़ील्ड इफ़ेक्ट ट्रांजिस्टर (FET) प्रवर्धक की विशेषताओं का अध्ययन और आलेखन करें Study and plot the characteristics of the FET Amplifier	
13	धातु-ऑक्साइड-अर्धचालक क्षेत्र-प्रभाव ट्रांजिस्टर (MOSFET) की विशेषताओं का अध्ययन और आलेखन करें Study and plot the characteristics of MOSFET	

अतिरिक्त जोड़े गए प्रयोग/ Additional Experiments Added

14	दिष्ट धारा (DC) को प्रत्यावर्ती धारा (AC) में परिवर्तित करने के लिए धातु-ऑक्साइड-अर्धचालक क्षेत्र-प्रभाव ट्रांजिस्टर (MOSFET) का उपयोग करके वोल्टेज इन्वर्टर को डिज़ाइन और कार्यान्वित करें। Design and implement a voltage inverter using a MOSFET to convert DC to AC.	
15	धातु-ऑक्साइड-अर्धचालक क्षेत्र-प्रभाव ट्रांजिस्टर (MOSFET) का उपयोग करके उच्च-आवृत्ति आरएफ एम्पलीफायर का डिज़ाइन, निर्माण और परीक्षण करें। इसके लाभ, बैंडविड्थ और स्थिरता विशेषताओं की जांच करें Design, build, and test a high-frequency RF amplifier using a MOSFET. Investigate its gain, bandwidth, and stability characteristics	

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	प्रयोग 1 Experiment 1		
विभाग **Department**	इलेक्ट्रॉनिक्स एवं संचार अभियांत्रिकी Electronics & Communication Engineering	**सत्र** **Session:**	2023-24
शिक्षक का नाम **Name of Teacher**	डॉ. राहुल कुमार चौरसिया Dr. Rahul Kumar Chaurasiya	**कार्यक्रम** **Program**	बी टेक B Tech
विषय **Subject**	इलेक्ट्रॉनिक सर्किट प्रयोगशाला (EC-217) Electronic Circuits Lab (EC-217)	**सेमेस्टर** **Semester**	III

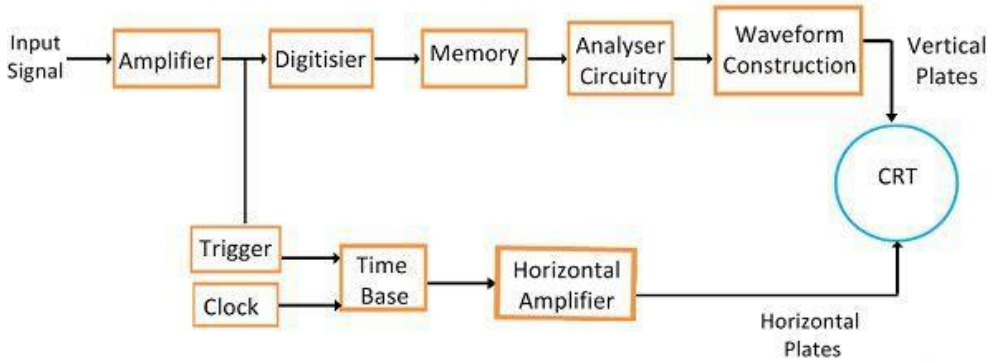
उद्देश्य: मल्टी-मीटर, डीएसओ (DSO), फ़ंक्शन जनरेटर और विद्युत आपूर्ति जैसे विभिन्न इलेक्ट्रॉनिक उपकरणों का अध्ययन

Objective: Study of various electronics instruments such as DSO, Function Generator, Power Supply and Multi-meter.

Theory:

DSO (Digital Storage Oscilloscope)

A **digital storage oscilloscope (DSO)** is an electronic instrument used to visualize and analyze electrical signals. It captures analog signals, converts them into digital form, and stores them in memory, allowing for detailed observation and measurement over time. In contrast to an analog oscilloscope, which uses a cathode ray tube (CRT) to display the signal, a DSO displays the signal on a digital screen, typically with higher resolution and more advanced features.



Functionality:

- **Signal capture:** Converts an analog signal into a digital representation using an Analog-to-Digital Converter (ADC).
- **Signal storage:** Stores the digital data in its memory, enabling viewing and analysis later.
- **Signal display:** Presents the stored signal on a digital screen with adjustable time and voltage scales.
- **Measurements:** Provides tools for measuring various parameters of the signal, such as amplitude, frequency, peak-to-peak voltage, and rise time.
- **Triggering:** Allows capturing specific portions of the signal based on predefined criteria, such as exceeding a certain voltage threshold.
- **Additional features:** Various advanced features may be available depending on the DSO model, such as waveform comparison, data export, and communication capabilities.

Benefits over analog oscilloscopes:

- **Higher resolution:** Provides clearer and more detailed signal visualization.
- **Waveform storage:** Enables reviewing and analyzing captured signals even after power off.
- **Advanced features:** Offers various functionalities for precise analysis and measurement.
- **Digital display:** Less prone to distortion and easier to share and document findings.

Choosing a DSO:

The selection of a suitable DSO depends on your specific needs and budget. Key factors to consider include:

- **Bandwidth:** Maximum frequency the DSO can accurately capture.
- **Sample rate:** Rate at which the signal is digitized, affecting detail and accuracy.
- **Number of channels:** Ability to visualize multiple signals simultaneously.
- **Memory size:** Determines the duration of the signal that can be captured and stored.

Components of a Digital Storage Oscilloscope:

There are 5 main components:

(i) Display (to visualize the electrical signal being measured)
(ii) Vertical input channel (to measure the amplitude of the signal)
(iii) Horizontal input channel (to measure the signal's frequency)
(iv) Trigger (to start and stop the measurement process)
(v) Analog to digital converter

DSO Operating Modes:

DSO has two operating modes

(i) Single-Shot (The oscilloscope acquires and stores one signal)

(ii) Repetitive (The oscilloscope continuously acquires and stores signals)

DSO Applications:

- **Electronics design and debugging:** Used to observe and troubleshoot circuit behaviour.
- **Signal analysis:** Employed in various fields like power electronics, communications, and signal processing.
- **Educational and research labs:** Provides a valuable tool for understanding and demonstrating electrical phenomena.

Function Generator

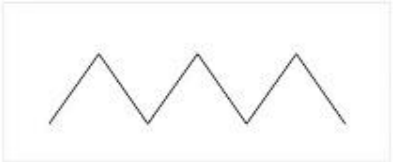
A **function generator** is a piece of electronic equipment used to generate various types of electrical waveforms over a wide range of frequencies. These waveforms can be essential for testing circuits, analyzing electronic systems, and calibrating instruments.

Common waveforms generated by function generators include:

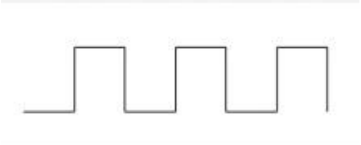
- **Sine waves:** Fundamental wave form with smooth, oscillating pattern.
- **Square waves:** Waveform with abrupt transitions between high and low voltage levels.
- **Triangle waves:** Ramp-like waveform with gradual slopes.
- **Sawtooth waves:** Similar to triangle waves but with a sharp drop at the end of each cycle.

Sine Wave

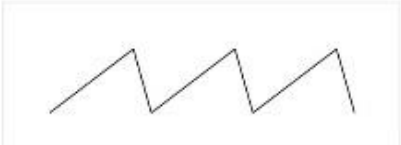
Triangular wave



Square Wave



Sawtooth Wave



Function Generator capabilities:

Function generators offer various features like adjustable amplitude, frequency, and offset, allowing fine control over the generated waveforms. Some advanced models might also generate more complex waveforms or offer digital modulation capabilities.

Function Generator Applications:

Function generators are normally used within the electronics development manufacturing test and service department.

- Circuit testing and debugging: Simulating various signals to test circuit functionality and identify issues.
- Component characterization: Measuring parameters like frequency response and gain of electronic components.
- Signal generation for calibration: Providing reference signals for calibrating instruments and sensors.
- Prototype development: Simulating real-world signals to test prototype circuits and systems

Power Supply

A DC power supply is a laboratory instrument that converts alternating current (AC) from the mains into a stable direct current (DC) voltage. It provides **regulated** and adjustable DC power to electronic circuits and devices, essential for testing, prototyping, and powering various equipment in electrical and electronics labs.

Functions:

- **Voltage Conversion:** Transforms AC voltage from the mains (typically 120V or 230V) into a desired DC voltage level.
- **Voltage Regulation:** Maintains the output voltage at a constant level despite fluctuations in the input voltage or changes in the load current. This ensures stable operation of powered devices.
- **Current Limiting:** Provides adjustable current limiting to protect devices from being damaged by excessive current draw.
- **Metering:** Most DC power supplies have displays or meters to monitor output voltage and current, enabling accurate adjustment and monitoring of performance.

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Types of power supply:

- **DC power supplies -**

(i) Linear power supply
(ii) Switched-mode power supply

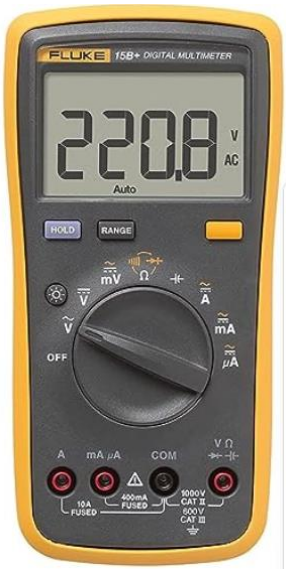
(iii) Capacitive power supply
(iv) Linear regulator

- **AC power supplies-**

(i) AC adapter
(ii) Programmable power supply
(iii) Uninterruptible power supply
(iv) High voltage power supply
(v) Bipolar power supply

Digital Multimeter

A digital multimeter (DMM) is a versatile tool used for measuring various electrical properties in both **direct current (DC)** and **alternating current (AC)** circuits. It combines the functions of several individual instruments like a voltmeter, ammeter, and ohmmeter into a single, compact unit. Unlike its analog counterpart, the DMM displays measurements digitally, offering better accuracy and readability.



