

AIAC-3

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Task-01

Prompt : To generate a Python program that Reads: Previous Units (PU), Current Units (CU), Type of Customer, Calculates units consumed, Implements logic directly in the main program (no functions).

Code:

```
# Utility Bill Calculator

# Reads: Previous Units (PU), Current Units (CU), Type of Customer

# Calculates units consumed and bill amount

print("=" * 60)

print("UTILITY BILL CALCULATOR")

print("=" * 60)

# Read Previous Units (PU)

while True:

    try:

        pu = float(input("\nEnter Previous Units (PU):"))

        if pu < 0:

            print("Error: Previous Units cannot be negative. Please try again.")

            continue

        break

    except ValueError:

        print("Error: Please enter a valid number.")

# Read Current Units (CU)

while True:

    try:

        cu = float(input("Enter Current Units (CU):"))

    except ValueError:
```

```
if cu < 0:
    print("Error: Current Units cannot be negative. Please try again.")
    continue

if cu < pu:
    print("Error: Current Units cannot be less than Previous Units. Please try again.")
    continue

break

except ValueError:
    print("Error: Please enter a valid number.")

# Read Type of Customer

print("\nCustomer Types:")
print("1. Domestic")
print("2. Commercial")
print("3. Industrial")

while True:

    try:
        customer_type_choice = input("\nEnter Customer Type (1/2/3): ").strip()

        if customer_type_choice == "1":
            customer_type = "Domestic"
            break

        elif customer_type_choice == "2":
            customer_type = "Commercial"
            break

        elif customer_type_choice == "3":
            customer_type = "Industrial"
            break

    else:
        print("Error: Please enter 1, 2, or 3.")

    except:
        print("Error: Invalid input. Please try again.")

# Calculate units consumed
```

```
units_consumed = cu - pu

# Display results

print("\n" + "=" * 60)
print("BILL CALCULATION")
print("=" * 60)

print(f"Previous Units (PU): {pu:.2f} units")
print(f"Current Units (CU): {cu:.2f} units")
print(f"Units Consumed: {units_consumed:.2f} units")
print(f"Customer Type: {customer_type}")

# Calculate bill based on customer type and units consumed

# Rate structure (example rates - can be modified)

if customer_type == "Domestic":

    if units_consumed <= 100:

        rate = 3.50

    elif units_consumed <= 200:

        rate = 4.50

    elif units_consumed <= 300:

        rate = 5.50

    else:

        rate = 6.50

elif customer_type == "Commercial":

    if units_consumed <= 100:

        rate = 5.00

    elif units_consumed <= 200:

        rate = 6.00

    elif units_consumed <= 300:

        rate = 7.00

    else:

        rate = 8.00

else: # Industrial

    if units_consumed <= 100:
```

```

rate = 6.00

elif units_consumed <= 200:

    rate = 7.50

elif units_consumed <= 300:

    rate = 9.00

else:

    rate = 10.50

# Calculate total bill

total_bill = units_consumed * rate

print(f"\nRate per unit:      ₹{rate:.2f}")

print(f"Total Bill Amount:   ₹{total_bill:.2f}")

print("=" * 60)

```

Output:

```

Python unit consumption calculation
In [1]: utility_bill_calculator.py
In [2]: # Utility bill calculator
# Reads Previous Units (PU), Current Units (CU), Type of Customer
# Calculates units consumed and total amount

print("=" * 60)
print("Utility BILL CALCULATOR")
print("=" * 60)

# Read Previous Units (PU)
while True:
    pu = float(input("\nEnter Previous Units (PU): "))
    if pu < 0:
        print("Error: Previous Units cannot be negative. Please try again.")
        continue
    break
except ValueError:
    print("Error: Please enter a valid number.")

# Read Current Units (CU)
cu = float(input("\nEnter Current Units (CU): "))

Customer Types:
1. Domestic
2. Commercial
3. Industrial
4. Industrial

Enter Customer Type (1/2/3): 3

BILL CALCULATION
Previous Units (PU): 12.00 units
Current Units (CU): 34.00 units
Customer Type: Industrial
Total Bill Amount: ₹360.00

```

Enter Previous Units (PU): 12

Enter Current Units (CU): 34

Customer Types:

1. Domestic

2. Commercial

3. Industrial

3. Industrial

Enter Customer Type (1/2/3): 1

=====

BILL CALCULATION

=====

Previous Units (PU): 12.00 units

Current Units (CU): 34.00 units

Units Consumed: 22.00 units

Customer Type: Domestic

Rate per unit: ₹3.50

Total Bill Amount: ₹77.00

Explanation:

Purpose: Calculates utility bill based on units consumed and customer type.**Main Steps:**

1. Input Collection (Lines 9-55):

- Reads Previous Units (PU) and Current Units (CU) with validation
- Reads Customer Type (1=Domestic, 2=Commercial, 3=Industrial)
- Validates: no negative values, CU ≥ PU

2. Calculation (Lines 57-100):

- Units Consumed = CU - PU
- Determines rate per unit based on customer type and consumption tier
- Total Bill = Units Consumed × Rate

3. Output (Lines 60-104):

- Displays PU, CU, units consumed, customer type, rate, and total bill

Key Features:

- Input validation with error handling
- Tiered pricing (different rates for different consumption levels)
- Customer-specific rates (Domestic/Commercial/Industrial)
- All logic in main program (no functions)

Example: If PU=100, CU=250, Type=Domestic → Units=150 → Rate=₹4.50 → Bill=₹675.00

Task-02

Prompt: Add Energy Charge (EC) calculation with optimized conditional logic for Domestic, Commercial, and Industrial consumers. Simplify and improve code readability

Code:

```
class UtilityBillCalculator:
```

```
    RATE_STRUCTURE = {  
        "Domestic": [  
            (0, 100, 3.50),  
            (101, 200, 4.50),  
            (201, 300, 5.50),  
            (301, float('inf')), 6.50)  
        ],  
        "Commercial": [  
            (0, 100, 5.00),  
            (101, 200, 6.00),  
            (201, 300, 7.00),  
            (301, float('inf')), 8.00)  
        ],  
        "Industrial": [  
            (0, 100, 6.00),  
            (101, 200, 7.50),  
            (201, 300, 9.00),  
            (301, float('inf')), 10.50)  
        ]  
    }
```

```
def __init__(self, previous_units: float, current_units: float, customer_type: str):
```

```
    """
```

Initialize the calculator with meter readings and customer type.

Args:

```
    previous_units: Previous meter reading (PU)
```

```
    current_units: Current meter reading (CU)
```

```
    customer_type: Type of customer (Domestic, Commercial, Industrial)
```

```
    """
```

```
    self.previous_units = previous_units
```

```
    self.current_units = current_units
```

```
    self.customer_type = customer_type
```

```
    self.units_consumed = current_units - previous_units
```

```
    # Validate inputs
```

```
    self._validate_inputs()
```

```
def _validate_inputs(self):
```

```
    """Validate that inputs are logical and valid."""
```

```
    if self.previous_units < 0:
```

```
        raise ValueError("Previous Units cannot be negative")
```

```
    if self.current_units < 0:
```

```
        raise ValueError("Current Units cannot be negative")
```

```
    if self.current_units < self.previous_units:
```

```
        raise ValueError("Current Units cannot be less than Previous Units")
```

```
    if self.customer_type not in self.RATE_STRUCTURE:
```

```
        raise ValueError(f"Invalid customer type: {self.customer_type}")
```

```
def get_rate_per_unit(self) -> float:
```

```
    """
```

Get the applicable rate per unit based on units consumed and customer type.

Optimized conditional logic using slab-based lookup.

Returns:

```

    Rate per unit in rupees
    """
rate_slabs = self.RATE_STRUCTURE[self.customer_type]

# Optimized: Direct lookup based on units consumed

for min_units, max_units, rate in rate_slabs:

    if min_units <= self.units_consumed <= max_units:

        return rate

# Fallback (should not reach here with proper structure)

return rate_slabs[-1][2]

def calculate_energy_charges(self) -> float:

    rate_per_unit = self.get_rate_per_unit()

    energy_charges = self.units_consumed * rate_per_unit

    return energy_charges

def get_bill_details(self) -> dict:

    rate_per_unit = self.get_rate_per_unit()

    energy_charges = self.calculate_energy_charges()

    return {

        "previous_units": self.previous_units,

        "current_units": self.current_units,

        "units_consumed": self.units_consumed,

        "customer_type": self.customer_type,

        "rate_per_unit": rate_per_unit,

        "energy_charges": energy_charges,

        "total_bill": energy_charges
    }

def display_bill(self):

    """Display the bill in a formatted manner."""

    details = self.get_bill_details()

    print("\n" + "=" * 60)

```

```

print("BILL CALCULATION")
print("=" * 60)

print(f"Previous Units (PU): {details['previous_units']:.2f} units")
print(f"Current Units (CU): {details['current_units']:.2f} units")
print(f"Units Consumed: {details['units_consumed']:.2f} units")
print(f"Customer Type: {details['customer_type']}")

print(f"\nRate per unit: ₹{details['rate_per_unit']:.2f}")

print(f"Energy Charges (EC): ₹{details['energy_charges']:.2f}")
print(f"Total Bill Amount: ₹{details['total_bill']:.2f}")

print("=" * 60)

def get_user_input() -> tuple[float, float, str]:
    print("=" * 60)

    print("UTILITY BILL CALCULATOR (Class-Based Implementation)")
    print("=" * 60)

    # Get Previous Units

    while True:
        try:
            pu = float(input("\nEnter Previous Units (PU):"))

            if pu < 0:
                print("Error: Previous Units cannot be negative. Please try again.")

                continue

            break
        except ValueError:
            print("Error: Please enter a valid number.")

    # Get Current Units

    while True:
        try:
            cu = float(input("Enter Current Units (CU):"))

            if cu < 0:

```

```
    print("Error: Current Units cannot be negative. Please try again.")

    continue

if cu < pu:

    print("Error: Current Units cannot be less than Previous Units. Please try again.")

    continue

break

except ValueError:

    print("Error: Please enter a valid number.")

# Get Customer Type

print("\nCustomer Types:")

print("1. Domestic")

print("2. Commercial")

print("3. Industrial")

customer_types = {"1": "Domestic", "2": "Commercial", "3": "Industrial"}

while True:

    choice = input("\nEnter Customer Type (1/2/3): ").strip()

    if choice in customer_types:

        return pu, cu, customer_types[choice]

    print("Error: Please enter 1, 2, or 3.")

def main():

    """Main program entry point."""

try:

    # Get user input

    pu, cu, customer_type = get_user_input()

    # Create calculator instance

    calculator = UtilityBillCalculator(pu, cu, customer_type)

    # Display bill

    calculator.display_bill()

except ValueError as e:
```

```

print(f"\nError: {e}")

except Exception as e:
    print(f"\nUnexpected error: {e}")

if __name__ == "__main__":
    main()

```

Output:

The screenshot shows the AI Assistant interface with the following details:

- Code Editor:** Displays the Python code for the utility_bill_calculator.py file.
- Workflow:**
 - 1. Input Collection: Gets Previous Units (PU) and Current Units (CU).
 - 2. Validation: Ensures values are non-negative, Checks CU > PU, and Validates customer type selection.
 - 3. Calculation: Calculates Total Bill based on consumption data for Domestic, Commercial, and Industrial customers.
 - 4. Output: Displays meter readings, units consumed, customer type, and total bill.
- Terminal:** Shows the execution command: `python3 utility_bill_calculator.py`.
- Output:** The terminal output shows the execution results for customer type 1 (Domestic) with PU 34 and CU 45.