Basic Functions:

- **Voltage measurement:** Measures the potential difference (voltage) between two points in a circuit, displayed in units like volts (V).
- **Current measurement:** Measures the flow of electrical charge (current) through a conductor, displayed in units like amperes (A).
- **Resistance measurement:** Measures the opposition to current flow in a conductor, displayed in units like ohms (Ω).
- **Frequency measurement:** Measures the rate of change of a periodic electrical signal, displayed in units like Hertz (Hz).
- **Capacitance measurement:** Measures the ability of a component to store electrical charge, displayed in units like Farads (F).
- **Diode testing:** Determines whether a diode is functioning properly by checking its forward and reverse voltage characteristics.
- **Continuity testing:** Checks for a complete electrical pathway between two points.

- **Temperature measurement:** Some DMMs offer temperature measurement with appropriate probes.

Benefits of using a DMM:

- **Versatility:** Measures multiple electrical properties with one tool.
- **Accuracy:** Provides digital readings with higher accuracy than analog meters.
- **Ease of use:** Simple to operate with clear displays and intuitive controls.
- **Portability:** Compact size makes it convenient for various applications.
- **Safety:** Most DMMs offer features like overload protection and fuse protection.

Applications of a DMM:

- **Electronics repair and troubleshooting:** Identifying issues in circuits by measuring voltages, currents, and resistances. Verifying proper wiring and component functionality
- **Hobby projects and DIY:** Building and testing electronic circuits.
- **Educational and research purposes:** Performing measurements in labs and experiments.
- **Industrial applications:** Testing and maintaining equipment in various industries.

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	प्रयोग 2 **Experiment 2**		
विभाग **Department**	इलेक्ट्रॉनिक्स एवं संचार अभियांत्रिकी Electronics & Communication Engineering	**सत्र** **Session:**	2023-24
शिक्षक का नाम **Name of Teacher**	डॉ. राहुल कुमार चौरसिया Dr. Rahul Kumar Chaurasiya	**कार्यक्रम** **Program**	बी टेक B Tech
विषय **Subject**	इलेक्ट्रॉनिक सर्किट प्रयोगशाला (EC-217) Electronic Circuits Lab (EC-217)	**सेमेस्टर** **Semester**	III

उद्देश्य: डीएसओ (DSO) पर साइन तरंग, वर्ग तरंग और त्रिकोणीय तरंग रूपों का निरीक्षण करना और तरंग रूपों के आयाम और आवृत्ति को मापना

Objective: To observe sine wave, square wave and triangular waveforms on DSO and to measure amplitude and frequency of the waveforms

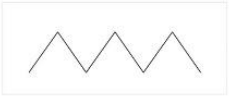
Components and Equipment Required:

1. DSO
2. Function Generator
3. BNC Leads

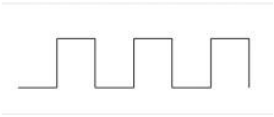
Theory:

Sine Wave

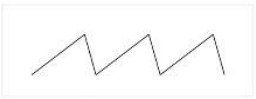
Triangular wave



Square Wave



Sawtooth Wave



Setup of Equipment's:

- Power on both the function generator and the DSO.
- Connect the function generator's output to the DSO's input using appropriate cables and probes (BNC Leads). Ensure proper grounding connectivity. (workbench available has internal grounding)
- Set the DSO's input impedance to match the function generator's output impedance. (workbench available already has impedance matched internally)

Function Generator Settings:

- **Choose the desired waveform:** Sine, square, triangle, sawtooth, or arbitrary.
- **Set the frequency:** Start with a moderate frequency (e.g., 1 kHz) and adjust later.

- **Set the amplitude:** Choose a voltage level suitable for your DSO's input range (e.g., $1V_{PP}$).
- **Adjust the DC offset:** Set it to 0V initially unless intended for specific applications.
- **Adjust the Similarity:** vary its value for getting the triangular and sawtooth wave from ramp settings.

DSO Settings:

- **Set the time base:** Adjust the timescale to display multiple cycles of the waveform clearly. Start with a slower sweep speed (e.g., 1ms/div) and adjust as needed.
- **Set the vertical scale:** Adjust the voltage scale to clearly visualize the waveform within the display. Start with a wider scale and zoom in later.
- **Triggering:** Set the trigger mode to capture stable waveform display. Common modes are automatic or edge trigger on the rising or falling edge of the signal.

Observation and Adjustments:

- **Observe** the waveform on the DSO display.
- **Adjust the function generator settings** (frequency, amplitude, offset) and observe the changes on the DSO. Adjust DSO settings (time base, vertical scale) as needed to maintain clear visualization.
- **Frequency variation:** Slowly modify the frequency and observe how the waveform changes (period, phase shift, etc.).
- **Amplitude variation:** Adjust the amplitude and observe how it affects the signal strength on the DSO.
- **Duty cycle variation** (for square waves): If available on your function generator, adjust the duty cycle and observe how the pulse width changes relative to the period.

Function	Input Parameters (volt/ freq duty cycle/ similarity index)	Vertical Division (a)	Volt/div (b)	Amplitude V_{PP} (a*b)	Horizontal Division (c)	Time/div (d)	Time T (c*d)	Freq. f (1/T)	Error (%)		Remark
									V_{PP}	f	
Sine Wave											
Square Wave											
Triangular wave											
Sawtooth Wave											

Conclusion: (to be written by student)

Precautions when using Function Generators and DSOs in the Lab:

Some essential precautions to remember when working with function generators and digital storage oscilloscopes (DSOs) in a laboratory setting

- Identify and follow proper grounding procedures to prevent electrical shock.
- Be aware of the voltage and current limitations of your equipment and do not exceed them (including maximum output voltage and current).

- Set output amplitude and offset within safe limits for connected devices.
- Never touch exposed electrical components (function generator's output terminals or DSO probes) while equipment is powered on.
- Do not connect or disconnect probes while the equipment is powered on.
- Keep the work area clean and organized to prevent accidents and report any observed hazards or malfunctions to your instructor immediately.

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	प्रयोग 3 **Experiment 3**		
विभाग **Department**	इलेक्ट्रॉनिक्स एवं संचार अभियांत्रिकी Electronics & Communication Engineering	**सत्र** **Session:**	2023-24
शिक्षक का नाम **Name of Teacher**	डॉ. राहुल कुमार चौरसिया Dr. Rahul Kumar Chaurasiya	**कार्यक्रम** **Program**	बी टेक B Tech
विषय **Subject**	इलेक्ट्रॉनिक सर्किट प्रयोगशाला (EC-217) Electronic Circuits Lab (EC-217)	**सेमेस्टर** **Semester**	III

उद्देश्य: PN संगम डायोड की अग्रिम और प्रतिलोम विशेषताओं का अध्ययन करें और कट-इन विद्युत दाब, ब्रेकडाउन विद्युत दाब और स्थैतिक प्रतिरोध तथा गतिशील प्रतिरोध का पता लगाएं

Objective: Study the forward and reverse characteristics of the PN junction diode and find cut-in, voltage, breakdown voltage, and static and dynamic resistance

Components and Equipment Required:

1. DC power supply with variable voltage output (0-30V)
2. Digital multimeter (DMM)
3. PN junction diode (e.g., 1N4001)
4. Resistor (e.g., 1kΩ, multiple values)
5. Breadboard and connecting wires

Diode and Characteristics:

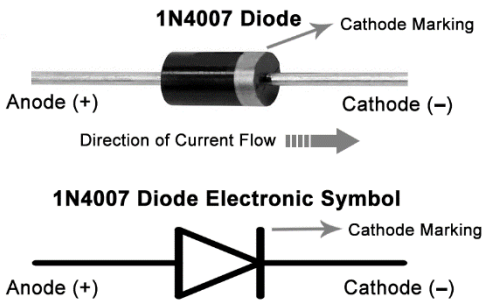

Fig 2. 1 Diode symbol and pins

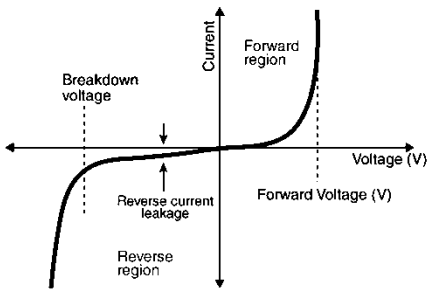

Fig 2. 2 Forward and Reverse Characteristics of the P-N Junction Diode

Procedure:

Forward Bias:

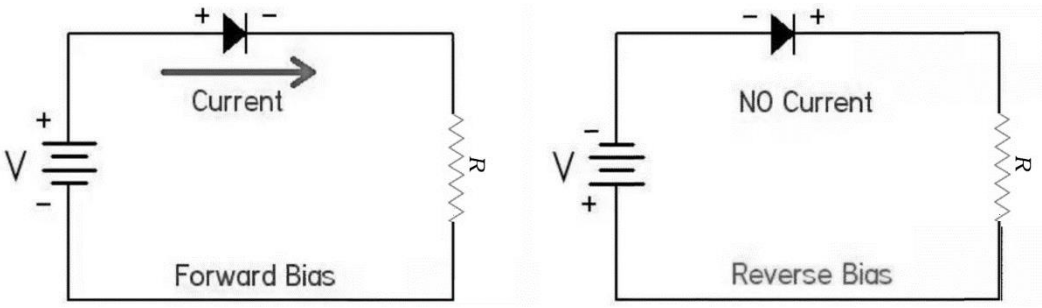

Fig 2. 3 Forward and Reverse Bias Circuits for the P-N Junction Diode

1. Connect the positive terminal of the power supply to the anode of the diode (usually identified by a band on the body).
2. Connect the cathode of the diode to the positive terminal of the DMM through the resistor.
3. Connect the negative terminal of the DMM and the negative terminal of the power supply to ground (common connection point).
4. Set the power supply voltage to 0V and gradually increase it in steps of 0.1V.
5. Record the voltage across the load resistor R (V_R) using the DMM for each voltage step.
6. Calculate the voltage drop across the diode $V_D = V - V_R$
7. Calculate the current through the diode (I_D) using Ohm's Law: $I_D = V_D / R$.
8. Continue recording V_D and calculating I_D until the current reaches a value close to the maximum specified diode current rating.