UTILITY BILL CALCULATOR (Class-Based Implementation)

Enter Previous Units (PU): 34

Enter Current Units (CU): 45

Customer Types:

1. Domestic
2. Commercial
3. Industrial

Enter Customer Type (1/2/3): 1

BILL CALCULATION

Previous Units (PU): 34.00 units

Current Units (CU): 45.00 units

Units Consumed: 11.00 units

Customer Type: Domestic

Rate per unit: ₹3.50

Energy Charges (EC): ₹38.50

Total Bill Amount: ₹38.50

Explanation:

Purpose: Calculates electricity bill from meter readings and customer type.

Workflow:

1. Input Collection

- Gets Previous Units (PU) and Current Units (CU)
- Gets Customer Type: Domestic (1), Commercial (2), or Industrial (3)

2. Validation

- Ensures values are non-negative
- Ensures CU ≥ PU
- Validates customer type selection

3. Calculation

- Units Consumed = CU - PU
- Rate by customer type and consumption slabs:
- **Domestic:** ₹3.50 (0-100), ₹4.50 (101-200), ₹5.50 (201-300), ₹6.50 (300+)
- **Commercial:** ₹5.00 (0-100), ₹6.00 (101-200), ₹7.00 (201-300), ₹8.00 (300+)
- **Industrial:** ₹6.00 (0-100), ₹7.50 (101-200), ₹9.00 (201-300), ₹10.50 (300+)
- Total Bill = Units Consumed × Rate per unit

4. Output

- Displays meter readings, units consumed, customer type, rate, and total bill

Task-03

Prompt: Develop a Python program with user-defined functions for calculating Energy Charges and Fixed Charges. Functions should accept inputs, return results, use simple logic

Code:

```

def calculate_energy_charges(units_consumed, customer_type):
    rate_structure = {
        "Domestic": [
            (0, 100, 3.50),    # First 100 units at ₹3.50 per unit
            (101, 200, 4.50),   # Next 100 units (101-200) at ₹4.50 per unit
            (201, 300, 5.50),   # Next 100 units (201-300) at ₹5.50 per unit
            (301, float('inf'), 6.50) # Above 300 units at ₹6.50 per unit
        ],
        "Commercial": [
            (0, 100, 5.00),    # First 100 units at ₹5.00 per unit
            (101, 200, 6.00),   # Next 100 units (101-200) at ₹6.00 per unit
            (201, 300, 7.00),   # Next 100 units (201-300) at ₹7.00 per unit
            (301, float('inf'), 8.00) # Above 300 units at ₹8.00 per unit
        ],
        "Industrial": [
            (0, 100, 6.00),    # First 100 units at ₹6.00 per unit
            (101, 200, 7.50),   # Next 100 units (101-200) at ₹7.50 per unit
            (201, 300, 9.00),   # Next 100 units (201-300) at ₹9.00 per unit
            (301, float('inf'), 10.50) # Above 300 units at ₹10.50 per unit
        ]
    }

    # Validate customer type
    if customer_type not in rate_structure:
        raise ValueError(f"Invalid customer type: {customer_type}. Must be Domestic, Commercial, or Industrial")

    # Get the applicable rate slabs for the customer type
    slabs = rate_structure[customer_type]

    # Find the applicable rate based on units consumed
    # The rate is determined by which consumption slab the total units fall into
    # All units are charged at the rate of the slab they fall into

```

```

for min_units, max_units, rate_per_unit in slabs:
    if min_units <= units_consumed <= max_units:
        # Units fall within this slab, calculate charges at this rate
        energy_charges = units_consumed * rate_per_unit
    return energy_charges

# Fallback: If consumption exceeds all defined slabs, use the highest rate

# This handles cases where consumption is very high

highest_rate = slabs[-1][2]

return units_consumed * highest_rate

def calculate_fixed_charges(customer_type, units_consumed):
    fixed_charges_structure = {

        "Domestic": {
            "low": 50.00,      # For consumption up to 100 units
            "medium": 75.00,   # For consumption 101-200 units
            "high": 100.00,    # For consumption 201-300 units
            "very_high": 150.00 # For consumption above 300 units
        },
        "Commercial": {
            "low": 200.00,     # For consumption up to 100 units
            "medium": 300.00,   # For consumption 101-200 units
            "high": 400.00,    # For consumption 201-300 units
            "very_high": 500.00 # For consumption above 300 units
        },
        "Industrial": {
            "low": 500.00,     # For consumption up to 100 units
            "medium": 750.00,   # For consumption 101-200 units
            "high": 1000.00,   # For consumption 201-300 units
            "very_high": 1500.00 # For consumption above 300 units
        }
    }

```

```

}

# Validate customer type

if customer_type not in fixed_charges_structure:

    raise ValueError(f"Invalid customer type: {customer_type}. Must be Domestic, Commercial, or Industrial")

# Determine consumption category based on units consumed

if units_consumed <= 100:

    category = "low"

elif units_consumed <= 200:

    category = "medium"

elif units_consumed <= 300:

    category = "high"

else:

    category = "very_high"

# Get and return the fixed charges for this customer type and category

fixed_charges = fixed_charges_structure[customer_type][category]

return fixed_charges

def calculate_total_bill(previous_units, current_units, customer_type):

    # Validate inputs

    if previous_units < 0:

        raise ValueError("Previous Units cannot be negative")

    if current_units < 0:

        raise ValueError("Current Units cannot be negative")

    if current_units < previous_units:

        raise ValueError("Current Units cannot be less than Previous Units")

# Calculate units consumed (difference between current and previous readings)

units_consumed = current_units - previous_units

# Calculate Energy Charges using the dedicated function

energy_charges = calculate_energy_charges(units_consumed, customer_type)

# Calculate Fixed Charges using the dedicated function

```

```

fixed_charges = calculate_fixed_charges(customer_type, units_consumed)

# Calculate total bill (Energy Charges + Fixed Charges)

total_bill = energy_charges + fixed_charges

# Return all calculated values as a dictionary

return {

    "previous_units": previous_units,
    "current_units": current_units,
    "units_consumed": units_consumed,
    "customer_type": customer_type,
    "energy_charges": energy_charges,
    "fixed_charges": fixed_charges,
    "total_bill": total_bill
}

def get_user_input():

    print("=" * 70)

    print("UTILITY BILL CALCULATOR - Function-Based Implementation")

    print("=" * 70)

    # Get Previous Units (PU) with validation

    while True:

        try:

            previous_units = float(input("\nEnter Previous Units (PU): "))

            if previous_units < 0:

                print("Error: Previous Units cannot be negative. Please try again.")

                continue

            break

        except ValueError:

            print("Error: Please enter a valid number.")

    # Get Current Units (CU) with validation

    while True:

```

```
try:  
    current_units = float(input("Enter Current Units (CU): "))  
  
    if current_units < 0:  
        print("Error: Current Units cannot be negative. Please try again.")  
  
        continue  
  
    if current_units < previous_units:  
        print("Error: Current Units cannot be less than Previous Units. Please try again.")  
  
        continue  
  
    break  
  
except ValueError:  
    print("Error: Please enter a valid number.")  
  
# Get Customer Type with validation  
print("\nCustomer Types:")  
print("1. Domestic")  
print("2. Commercial")  
print("3. Industrial")  
customer_types = {"1": "Domestic", "2": "Commercial", "3": "Industrial"}  
  
while True:  
    choice = input("\nEnter Customer Type (1/2/3): ").strip()  
  
    if choice in customer_types:  
        customer_type = customer_types[choice]  
  
        break  
  
    print("Error: Please enter 1, 2, or 3.")  
  
return previous_units, current_units, customer_type  
  
def display_bill(bill_details):  
    print("\n" + "=" * 70)  
    print("BILL CALCULATION RESULTS")  
    print("=" * 70)  
    print(f"Previous Units (PU): {bill_details['previous_units']:.2f} units")
```

```

print(f"Current Units (CU):      {bill_details['current_units']:.2f} units")
print(f"Units Consumed:           {bill_details['units_consumed']:.2f} units")
print(f"Customer Type:            {bill_details['customer_type']}")
print("-" * 70)
print(f"Energy Charges (EC):     ₹{bill_details['energy_charges']:.2f}")
print(f"Fixed Charges (FC):       ₹{bill_details['fixed_charges']:.2f}")
print("-" * 70)
print(f"TOTAL BILL AMOUNT:       ₹{bill_details['total_bill']:.2f}")
print("=" * 70)

```

```

def main():
    try:
        # Step 1: Get user input
        previous_units, current_units, customer_type = get_user_input()

        # Step 2: Calculate bill using the calculate_total_bill function
        # This function internally calls calculate_energy_charges and calculate_fixed_charges
        bill_details = calculate_total_bill(previous_units, current_units, customer_type)

        # Step 3: Display the calculated bill
        display_bill(bill_details)

    except ValueError as e:
        print(f"\nError: {e}")

    except Exception as e:
        print(f"\nUnexpected error: {e}")

    # Program entry point
if __name__ == "__main__":
    main()

```

Output:

UTILITY BILL CALCULATOR - Function-Based Implementation

Enter Previous Units (PU): 45

Enter Current Units (CU): 56

Customer Types:

1. Domestic
2. Commercial
3. Industrial

Enter Customer Type (1/2/3): 2

BILL CALCULATION RESULTS

Previous Units (PU): 45.00 units

Current Units (CU): 56.00 units

Units Consumed: 11.00 units

Customer Type: Commercial

Energy Charges (EC): ₹55.00

Fixed Charges (FC): ₹200.00

TOTAL BILL AMOUNT: ₹255.00

The screenshot shows a Jupyter Notebook environment with two code cells and a terminal output area.