Reverse Bias:

1. Reverse the connections of the diode, connecting the anode to the negative terminal of the power supply and the cathode to the positive terminal of the DMM.
2. Set the power supply voltage to 0V and gradually increase it in steps of 0.1V, but stop well before reaching the breakdown voltage (typically indicated in the diode datasheet).
3. Record the voltage across the diode (V_D) using the DMM for each voltage step.
4. The current through the diode in reverse bias is very small and usually negligible.

Observation and Calculations:

Prepare graphical representation on graph paper

1. Plot the forward and reverse I-V characteristics of the diode, with voltage (V) on the x-axis and current (I) on the y-axis.
2. Determine the cut-in voltage ($V_{cut\text{-}in}$) from the forward characteristic as the voltage where the current starts to increase significantly.
3. Identify the breakdown voltage (V_{break}) from the reverse characteristic as the voltage where the current starts to increase rapidly.
4. Calculate the static resistance (Rs) in the forward bias region at a specific voltage (e.g., 1V) using the formula: $Rs = V_D / I_D$.
5. Calculate the dynamic resistance (R_d) in the forward bias region at a specific voltage (e.g., 1V) by calculating the slope of the I-V curve. Use graphical methods to calculate the slope $R_d = \Delta V/\Delta I$.

Resistance (R): note the value of resistance used (approx. 1kΩ).

S.No.	V_{in}	V_R	$V_D = V_{in} - V_R$	$I_D = V_D / R$	$R_S = V_D / I_D$	$R_d = \Delta V/\Delta I$

Conclusion: (to be written by student)

Precautions when working with electrical components in the Lab

Some essential precautions to remember when working with electrical components

- Identify and follow proper grounding procedures to prevent electrical shock.
- Never connect, disconnect probes or touch exposed electrical components (connecting wires or DSO probes) while equipment is powered on.
- Consult diode datasheets for specifications: Know its maximum forward and reverse voltage and current ratings.
- Consider thermal dissipation: Diodes may heat up when conducting current for prolonged times.
- Beware of polarity: Connect the diode correctly. Reverse connection can damage the diode
- Start with low values: Initially, power the circuit with lower voltages and gradually increase while monitoring current and temperature.
- Disconnect power quickly in case of faults: Be prepared to react quickly and disconnect power if excessive current, smoke, or unusual behavior is observed.
- Keep the work area clean and organized to prevent accidents and report any observed hazards or malfunctions to your instructor immediately.

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	प्रयोग 4 **Experiment 4**		
विभाग **Department**	इलेक्ट्रॉनिक्स एवं संचार अभियांत्रिकी Electronics & Communication Engineering	**सत्र** **Session:**	2023-24
शिक्षक का नाम **Name of Teacher**	डॉ. राहुल कुमार चौरसिया Dr. Rahul Kumar Chaurasiya	**कार्यक्रम** **Program**	बी टेक B Tech
विषय **Subject**	इलेक्ट्रॉनिक सर्किट प्रयोगशाला (EC-217) Electronic Circuits Lab (EC-217)	**सेमेस्टर** **Semester**	III

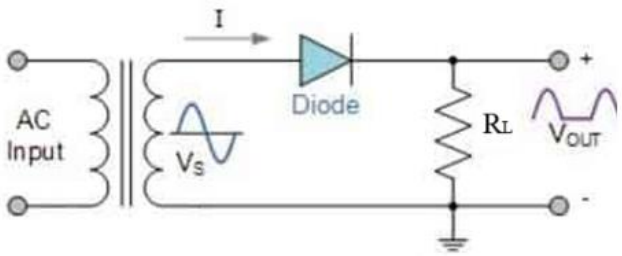
उद्देश्य: PN अर्ध तरंग दिष्टकारी (हाफ-वेव रेक्टिफायर) परिपथ का अध्ययन करना और इसके तरंग कारक और दक्षता की गणना करना

Objective: To study the half-wave rectifier circuit and calculate its ripple factor and efficiency

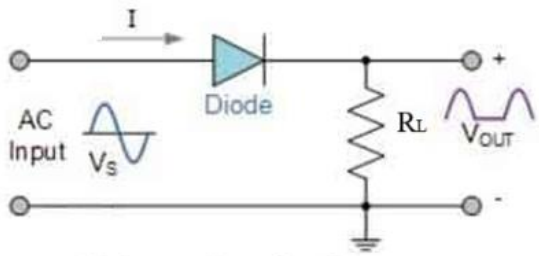
Components and Equipment Required:

1. Transformer (suitable voltage and power rating for desired output)
2. Digital multimeter (DMM)
3. Digital Storage Oscilloscope (DSO)
4. PN junction diode (1N4007)
5. Resistor (e.g., 1kΩ, multiple values)
6. Breadboard and connecting wires
7. Graph paper for plotting

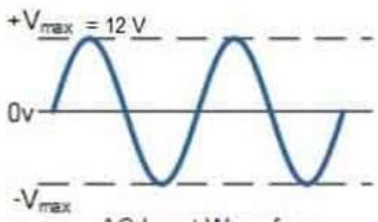
Circuit Diagram:



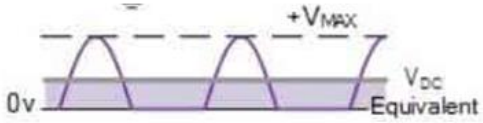
AC Source: Step-down Transformer



AC Source: Function Generator



AC Input Waveform



Resultant Output Waveform

Procedure:

1. Connect the transformer's primary side to the AC mains supply.
2. On the secondary side, connect the transformer output to a diode in series with the resistor, or from Function Generator. Ensure correct diode polarity (anode to transformer output, cathode to resistor).
3. Connect the resistor's other end to ground.
4. Measure the DC voltage across the resistor using the DMM. Record the value.
5. Use the DSO to measure the peak-to-peak value of the ripple voltage on the output waveform.

Observation and Calculations:

Trace graphical representation from DSO screen on graph paper and use Measure function to record the values.

1. DC Voltage: Measure the DC voltage across the resistor (V_{dc}) using the DMM. Record the value.
2. Ripple Factor: Use the DSO to measure the peak-to-peak value of the ripple voltage (Vrms) on the output waveform.
3. Calculate the ripple factor (R_F) using the formula: $R_F = \sqrt{(\frac{Vrms}{Vdc})^2 - 1}$

   When using transformer

4. Measure the AC voltage at the transformer's secondary terminals (V_{ac}) using the DMM.
5. Calculate the input power (P_{in}) using the formula: $P_{in} = (V_{ac}\text{^}2) / R_T$, where R_T is the transformer's secondary side resistance.
6. Calculate the output power (P_{out}) using the formula: $P_{out} = (V_{dc}\text{^}2) / R_L$, where R_L is the load resistor value.
7. Calculate the efficiency (η) using the formula: η = (Pout / Pin) * 100%.
8. Repeat steps 2 and 3 for different load resistor values.

S.No.	R_L	R_T	V_{dc}	V_{rms}	V_{ac}	P_{in}	P_{out}	η	R_F

Conclusion: (to be written by student)

Trace the AC input and measured DC voltage from DSO screen on graph paper

Precautions when working with electrical components in the Lab

Some essential precautions to remember when working with electrical components

- Identify and follow proper grounding procedures to prevent electrical shock.

- Never connect, disconnect probes or touch exposed electrical components (transformer, connecting wires or DSO probes) while equipment is powered on.
- Consult transformer and diode datasheets for specifications: Know its maximum forward and reverse voltage and current ratings.
- Consider thermal dissipation: Transformer and Diodes may heat up when conducting current for prolonged times.
- Beware of equipment's polarity
- Disconnect power quickly in case of faults: Be prepared to react quickly and disconnect power if excessive current, smoke, or unusual behavior is observed.
- Keep the work area clean and organized to prevent accidents and report any observed hazards or malfunctions to your instructor immediately.