Code Cell 1:

```
Python charge calculation with functions
In [1]: def calculate_energy_charges(units_consumed, customer_type):
    rate_structure = {
        "Domestic": [
            (0, 100, 3.50),  # For first 100 units at ₹3.50 per unit
            (101, 200, 4.50), # For next 100 units (101-200) at ₹4.50 per unit
            (201, 300, 5.50), # For next 100 units (201-300) at ₹5.50 per unit
            (301, float('inf'), 6.50) # Above 300 units at ₹6.50 per unit
        ],
        "Commercial": [
            (0, 100, 5.00),  # For first 100 units at ₹5.00 per unit
            (101, 200, 6.00), # For next 100 units (101-200) at ₹6.00 per unit
            (201, 300, 7.00), # For next 100 units (201-300) at ₹7.00 per unit
            (301, float('inf'), 8.00) # Above 300 units at ₹8.00 per unit
        ],
        "Industrial": [
            (0, 100, 6.00),  # For first 100 units at ₹6.00 per unit
            (101, 200, 7.50), # For next 100 units (101-200) at ₹7.50 per unit
            ...
        ]
    }
    if customer_type == "Domestic":
        return sum([rate[2] * min(rate[0], units_consumed) for rate in rate_structure["Domestic"]])
    elif customer_type == "Commercial":
        return sum([rate[2] * min(rate[0], units_consumed) for rate in rate_structure["Commercial"]])
    else:
        return sum([rate[2] * min(rate[0], units_consumed) for rate in rate_structure["Industrial"]])

# calculate fixed charges
def calculate_fixed_charges():
    return 200.00
```

Code Cell 2:

```
def calculate_bill_amount(previous_units, current_units):
    units_consumed = current_units - previous_units
    customer_type = input("Enter Customer Type (1/2/3): ")
    energy_charge = calculate_energy_charges(units_consumed, customer_type)
    fixed_charge = calculate_fixed_charges()
    total_bill_amount = energy_charge + fixed_charge
    print(f"\nBILL CALCULATION RESULTS\n")
    print(f"Enter Previous Units (PU): {previous_units}")
    print(f"Enter Current Units (CU): {current_units}")
    print(f"Customer Types:")
    print(f"1. Domestic")
    print(f"2. Commercial")
    print(f"3. Industrial")
    print(f"\nEnter Customer Type (1/2/3): {customer_type}")
    print(f"\nBILL CALCULATION RESULTS\n")
    print(f"Total Bill Amount: {total_bill_amount} Rupees")
```

Terminal Output:

```
In [1]: calculate_bill_amount(45, 56)
Enter Customer Type (1/2/3): 2
Customer Types:
1. Domestic
2. Commercial
3. Industrial
Enter Customer Type (1/2/3): 2
BILL CALCULATION RESULTS
Enter Previous Units (PU): 45
Enter Current Units (CU): 56
Total Bill Amount: 255.00 Rupees
```

Explanation:

1. User enters previous units, current units, and customer type
2. Program calculates units consumed = current - previous
3. Energy Charges = units × rate (based on consumption slab)
4. Fixed Charges = fixed amount (based on customer type and consumption category)
5. Total Bill = Energy Charges + Fixed Charges
6. Results are displayed

Task-04

Prompt:

Extend the program to calculate Fixed Charges (FC), Customer Charges (CC), and Electricity Duty. Add electricity duty calculation, improve billing accuracy, and keep the code simple and readable.

Code:

```
def calculate_energy_charges(units_consumed, customer_type):  
    rate_structure = {  
        "Domestic": [  
            (0, 100, 3.50),    # First 100 units at ₹3.50 per unit  
            (101, 200, 4.50),   # Next 100 units (101-200) at ₹4.50 per unit  
            (201, 300, 5.50),   # Next 100 units (201-300) at ₹5.50 per unit  
            (301, float('inf'), 6.50) # Above 300 units at ₹6.50 per unit  
        ],  
        "Commercial": [  
            (0, 100, 5.00),    # First 100 units at ₹5.00 per unit  
            (101, 200, 6.00),   # Next 100 units (101-200) at ₹6.00 per unit  
            (201, 300, 7.00),   # Next 100 units (201-300) at ₹7.00 per unit  
            (301, float('inf'), 8.00) # Above 300 units at ₹8.00 per unit  
        ],
```

```
"Industrial": [  
    (0, 100, 6.00),    # First 100 units at ₹6.00 per unit  
    (101, 200, 7.50),   # Next 100 units (101-200) at ₹7.50 per unit  
    (201, 300, 9.00),   # Next 100 units (201-300) at ₹9.00 per unit  
    (301, float('inf')), 10.50) # Above 300 units at ₹10.50 per unit  
]  
}
```

Validate customer type

```
if customer_type not in rate_structure:
```

```
    raise ValueError(f"Invalid customer type: {customer_type}. Must be Domestic,  
Commercial, or Industrial")
```

Get the applicable rate slabs for the customer type

```
slabs = rate_structure[customer_type]
```

Find the applicable rate based on units consumed

The rate is determined by which consumption slab the total units fall into

All units are charged at the rate of the slab they fall into

```
for min_units, max_units, rate_per_unit in slabs:
```

```
    if min_units <= units_consumed <= max_units:
```

Units fall within this slab, calculate charges at this rate

```
    energy_charges = units_consumed * rate_per_unit
```

```
    return energy_charges
```

Fallback: If consumption exceeds all defined slabs, use the highest rate

This handles cases where consumption is very high

```
highest_rate = slabs[-1][2]
```

```
return units_consumed * highest_rate
```

```

def calculate_fixed_charges(customer_type, units_consumed):
    # Define fixed charges structure
    # Fixed charges may vary by customer type and consumption category
    fixed_charges_structure = {
        "Domestic": {
            "low": 50.00,    # For consumption up to 100 units
            "medium": 75.00, # For consumption 101-200 units
            "high": 100.00,  # For consumption 201-300 units
            "very_high": 150.00 # For consumption above 300 units
        },
        "Commercial": {
            "low": 200.00,   # For consumption up to 100 units
            "medium": 300.00, # For consumption 101-200 units
            "high": 400.00,  # For consumption 201-300 units
            "very_high": 500.00 # For consumption above 300 units
        },
        "Industrial": {
            "low": 500.00,   # For consumption up to 100 units
            "medium": 750.00, # For consumption 101-200 units
            "high": 1000.00, # For consumption 201-300 units
            "very_high": 1500.00 # For consumption above 300 units
        }
    }

    # Validate customer type
    if customer_type not in fixed_charges_structure:
        raise ValueError(f"Invalid customer type: {customer_type}. Must be Domestic, Commercial, or Industrial")

    # Determine consumption category based on units consumed

```

```

if units_consumed <= 100:
    category = "low"
elif units_consumed <= 200:
    category = "medium"
elif units_consumed <= 300:
    category = "high"
else:
    category = "very_high"

# Get and return the fixed charges for this customer type and category
fixed_charges = fixed_charges_structure[customer_type][category]
return fixed_charges

def calculate_customer_charges(customer_type, units_consumed):
    # Define customer charges structure
    # Customer charges vary by customer type and consumption level
    customer_charges_structure = {
        "Domestic": {
            "low": 25.00,    # For consumption up to 100 units
            "medium": 35.00, # For consumption 101-200 units
            "high": 50.00,   # For consumption 201-300 units
            "very_high": 75.00 # For consumption above 300 units
        },
        "Commercial": {
            "low": 100.00,   # For consumption up to 100 units
            "medium": 150.00, # For consumption 101-200 units
            "high": 200.00,   # For consumption 201-300 units
            "very_high": 300.00 # For consumption above 300 units
        },
    }

```

```

    "Industrial": {

        "low": 250.00,  # For consumption up to 100 units
        "medium": 400.00, # For consumption 101-200 units
        "high": 600.00,  # For consumption 201-300 units
        "very_high": 900.00 # For consumption above 300 units
    }
}

# Validate customer type
if customer_type not in customer_charges_structure:
    raise ValueError(f"Invalid customer type: {customer_type}. Must be Domestic, Commercial, or Industrial")

# Determine consumption category based on units consumed
if units_consumed <= 100:
    category = "low"
elif units_consumed <= 200:
    category = "medium"
elif units_consumed <= 300:
    category = "high"
else:
    category = "very_high"

# Get and return the customer charges for this customer type and category
customer_charges = customer_charges_structure[customer_type][category]
return customer_charges

def calculate_electricity_duty(energy_charges, customer_type):
    # Define electricity duty percentage by customer type
    # ED is calculated as a percentage of Energy Charges

```

```

duty_percentage = {
    "Domestic": 5.0,    # 5% of EC for Domestic customers
    "Commercial": 8.0,   # 8% of EC for Commercial customers
    "Industrial": 10.0   # 10% of EC for Industrial customers
}

# Validate customer type
if customer_type not in duty_percentage:
    raise ValueError(f"Invalid customer type: {customer_type}. Must be Domestic, Commercial, or Industrial")

# Validate energy charges
if energy_charges < 0:
    raise ValueError("Energy Charges cannot be negative")

# Calculate electricity duty as percentage of energy charges
duty_percent = duty_percentage[customer_type]
electricity_duty = energy_charges * (duty_percent / 100.0)

return electricity_duty

def calculate_total_bill(previous_units, current_units, customer_type):
    # Validate inputs
    if previous_units < 0:
        raise ValueError("Previous Units cannot be negative")
    if current_units < 0:
        raise ValueError("Current Units cannot be negative")
    if current_units < previous_units:
        raise ValueError("Current Units cannot be less than Previous Units")

```

```
# Calculate units consumed (difference between current and previous readings)
units_consumed = current_units - previous_units

# Calculate Energy Charges using the dedicated function
energy_charges = calculate_energy_charges(units_consumed, customer_type)

# Calculate Fixed Charges using the dedicated function
fixed_charges = calculate_fixed_charges(customer_type, units_consumed)

# Calculate Customer Charges using the dedicated function
customer_charges = calculate_customer_charges(customer_type, units_consumed)

# Calculate Electricity Duty as percentage of Energy Charges
electricity_duty = calculate_electricity_duty(energy_charges, customer_type)

# Calculate total bill (EC + FC + CC + ED)
total_bill = energy_charges + fixed_charges + customer_charges + electricity_duty

# Return all calculated values as a dictionary
return {
    "previous_units": previous_units,
    "current_units": current_units,
    "units_consumed": units_consumed,
    "customer_type": customer_type,
    "energy_charges": energy_charges,
    "fixed_charges": fixed_charges,
    "customer_charges": customer_charges,
    "electricity_duty": electricity_duty,
    "total_bill": total_bill
}
```

```
}
```

```
def get_user_input():

    print("=" * 70)

    print("UTILITY BILL CALCULATOR - Extended Version")

    print("Calculates: EC, FC, CC, and ED")

    print("=" * 70)

# Get Previous Units (PU) with validation

    while True:

        try:

            previous_units = float(input("\nEnter Previous Units (PU): "))

            if previous_units < 0:

                print("Error: Previous Units cannot be negative. Please try again.")

                continue

            break

        except ValueError:

            print("Error: Please enter a valid number.")

# Get Current Units (CU) with validation

    while True:

        try:

            current_units = float(input("Enter Current Units (CU): "))

            if current_units < 0:

                print("Error: Current Units cannot be negative. Please try again.")

                continue

            if current_units < previous_units:

                print("Error: Current Units cannot be less than Previous Units. Please try again.")

                continue
```

```
break
except ValueError:
    print("Error: Please enter a valid number.")

# Get Customer Type with validation
print("\nCustomer Types:")
print("1. Domestic")
print("2. Commercial")
print("3. Industrial")

customer_types = {"1": "Domestic", "2": "Commercial", "3": "Industrial"}

while True:
    choice = input("\nEnter Customer Type (1/2/3): ").strip()
    if choice in customer_types:
        customer_type = customer_types[choice]
        break
    print("Error: Please enter 1, 2, or 3.")

return previous_units, current_units, customer_type
```

```
def display_bill(bill_details):
```

```
    ....
```

```
    Display the calculated bill in a formatted, user-friendly manner.
```