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	प्रयोग 5 **Experiment 5**		
विभाग **Department**	इलेक्ट्रॉनिक्स एवं संचार अभियांत्रिकी Electronics & Communication Engineering	**सत्र** **Session:**	2023-24
शिक्षक का नाम **Name of Teacher**	डॉ. राहुल कुमार चौरसिया Dr. Rahul Kumar Chaurasiya	**कार्यक्रम** **Program**	बी टेक B Tech
विषय **Subject**	इलेक्ट्रॉनिक सर्किट प्रयोगशाला (EC-217) Electronic Circuits Lab (EC-217)	**सेमेस्टर** **Semester**	III

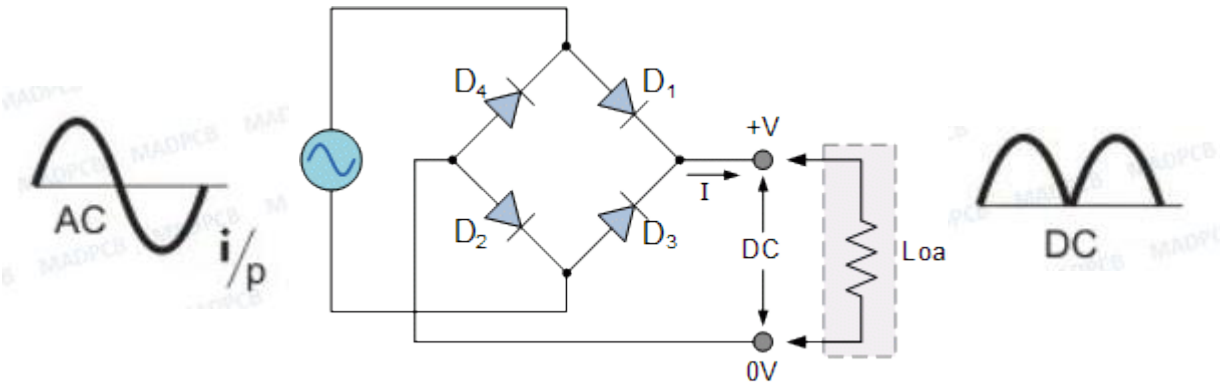
उद्देश्य: पूर्ण तरंग दिष्टकारी (फुल वेव रेक्टिफायर) परिपथ का अध्ययन करना और इसके तरंग कारक और दक्षता की गणना करना

Objective: To study the full wave rectifier circuit and calculate its ripple factor and efficiency

Components and Equipment Required:

1. Transformer (suitable voltage and power rating for desired output)
2. Digital multimeter (DMM)
3. Digital Storage Oscilloscope (DSO)
4. PN junction diode (1N4007)
5. Resistor (e.g., 1kΩ, multiple values)
6. Breadboard and connecting wires
7. Graph paper for plotting

Circuit Diagram:



Procedure:

1. Connect the transformer's primary side to the AC mains supply.
2. On the secondary side, connect the transformer output to the AC terminals of the bridge rectifier module.
3. Connect the DC output terminals of the bridge rectifier to the resistor in series.

4. Connect the resistor's other end to ground.
5. Connect the positive terminal of the DMM to the resistor's junction with the bridge rectifier, and the negative terminal to ground. This measures the rectified output voltage.
6. Connect the DSO probes to the resistor's junction with the bridge rectifier and ground to observe the output waveform.

Observation and Calculations:

Trace graphical representation from DSO screen on graph paper

1. **DC Voltage:** Measure the DC voltage across the resistor (V_{dc}) using the DMM.
2. **Ripple Factor:** Use the DSO to measure the peak-to-peak value of the ripple voltage (V_{rms}) on the output waveform.
3. Calculate the ripple factor (R_F) using the formula: $R_F = \sqrt{\left(\frac{Vrms}{Vdc}\right)^2 - 1}$
4. Measure the AC voltage at the transformer's secondary terminals (V_{ac}) using the DMM.
5. Calculate the input power (P_{in}) using the formula: $P_{in} = (V_{ac}\text{^}2) / R$, where R is the transformer's secondary side resistance.
6. Calculate the output power (P_{out}) using the formula: $P_{out} = V_{dc}\text{^}2 / R$, where R is the load resistor value.
7. Calculate the efficiency (η) using the formula: $\eta = (P_{out} / P_{in}) * 100\%. = (V_{ac} / V_{dc})\text{^}2$
8. Repeat steps 2 and 3 for different load resistor values.

S.No.	R_L	R_T	V_{dc}	V_{rms}	V_{ac}	P_{in}	P_{out}	η	R_F

Conclusion: (to be written by student)

Trace the AC input and measured DC voltage from DSO screen on graph paper

Precautions when working with electrical components in the Lab

Some essential precautions to remember when working with electrical components

- Identify and follow proper grounding procedures to prevent electrical shock.
- Never connect, disconnect probes or touch exposed electrical components (transformer, connecting wires or DSO probes) while equipment is powered on.
- Consult transformer and diode datasheets for specifications: Know its maximum forward and reverse voltage and current ratings.
- Consider thermal dissipation: Transformer and Diodes may heat up when conducting current for prolonged times.
- Beware of equipment’s polarity
- Disconnect power quickly in case of faults: Be prepared to react quickly and disconnect power if excessive current, smoke, or unusual behavior is observed.

- Keep the work area clean and organized to prevent accidents and report any observed hazards or malfunctions to your instructor immediately.

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	प्रयोग 6 **Experiment 6**		
विभाग **Department**	इलेक्ट्रॉनिक्स एवं संचार अभियांत्रिकी Electronics & Communication Engineering	**सत्र** **Session:**	2023-24
शिक्षक का नाम **Name of Teacher**	डॉ. राहुल कुमार चौरसिया Dr. Rahul Kumar Chaurasiya	**कार्यक्रम** **Program**	बी टेक B Tech
विषय **Subject**	इलेक्ट्रॉनिक सर्किट प्रयोगशाला (EC-217) Electronic Circuits Lab (EC-217)	**सेमेस्टर** **Semester**	III

उद्देश्य: जेनर डायोड की VI विशेषताएँ प्लॉट करें, तथा नीचे लिखे मापदंडों को मापें

(i) प्रतिलोम पूर्वाग्रह स्थितियों में ब्रेकडाउन विद्युत दाब |

(ii) अग्रिम और प्रतिलोम पूर्वाग्रह स्थितियों में स्थैतिक प्रतिरोध और गतिशील प्रतिरोध की गणना करें

Objective: To plot VI characteristics of the Zener diode and determine

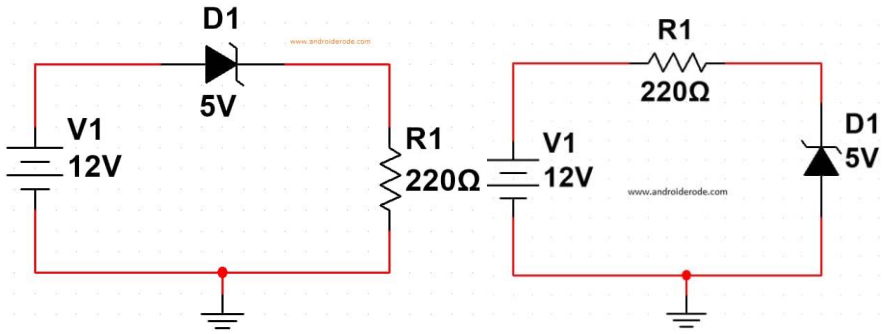
(i) Breakdown voltage in reverse biased condition

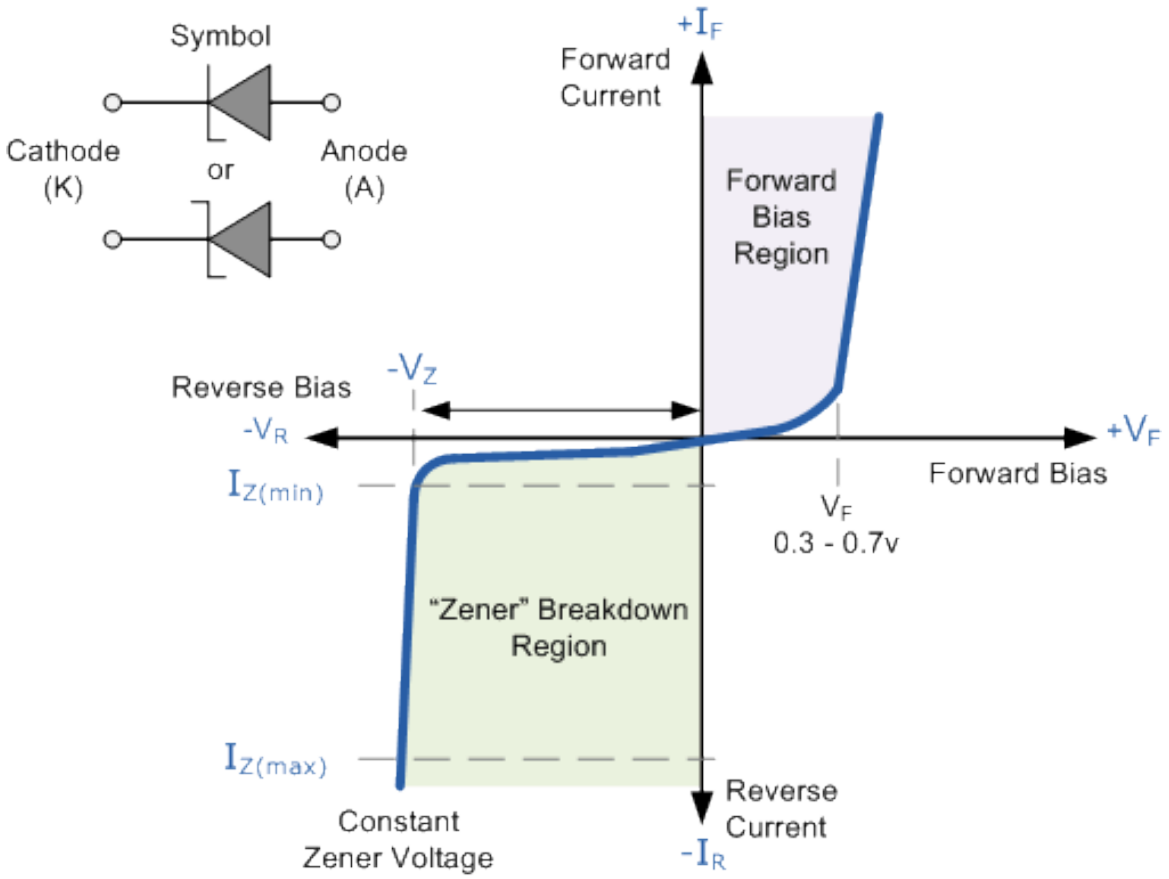
(ii) Calculate static resistance and dynamic resistance in both forward and reverse bias condition

Components and Equipment Required:

1. Zener diode
2. DC power supply with variable voltage output
3. Multimeter
4. Resistor (very small value just fir limiting the current)
5. Breadboard and Connecting wires
6. Graph paper for plotting

Circuit Diagram:





Procedure:

Forward Bias:

1. Connect the Zener diode in forward bias (anode to positive terminal, cathode to negative terminal) on the breadboard.
2. Connect a series resistor with the Zener diode to limit current.
3. Connect the resistor-diode combination to the DC power supply with the positive terminal to the anode and the negative terminal to the cathode.
4. Set the power supply voltage to 0V and gradually increase it in steps of 0.1V.
5. At each voltage step, measure and record in table the voltage across the diode (V_D) and the current through the circuit (I) using the multimeter.
6. Repeat steps 4-6 until the current reaches a predetermined limit (e.g., 20mA).