Args:

bill_details (dict): Dictionary containing bill calculation results

```
    ....
```

```
    print("\n" + "=" * 70)
```

```

print("BILL CALCULATION RESULTS")
print("=" * 70)

print(f"Previous Units (PU): {bill_details['previous_units']:.2f} units")
print(f"Current Units (CU): {bill_details['current_units']:.2f} units")
print(f"Units Consumed: {bill_details['units_consumed']:.2f} units")
print(f"Customer Type: {bill_details['customer_type']}")

print("-" * 70)

print("CHARGE BREAKDOWN:")

print(f" Energy Charges (EC): ₹{bill_details['energy_charges']:.2f}")
print(f" Fixed Charges (FC): ₹{bill_details['fixed_charges']:.2f}")
print(f" Customer Charges (CC): ₹{bill_details['customer_charges']:.2f}")
print(f" Electricity Duty (ED): ₹{bill_details['electricity_duty']:.2f}")

print("-" * 70)

print(f"TOTAL BILL AMOUNT: ₹{bill_details['total_bill']:.2f}")

print("=" * 70)

```

```
def main():
```

```
    try:
```

Step 1: Get user input

```
        previous_units, current_units, customer_type = get_user_input()
```

```
        bill_details = calculate_total_bill(previous_units, current_units, customer_type)
```

Step 3: Display the calculated bill

```
        display_bill(bill_details)
```

```
    except ValueError as e:
```

```
        print(f"\nError: {e}")
```

```
    except Exception as e:
```

```
        print(f"\nUnexpected error: {e}")
```

```
# Program entry point

if __name__ == "__main__":
    main()
```

Output:

The screenshot shows a Jupyter Notebook interface with two code cells and their outputs.

Code Cell 1:

```
Electricity duty and billing calculations
(give in another file)

1 EC (Customer Charged) — service charges by customer type and
consumption
2 FC (Electricity Duty) — percentage of EC (5% Domestic, 8%
Commercial, 10% Industrial)

Functions included:
• calculate_energy_charge() — Energy Charges calculation
• calculate_fix_charges() — Fixed Charges calculation
• calculate_customer_charge() — Customer Charges
calculation
• calculate_electricity_duty() — Electricity Duty calculation
(percentage of EC)
• calculate_total_bill() — Main function that calculates all
components
• get_user_input() — User Input with validation
• display_bill() — Formatted bill display
• main() — Program entry point

Bill Display:
The Bill shows:
• Previous Units (PU) and Current Units (CU)
• Units Consumed
```

Code Cell 2:

```
utility_bill_calculator_ecdomestic.py @ calculate_energy_charge()
rate_structure = [
    {
        "customer_type": "Domestic",
        "units_consumed": 0,
        "rate": 0.50
    },
    {
        "customer_type": "Domestic",
        "units_consumed": 100,
        "rate": 0.50
    },
    {
        "customer_type": "Domestic",
        "units_consumed": 200,
        "rate": 0.50
    },
    {
        "customer_type": "Domestic",
        "units_consumed": 300,
        "rate": 0.50
    },
    {
        "customer_type": "Domestic",
        "units_consumed": float("inf"),
        "rate": 0.50
    }
]
{
    "customer_type": "Commercial",
    "units_consumed": 0,
    "rate": 0.75
}
{
    "customer_type": "Commercial",
    "units_consumed": 100,
    "rate": 0.75
}
{
    "customer_type": "Commercial",
    "units_consumed": 200,
    "rate": 0.75
}
{
    "customer_type": "Commercial",
    "units_consumed": 300,
    "rate": 0.75
}
{
    "customer_type": "Commercial",
    "units_consumed": float("inf"),
    "rate": 0.75
}
{
    "customer_type": "Industrial",
    "units_consumed": 0,
    "rate": 0.90
}
{
    "customer_type": "Industrial",
    "units_consumed": 100,
    "rate": 0.90
}
{
    "customer_type": "Industrial",
    "units_consumed": 200,
    "rate": 0.90
}
{
    "customer_type": "Industrial",
    "units_consumed": 300,
    "rate": 0.90
}
{
    "customer_type": "Industrial",
    "units_consumed": float("inf"),
    "rate": 0.90
}

def calculate_energy_charge(units_consumed, customer_type):
    rate_structure = [
        {
            "customer_type": "Domestic",
            "units_consumed": 0,
            "rate": 0.50
        },
        {
            "customer_type": "Domestic",
            "units_consumed": 100,
            "rate": 0.50
        },
        {
            "customer_type": "Domestic",
            "units_consumed": 200,
            "rate": 0.50
        },
        {
            "customer_type": "Domestic",
            "units_consumed": 300,
            "rate": 0.50
        },
        {
            "customer_type": "Domestic",
            "units_consumed": float("inf"),
            "rate": 0.50
        }
    ]
    {
        "customer_type": "Commercial",
        "units_consumed": 0,
        "rate": 0.75
    }
    {
        "customer_type": "Commercial",
        "units_consumed": 100,
        "rate": 0.75
    }
    {
        "customer_type": "Commercial",
        "units_consumed": 200,
        "rate": 0.75
    }
    {
        "customer_type": "Commercial",
        "units_consumed": 300,
        "rate": 0.75
    }
    {
        "customer_type": "Commercial",
        "units_consumed": float("inf"),
        "rate": 0.75
    }
}
{
    "customer_type": "Industrial",
    "units_consumed": 0,
    "rate": 0.90
}
{
    "customer_type": "Industrial",
    "units_consumed": 100,
    "rate": 0.90
}
{
    "customer_type": "Industrial",
    "units_consumed": 200,
    "rate": 0.90
}
{
    "customer_type": "Industrial",
    "units_consumed": 300,
    "rate": 0.90
}
{
    "customer_type": "Industrial",
    "units_consumed": float("inf"),
    "rate": 0.90
}

def calculate_fix_charges():
    return 5
```