Reverse Bias:

1. Reverse the connections of the Zener diode on the breadboard (anode to negative terminal, cathode to positive terminal).
2. Set the power supply voltage to 0V and gradually increase it in steps of 0.1V.
3. Continue increasing the voltage until the current through the circuit starts to increase rapidly, indicating breakdown.
4. Record the voltage at which breakdown occurs as the breakdown voltage (V_Z).
5. **Do not exceed the current rating of the Zener diode during reverse bias**.

Observation and Calculations:

Trace graphical representation from DSO screen on graph paper

1. Plot the measured V_D and I values for forward and reverse bias on a graph (V_D on the x-axis, I on the y-axis).
2. Calculate the static resistance (Rs) in the forward bias region using the formula: $Rs = V_D / I$ for several points on the graph.
3. Calculate the dynamic resistance (Rd) in the reverse bias region using the formula: $Rd = \Delta V_D / \Delta I$ for a small section of the graph near the breakdown voltage.
4. Repeat the experiment with **different Zener diodes** to compare their characteristics

S.No.	V_D	V_{RL}	$I = V_{RL} * R_L$	$R_S = V_D / I_D$	$R_d = \Delta V_D / \Delta I$
*Observation table to be made for both bias conditions separately					

Conclusion: (to be written by student)

- Discuss the characteristics of the curves obtained for both forward and reverse bias.
- Explain the concept of breakdown voltage and its importance in Zener diode applications

Precautions when working with electrical components in the Lab

Some essential precautions to remember when working with electrical components

- Identify and follow proper grounding procedures to prevent electrical shock.
- Never connect, disconnect probes or touch exposed electrical components (connecting wires) while equipment is powered on.
- Consult diode datasheets for specifications: Know its maximum forward and reverse voltage and current ratings.
- Consider thermal dissipation: diodes may heat up when conducting current for prolonged times.
- Beware of equipment's polarity
- Disconnect power quickly in case of faults: Be prepared to react quickly and disconnect power if excessive current, smoke, or unusual behavior is observed.
- Keep the work area clean and organized to prevent accidents and report any observed hazards or malfunctions to your instructor immediately.

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	प्रयोग 7 **Experiment 7**		
विभाग **Department**	इलेक्ट्रॉनिक्स एवं संचार अभियांत्रिकी Electronics & Communication Engineering	**सत्र** **Session:**	2023-24
शिक्षक का नाम **Name of Teacher**	डॉ. राहुल कुमार चौरसिया Dr. Rahul Kumar Chaurasiya	**कार्यक्रम** **Program**	बी टेक B Tech
विषय **Subject**	इलेक्ट्रॉनिक सर्किट प्रयोगशाला (EC-217) Electronic Circuits Lab (EC-217)	**सेमेस्टर** **Semester**	III

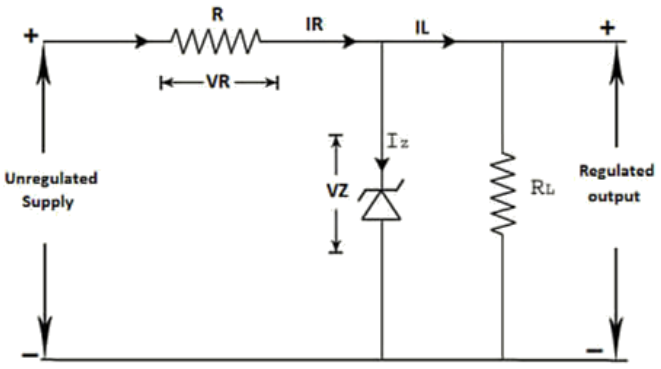
उद्देश्य: प्रयोविद्युत दाब नियामक के रूप में जेनर डायोड के संचालन का अध्ययन और निष्पादन करें

Objective: Study and perform the operation of the Zener Diode as a voltage Regulator

Components and Equipment Required:

1. Zener diode
2. DC power supply with variable voltage output
3. Multimeter
4. Variable Load Resistor
5. Breadboard and Connecting wires

Circuit Diagram:



Procedure:

1. Select a Zener diode with a breakdown voltage slightly higher than the desired regulated output voltage.
2. Calculate the series resistor value using the formula: Rs = (Vin - Vz) / Iz, where Vin is the minimum expected input voltage, Vz is the Zener diode breakdown voltage, and Iz is the minimum desired current through the diode (refer to datasheet).
3. Build the voltage regulator circuit on the breadboard:

a. Connect the Zener diode in reverse bias with the anode towards the positive terminal and cathode towards the load resistor.
b. Connect the series resistor in series with the Zener diode and the power supply input.
c. Connect the load resistor across the output terminals (Zener diode cathode and ground).

Observation and Calculations:

1. Set the DC power supply to a voltage slightly higher than the Zener diode breakdown voltage.
2. Measure the output voltage (Vo) across the load resistor using the multimeter. Record the value.
3. Gradually increase the load resistance (if variable) in steps and measure the corresponding output voltage for each step.
4. Maintain the input voltage constant throughout this measurement.
5. Repeat steps 3 and 4 for different input voltages, covering a range around the expected operating range
6. Plot the measured output voltage as a function of the load resistance for each input voltage.
7. Calculate the voltage regulation percentage using the formula: Regulation (%) = [(Vin - Vo) / Vin] * 100%, where Vin is the input voltage and Vo is the output voltage.
8. Plot the calculated regulation percentage as a function of the load resistance for each input voltage.
9. Compare the theoretical regulation percentage calculated from the Zener diode specifications with the experimental values.
10. Calculate the power dissipated by the Zener diode and series resistor at different load and input voltage conditions.

S.No.	V_{in} = value 1			
	R_L	V_o	Regulation (%) Theoretical	Regulation (%) Actual

Conclusion: (to be written by student)

- Discuss the power dissipated by the Zener diode and series resistor at different load and input voltage conditions

Precautions when working with electrical components in the Lab

Some essential precautions to remember when working with electrical components

- Identify and follow proper grounding procedures to prevent electrical shock.
- Never connect, disconnect probes or touch exposed electrical components (connecting wires) while equipment is powered on.
- Consult diode datasheets for specifications: Know its maximum forward and reverse voltage and current ratings.
- Consider thermal dissipation: diodes may heat up when conducting current for prolonged times.
- Beware of equipment's polarity

- Disconnect power quickly in case of faults: Be prepared to react quickly and disconnect power if excessive current, smoke, or unusual behavior is observed.
- Keep the work area clean and organized to prevent accidents and report any observed hazards or malfunctions to your instructor immediately.

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	प्रयोग 8 **Experiment 8**		
विभाग **Department**	इलेक्ट्रॉनिक्स एवं संचार अभियांत्रिकी Electronics & Communication Engineering	**सत्र** **Session:**	2023-24
शिक्षक का नाम **Name of Teacher**	डॉ. राहुल कुमार चौरसिया Dr. Rahul Kumar Chaurasiya	**कार्यक्रम** **Program**	बी टेक B Tech
विषय **Subject**	इलेक्ट्रॉनिक सर्किट प्रयोगशाला (EC-217) Electronic Circuits Lab (EC-217)	**सेमेस्टर** **Semester**	III

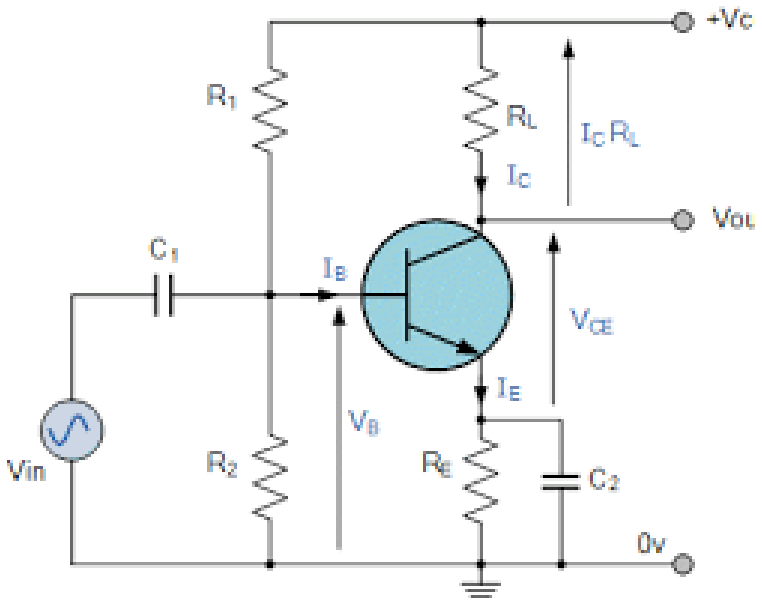
उद्देश्य: कॉमन एमिटर और कॉमन बेस मोड में ट्रांजिस्टर प्रवर्धक का अध्ययन करें

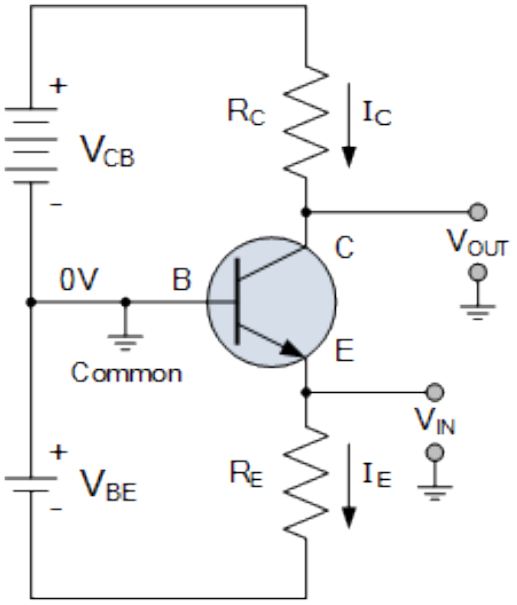
Objective: Study of Transistor Amplifier in Common Emitter and Common Base mode

Components and Equipment Required:

1. NPN transistor (e.g., BC547)
2. DC power supply with variable voltage output
3. Multimeter
4. Variable Load Resistor
5. Breadboard and Connecting wires

Circuit Diagram:





Procedure:

Common Emitter (CE):

1. Build the CE amplifier circuit on the breadboard, following the diagram.
2. Choose appropriate resistor values for biasing the transistor in the active region (refer to transistor datasheet).
3. Connect the DC power supply to the circuit, ensuring correct polarity.
4. Connect the signal generator to the input (base) and the oscilloscope to the output (collector).
5. Apply a small AC signal (e.g., 1 kHz, 10mV) from the signal generator and observe the amplified output on the oscilloscope.
6. Measure the voltage gain using the formula: Av = Vo / Vin, where Vo is the peak-to-peak output voltage and Vin is the peak-to-peak input voltage.
7. Measure the input impedance (Zin) using an AC impedance meter (if available) or by injecting a small AC current and measuring the resulting voltage drop across the input resistor.
8. Measure the output impedance (Zout) using an AC impedance meter or by injecting a small AC current into the output and measuring the resulting voltage drop.

Common Base (CB):

1. Build the CB amplifier circuit on the breadboard, following the diagram.
2. Choose appropriate resistor values for biasing as in the CE configuration.
3. Connect the DC power supply and signal generator/oscilloscope as before.
4. Apply a small AC signal and measure the voltage gain, input impedance, and output impedance following the same procedure as in the CE configuration.

Observation and Calculations:

Compare the measured voltage gain, input impedance, and output impedance for both CE and CB configurations.

S.No.	Vin	Vo	Av	Zin	Zout

Conclusion: (to be written by student)

Discuss the advantages and disadvantages of each configuration based on the obtained results

Precautions when working with electrical components in the Lab

Some essential precautions to remember when working with electrical components

- Identify and follow proper grounding procedures to prevent electrical shock.
- Never connect, disconnect probes or touch exposed electrical components while equipment is powered on.
- Consult transistor datasheets for specifications: Know its maximum forward and reverse voltage and current ratings.
- Consider thermal dissipation: transistor may heat up when conducting current for prolonged times.
- Beware of equipment's polarity
- Disconnect power quickly in case of faults: Be prepared to react quickly and disconnect power if excessive current, smoke, or unusual behavior is observed.
- Keep the work area clean and organized to prevent accidents and report any observed hazards or malfunctions to your instructor immediately

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	प्रयोग 9 **Experiment 9**		
विभाग **Department**	इलेक्ट्रॉनिक्स एवं संचार अभियांत्रिकी Electronics & Communication Engineering	**सत्र** **Session:**	2023-24
शिक्षक का नाम **Name of Teacher**	डॉ. राहुल कुमार चौरसिया Dr. Rahul Kumar Chaurasiya	**कार्यक्रम** **Program**	बी टेक B Tech
विषय **Subject**	इलेक्ट्रॉनिक सर्किट प्रयोगशाला (EC-217) Electronic Circuits Lab (EC-217)	**सेमेस्टर** **Semester**	III

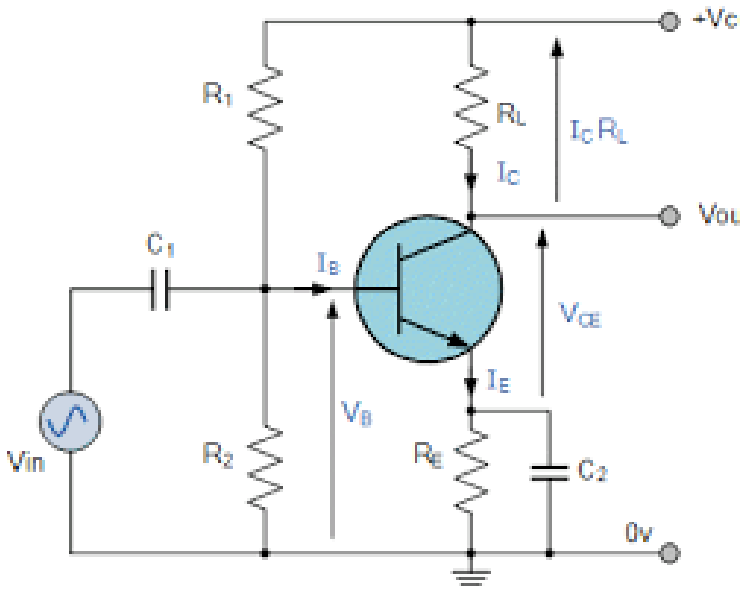
उद्देश्य: विभिन्न पूर्वाग्रह तकनीक द्वारा बाइपोलर जंक्शन ट्रांजिस्टर (BJT) के विद्युत दाब के लाभ की गणना करें

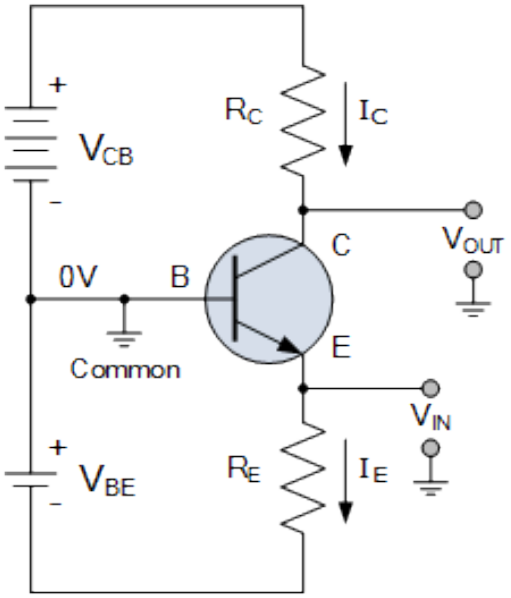
Objective: Calculate the voltage gain of the Bipolar Junction Transistor (BJT) by different biasing techniques

Components and Equipment Required:

1. NPN transistor (e.g., BC547)
2. DC power supply with variable voltage output
3. Multimeter
4. Variable Load Resistor
5. Breadboard and Connecting wires

Circuit Diagram:





Procedure:

Forward Bias (CE):

1. Build the forward-biased CE amplifier circuit on the breadboard, following the diagram.
2. Refer to the transistor datasheet by choosing appropriate resistor values for biasing the transistor in the active region.
3. Connect the DC power supply to the circuit, ensuring correct polarity.
4. Apply a small DC voltage (e.g., 10mV) to the input (base) using the power supply or a signal generator.
5. Measure the DC voltage at the output (collector) using the multimeter.
6. Calculate the voltage gain (Av) using the formula: Av = Vo / Vin, where Vo is the output voltage and Vin is the input voltage.
7. Repeat steps 4-6 for different input voltages, ensuring they stay within the safe operating area of the transistor.

Reverse Bias (CB):

1. Build the reverse-biased CB circuit on the breadboard, following the diagram.
2. Use the same resistor values as in the CE configuration for initial comparison.
3. Connect the DC power supply to the circuit, ensuring correct polarity.
4. Apply a small DC voltage to the input (emitter) using the power supply or a signal generator.
5. Measure the DC voltage at the output (collector) using the multimeter.
6. Calculate the voltage gain using the same formula as in the CE configuration.
7. Repeat steps 4-6 for different input voltages, staying within safe limits.

Observation and Calculations:

Compare the measured voltage gain, for both CE and CB configurations.

S.No.	Configuration	Input Voltage (Vin)	Output Voltage (Vo)

	Forward Bias (CE)		
	Reverse Bias (CB)		

Conclusion: (to be written by student)

Compare the measured voltage gain values for both forward and reverse biased configurations
Explain why a BJT typically does not operate as a linear amplifier in reverse bias.

Precautions when working with electrical components in the Lab

Some essential precautions to remember when working with electrical components

- Identify and follow proper grounding procedures to prevent electrical shock.
- Never connect, disconnect probes or touch exposed electrical components while equipment is powered on.
- Consult transistor datasheets for specifications: Know its maximum forward and reverse voltage and current ratings.
- Consider thermal dissipation: transistor may heat up when conducting current for prolonged times.
- Beware of equipment's polarity
- Disconnect power quickly in case of faults: Be prepared to react quickly and disconnect power if excessive current, smoke, or unusual behavior is observed.
- Keep the work area clean and organized to prevent accidents and report any observed hazards or malfunctions to your instructor immediately

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	प्रयोग 10 **Experiment 10**		
विभाग **Department**	इलेक्ट्रॉनिक्स एवं संचार अभियांत्रिकी Electronics & Communication Engineering	**सत्र** **Session:**	2023-24
शिक्षक का नाम **Name of Teacher**	डॉ. राहुल कुमार चौरसिया Dr. Rahul Kumar Chaurasiya	**कार्यक्रम** **Program**	बी टेक B Tech
विषय **Subject**	इलेक्ट्रॉनिक सर्किट प्रयोगशाला (EC-217) Electronic Circuits Lab (EC-217)	**सेमेस्टर** **Semester**	III

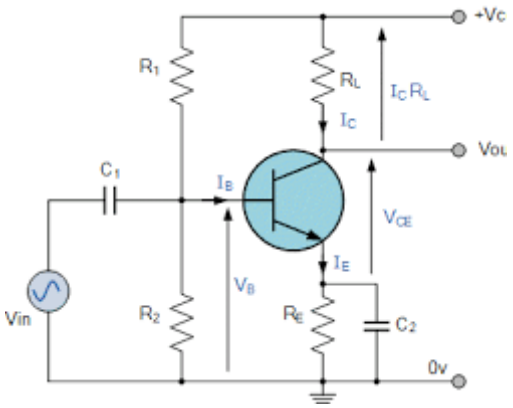
उद्देश्य: प्रवर्धक के रूप में ट्रांजिस्टर की विशेषताओं का अध्ययन और प्रदर्शन करें

Objective: Study and perform the characteristics of a Transistor as an Amplifier

Components and Equipment Required:

1. NPN transistor (e.g., BC547)
2. DC power supply with variable voltage output
3. Multimeter
4. Variable Load Resistor
5. Breadboard and Connecting wires

Circuit Diagram:



Procedure:

DC Biasing:

1. Build the CE amplifier circuit on the breadboard following the diagram.

2. Select appropriate resistor values for biasing the transistor in the active region. Refer to the transistor datasheet for recommended values and safe operating area.
3. Connect the DC power supply to the circuit, ensuring correct polarity.
4. Measure the DC voltage at the collector (Vc), base (Vb), and emitter (Ve) using the multimeter. Record these values in the observation table.
5. Calculate the collector current (Ic) using the formula: Ic = (Vc - Ve) / Rc, where Rc is the collector resistor.
6. Calculate the base current (Ib) using the formula: Ib = (Vb - Ve) / Rb, where Rb is the base resistor.

2. Input Characteristics:

1. Connect a signal generator (optional) to the base and an oscilloscope (optional) to the collector (if not using the multimeter for AC measurements).
2. Set the signal generator to a fixed frequency (e.g., 1 kHz) and small amplitude (e.g., 10mV).
3. Gradually increase the base voltage (Vb) in steps (e.g., 10mV) while keeping the collector voltage (Vc) constant.
4. At each step, record the base voltage (Vb), base current (Ib), collector voltage (Vc), and collector current (Ic) in the observation table.

3. Output Characteristics:

1. Keep the base voltage (Vb) constant at a chosen value within the active region.
2. Gradually increase the collector voltage (Vc) in steps (e.g., 1V) using the DC power supply.
3. At each step, record the collector voltage (Vc), collector current (Ic), and base voltage (Vb) in the observation table.

Observation and Calculations:

- Plot the input characteristics (I_b vs V_b) and output characteristics (I_c vs V_c) on separate graphs.
- Calculate the DC voltage gain (A_v) using the formula: $A_v = \Delta V_c / \Delta V_b$, where ΔV_c and ΔV_b are changes in collector and base voltage, respectively.
- Calculate the input impedance (Z_{in}) using the formula: $Z_{in} = \Delta V_b / \Delta I_b$, where ΔV_b and ΔI_b are small changes in base voltage and current, respectively.
- Calculate the output impedance (Z_{out}) using an AC impedance meter or by injecting a small AC current into the output and measuring the resulting voltage drop.

S.No.	R_c	V_c	V_b	V_e	I_b	I_c	A_v	Z_{in}	Z_{out}

Conclusion: (to be written by student)

Discuss the observed trends in the input and output characteristics.
Explain how the biasing point affects the gain and impedances.

Precautions when working with electrical components in the Lab

Some essential precautions to remember when working with electrical components

- Identify and follow proper grounding procedures to prevent electrical shock.
- Never connect, disconnect probes or touch exposed electrical components while equipment is powered on.
- Consult transistor datasheets for specifications: Know its maximum forward and reverse voltage and current ratings.
- Consider thermal dissipation: transistor may heat up when conducting current for prolonged times.
- Beware of equipment's polarity
- Disconnect power quickly in case of faults: Be prepared to react quickly and disconnect power if excessive current, smoke, or unusual behavior is observed.
- Keep the work area clean and organized to prevent accidents and report any observed hazards or malfunctions to your instructor immediately

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	प्रयोग 11 **Experiment** 11		
विभाग **Department**	इलेक्ट्रॉनिक्स एवं संचार अभियांत्रिकी Electronics & Communication Engineering	**सत्र** **Session:**	2023-24
शिक्षक का नाम **Name of Teacher**	डॉ. राहुल कुमार चौरसिया Dr. Rahul Kumar Chaurasiya	**कार्यक्रम** **Program**	बी टेक B Tech
विषय **Subject**	इलेक्ट्रॉनिक सर्किट प्रयोगशाला (EC-217) Electronic Circuits Lab (EC-217)	**सेमेस्टर** **Semester**	III

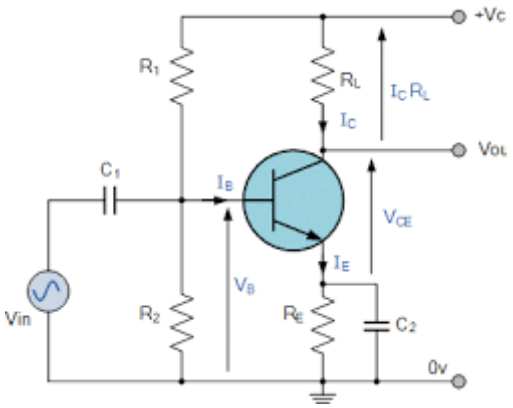
उद्देश्य: फ़ील्ड इफ़ेक्ट ट्रांजिस्टर (FET) की विशेषताओं का अध्ययन और आलेखन करें

Objective: Study and plot the characteristics of the Field Effect Transistor

Components and Equipment Required:

1. N-channel FET
2. DC power supply with variable voltage output
3. Multimeter
4. Variable Load Resistor
5. Breadboard and Connecting wires

Circuit Diagram:



Procedure:

Enhancement-mode MOSFET (NMOS):

1. Build the common source (CS) circuit for the NMOS transistor on the breadboard, following the diagram.

2. Choose appropriate resistor values for biasing the transistor in the active region, referring to the datasheet.
3. Connect the DC power supply to the circuit, ensuring correct polarity.

Transfer Characteristics:

1. Set a constant drain voltage (V_d) using the power supply.
2. Gradually increase the gate voltage (V_g) in steps (e.g., 0.1V) from negative to positive values, exceeding the threshold voltage (V_t).
3. At each step, measure and record the drain current (I_D) using the multimeter.

Drain Characteristics:

1. Set a constant gate voltage (V_g) within the active region.
2. Gradually increase the drain voltage (V_d) in steps (e.g., 1V) from 0V to a safe limit.
3. At each step, measure and record the drain current (I_D) using the multimeter.

Observation and Calculations:

- Transfer Characteristics: plot the measured I_D vs V_g on a graph (I_D on y-axis, V_g on x-axis). Repeat for different values of V_d
- Drain Characteristics: plot the measured I_D vs V_d on a graph (I_D on y-axis, V_d on x-axis). Repeat for different values of V_g
- Calculate the transconductance (g_m) from the slope of the linear region in the transfer characteristic plot using the formula: $gm = \Delta I_D / \Delta V_g$
- Estimate the threshold voltage (V_t) from the transfer characteristic plot as the gate voltage where I_D starts to increase significantly.

S.No.	Transfer Characterstics			Drain Characterstics		
		V_g	I_D		V_d	I_D
	V_d=constant 1			V_g=constant 1		
	V_d=constant 2			V_g=constant 2		

Conclusion: (to be written by student)

Compare and discuss the shapes of the transfer and drain characteristics for both types of FETs.
Analyze the calculated transconductance (gm) and threshold voltage (Vt) values for each transistor.

Precautions when working with electrical components in the Lab

Some essential precautions to remember when working with electrical components

- Identify and follow proper grounding procedures to prevent electrical shock.
- Never connect, disconnect probes or touch exposed electrical components while equipment is powered on.
- Consult transistor datasheets for specifications: Know its maximum forward and reverse voltage and current ratings.
- Consider thermal dissipation: transistor may heat up when conducting current for prolonged times.
- Beware of equipment's polarity
- Disconnect power quickly in case of faults: Be prepared to react quickly and disconnect power if excessive current, smoke, or unusual behavior is observed.
- Keep the work area clean and organized to prevent accidents and report any observed hazards or malfunctions to your instructor immediately

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	प्रयोग 12 **Experiment 12**		
विभाग **Department**	इलेक्ट्रॉनिक्स एवं संचार अभियांत्रिकी Electronics & Communication Engineering	**सत्र** **Session:**	2023-24
शिक्षक का नाम **Name of Teacher**	डॉ. राहुल कुमार चौरसिया Dr. Rahul Kumar Chaurasiya	**कार्यक्रम** **Program**	बी टेक B Tech
विषय **Subject**	इलेक्ट्रॉनिक सर्किट प्रयोगशाला (EC-217) Electronic Circuits Lab (EC-217)	**सेमेस्टर** **Semester**	III

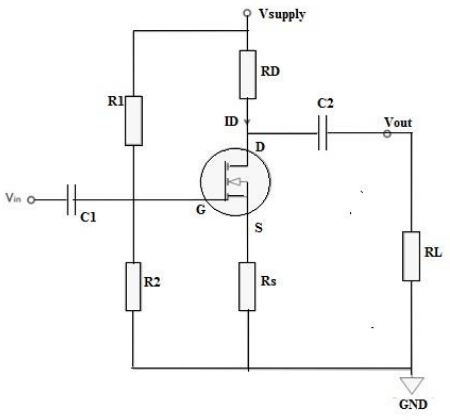
उद्देश्य: फ़ील्ड इफ़ेक्ट ट्रांजिस्टर (FET) प्रवर्धक की विशेषताओं का अध्ययन और आलेखन करें

Objective: Study and plot the characteristics of the FET Amplifier

Components and Equipment Required:

1. N-channel FET
2. DC power supply with variable voltage output
3. Signal Generator
4. Digital Storage Oscilloscope
5. Multimeter
6. Variable Load Resistor
7. Breadboard and Connecting wires

Circuit Diagram:



Procedure:

Setting Up the Circuit:

1. Build the CS FET amplifier circuit on the breadboard, following the diagram.

2. Choose appropriate resistor values for biasing the transistor in the active region, referring to the datasheet.
3. Connect the DC power supply to the circuit, ensuring correct polarity.
4. Connect the signal generator to the input (gate) and the oscilloscope to the output (drain).

Measuring Gain:

1. Set the signal generator to a small AC signal (e.g., 1 kHz, 10mV).
2. Gradually increase the input signal amplitude while keeping it within the safe operating area of the FET.
3. At each step, measure the peak-to-peak voltage of the input signal (Vin) and the output signal (Vout) using the oscilloscope.
4. Calculate the voltage gain (Av) at each step using the formula: Av = Vout / Vin.
5. Plot the voltage gain (Av) versus the input signal amplitude (Vin) on a graph (Av on y-axis, Vin on x-axis).

Frequency Response:

1. Keep the input signal amplitude constant at a chosen value.
2. Sweep the signal generator frequency from a low value (e.g., 100 Hz) to a high value (e.g., 1 MHz) in logarithmic steps.
3. At each frequency, measure the output signal amplitude (Vout) using the oscilloscope.
4. Normalize the output amplitude to the gain measured at a low frequency (e.g., DC gain).

Optional Comparison with BJT Amplifier:

1. Repeat steps 2-4 with a BJT amplifier circuit (e.g., common emitter) under similar conditions.
2. Compare the gain, input/output impedance, and frequency response of both FET and BJT amplifiers.
3. Discuss the observed differences and their implications for choosing the appropriate transistor type for specific applications.

Observation and Calculations:

1. Gain: Plot the voltage gain (Av) versus the input signal amplitude (Vin) on a graph (Av on y-axis, Vin on x-axis).
2. Plot the normalized output amplitude versus the frequency on a log-log graph
3. Input Impedance (Zin): Use an AC impedance meter (if available) to measure the impedance directly at the input (gate) terminals
4. Out Impedance (Zout): Use an AC impedance meter (if available) to measure the impedance directly at the output (drain) terminals

S.No.	Gain Measurement			Frequency Response		
	V_{in}	V_{out}	A_v	V_{in} constant	Freq	$V_{out\ v}$

Conclusion: (to be written by student)

Discuss the frequency response plot of FET.

Precautions when working with electrical components in the Lab

- Some essential precautions to remember when working with electrical components
- Identify and follow proper grounding procedures to prevent electrical shock.
- Never connect, disconnect probes or touch exposed electrical components while equipment is powered on.
- Consult transistor datasheets for specifications: Know its maximum forward and reverse voltage and current ratings.
- Consider thermal dissipation: transistor may heat up when conducting current for prolonged times.
- Beware of equipment's polarity
- Disconnect power quickly in case of faults: Be prepared to react quickly and disconnect power if excessive current, smoke, or unusual behavior is observed.
- Keep the work area clean and organized to prevent accidents and report any observed hazards or malfunctions to your instructor immediately

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	प्रयोग 13 **Experiment 13**		
विभाग **Department**	इलेक्ट्रॉनिक्स एवं संचार अभियांत्रिकी Electronics & Communication Engineering	**सत्र** **Session:**	2023-24
शिक्षक का नाम **Name of Teacher**	डॉ. राहुल कुमार चौरसिया Dr. Rahul Kumar Chaurasiya	**कार्यक्रम** **Program**	बी टेक B Tech
विषय **Subject**	इलेक्ट्रॉनिक सर्किट प्रयोगशाला (EC-217) Electronic Circuits Lab (EC-217)	**सेमेस्टर** **Semester**	III

उद्देश्य: धातु-ऑक्साइड-अर्धचालक क्षेत्र-प्रभाव ट्रांजिस्टर (MOSFET) की विशेषताओं का अध्ययन और आलेखन करें

Objective: Study and plot the characteristics of MOSFET

Components and Equipment Required:

1. N-channel enhancement-mode MOSFET
2. DC power supply with variable voltage output
3. Signal Generator
4. Digital Storage Oscilloscope
5. Multimeter
6. Variable Load Resistor
7. Breadboard and Connecting wires

Circuit Diagram:

Procedure:

Setting Up the Circuit:

Setting Up the Circuit:

1. Build the CS NMOS circuit on the breadboard following the diagram.
2. Choose appropriate resistor values for biasing the transistor in the active region, referring to the NMOS datasheet.
3. Connect the DC power supply to the circuit, ensuring correct polarity.

2. Transfer Characteristics (ID vs Vg):

1. Set a constant drain voltage (Vd) using the power supply.
2. Gradually increase the gate voltage (Vg) in steps (e.g., 0.1V) from negative to positive values, exceeding the threshold voltage (Vt).
3. At each step, measure and record the drain current (ID) using the multimeter.
4. Plot the measured ID vs Vg on a graph (ID on y-axis, Vg on x-axis).

5. From the plot, estimate the threshold voltage (Vt) as the gate voltage where ID starts to increase significantly.
6. Calculate the transconductance (gm) in the linear region of the plot using the formula: gm = ΔID / ΔVg.

3. Drain Characteristics (ID vs Vd):

1. Set a constant gate voltage (Vg) within the active region.
2. Gradually increase the drain voltage (Vd) in steps (e.g., 1V) from 0V to a safe limit as per the datasheet.
3. At each step, measure and record the drain current (ID) using the multimeter.
4. Plot the measured ID vs Vd on a graph (ID on y-axis, Vd on x-axis).
5. Observe the saturation region where ID remains constant despite increasing Vd.

4. Optional: Frequency Response Analysis:

1. Use an oscilloscope and function generator (optional) to apply a small AC signal to the gate and measure the AC response at the drain.
2. Sweep the signal frequency and observe the gain and phase shift characteristics.

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Additional Experiment

	प्रयोग 14 **Experiment 14**		
विभाग **Department**	इलेक्ट्रॉनिक्स एवं संचार अभियांत्रिकी Electronics & Communication Engineering	**सत्र** **Session:**	2023-24
शिक्षक का नाम **Name of Teacher**	डॉ. राहुल कुमार चौरसिया Dr. Rahul Kumar Chaurasiya	**कार्यक्रम** **Program**	बी टेक B Tech
विषय **Subject**	इलेक्ट्रॉनिक सर्किट प्रयोगशाला (EC-217) Electronic Circuits Lab (EC-217)	**सेमेस्टर** **Semester**	III

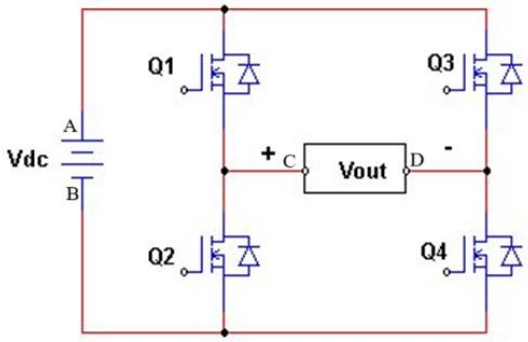
उद्देश्य: DC को AC में परिवर्तित करने के लिए MOSFET का उपयोग करके वोल्टेज इन्वर्टर को डिज़ाइन और कार्यान्वित करें

Objective: Design and implement a voltage inverter using a MOSFET to convert DC to AC

Components and Equipment Required:

1. N-channel power MOSFET (e.g., IRFP150)
2. DC power supply with variable voltage output
3. Resistors (various values)
4. Capacitor (for filtering)
5. Signal Generator
6. Digital Storage Oscilloscope
7. Multimeter
8. Breadboard and Connecting wires

Circuit Diagram:



Procedure:

1. Design the Inverter Circuit as shown in above figure

2. Choose a suitable PWM frequency (e.g., 20 kHz) for Q1, Q2, Q3 and Q4 MOSFET switches using signal generator.
3. Ensure the MOSFET is rated for the required voltage and current levels.

Setting Up the Circuit:

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1. Assemble the circuit on the breadboard according to the diagram
2. Connect DC voltage supply to terminals A and B
3. Take the PWM outputs from the signal generator Channel 1 and Channel 2 through BNC cable and connect on the breadboard (mark these as S1 and S2)
4. Now connect the S1 on Q1 and Q4
5. Connect S2 to Q3 and Q2
6. Measure the output across load terminal C and D

Measure the Output Waveform:

Use the oscilloscope to observe the output waveform.
Adjust the duty cycle of the PWM signal to control the amplitude of the output waveform.
Measure the peak-to-peak voltage of the output waveform.

Calculate Efficiency:

Measure the input power (Pin) as the product of the input voltage and current.
Measure the output power (Pout) as the product of the output voltage and current.

Calculate the efficiency (η) as (Pout / Pin) * 100%.

Observation and Calculations