Output Cell 1:

```
UTILITY BILL CALCULATOR - Extended Version
Calculates: EC, FC, CC, and ED
```

Output Cell 2:

```
Enter Previous Units (PU): 25
Enter Current Units (CU): 50
Customer Types:
1. Domestic
2. Commercial
3. Industrial
Enter Customer Type (1/2/3): 1
Do you want to install the new 'rainbow_csv' extension from
datacamp? [Y/n]: n
```

UTILITY BILL CALCULATOR - Extended Version

Calculates: EC, FC, CC, and ED

Enter Previous Units (PU): 25

Enter Current Units (CU): 50

Customer Types:

1. Domestic

2. Commercial

3. Industrial

Enter Customer Type (1/2/3): 1

BILL CALCULATION RESULTS

Previous Units (PU): 25.00 units

Current Units (CU): 50.00 units

Units Consumed: 25.00 units

Customer Type: Domestic

CHARGE BREAKDOWN:

Energy Charges (EC): ₹87.50

Fixed Charges (FC): ₹50.00

Customer Charges (CC): ₹25.00

Electricity Duty (ED): ₹4.38

TOTAL BILL AMOUNT: ₹166.88

Explanation:

- calculate_energy_charges() — Energy Charges calculation
- calculate_fixed_charges() — Fixed Charges calculation
- calculate_customer_charges() — Customer Charges calculation
- calculate_electricity_duty() — Electricity Duty calculation (percentage of EC)
- calculate_total_bill() — Main function that calculates all components
- get_user_input() — User input with validation
- display_bill() — Formatted bill display
- main() — Program entry point

Task-05

Prompt: Develop a Python application to calculate and display Energy Charges (EC), Fixed Charges (FC), Customer Charges (CC), Electricity Duty (ED), and the Total Bill (EC + FC + CC + ED).

Code:

```
def calculate_energy_charges(units_consumed, customer_type):  
    rate_structure = {  
        "Domestic": [  
            (0, 100, 3.50),    # First 100 units at ₹3.50 per unit  
            (101, 200, 4.50),   # Next 100 units (101-200) at ₹4.50 per unit  
            (201, 300, 5.50),   # Next 100 units (201-300) at ₹5.50 per unit  
            (301, float('inf'), 6.50) # Above 300 units at ₹6.50 per unit
```

```

        ],
    "Commercial": [
        (0, 100, 5.00),    # First 100 units at ₹5.00 per unit
        (101, 200, 6.00),   # Next 100 units (101-200) at ₹6.00 per unit
        (201, 300, 7.00),   # Next 100 units (201-300) at ₹7.00 per unit
        (301, float('inf'), 8.00) # Above 300 units at ₹8.00 per unit
    ],
    "Industrial": [
        (0, 100, 6.00),    # First 100 units at ₹6.00 per unit
        (101, 200, 7.50),   # Next 100 units (101-200) at ₹7.50 per unit
        (201, 300, 9.00),   # Next 100 units (201-300) at ₹9.00 per unit
        (301, float('inf'), 10.50) # Above 300 units at ₹10.50 per unit
    ]
}

# Validate customer type
if customer_type not in rate_structure:
    raise ValueError(f"Invalid customer type: {customer_type}. Must be Domestic, Commercial, or Industrial")

# Validate units consumed
if units_consumed < 0:
    raise ValueError("Units consumed cannot be negative")

# Get the applicable rate slabs for the customer type
slabs = rate_structure[customer_type]

# Find the applicable rate based on units consumed
for min_units, max_units, rate_per_unit in slabs:
    if min_units <= units_consumed <= max_units:
        # Units fall within this slab, calculate charges at this rate
        energy_charges = units_consumed * rate_per_unit
return energy_charges

```

```

# Fallback: If consumption exceeds all defined slabs, use the highest rate
highest_rate = slabs[-1][2]
return units_consumed * highest_rate

def calculate_fixed_charges(customer_type, units_consumed):
    fixed_charges_structure = {
        "Domestic": {
            "low": 50.00, # For consumption up to 100 units
            "medium": 75.00, # For consumption 101-200 units
            "high": 100.00, # For consumption 201-300 units
            "very_high": 150.00 # For consumption above 300 units
        },
        "Commercial": {
            "low": 200.00, # For consumption up to 100 units
            "medium": 300.00, # For consumption 101-200 units
            "high": 400.00, # For consumption 201-300 units
            "very_high": 500.00 # For consumption above 300 units
        },
        "Industrial": {
            "low": 500.00, # For consumption up to 100 units
            "medium": 750.00, # For consumption 101-200 units
            "high": 1000.00, # For consumption 201-300 units
            "very_high": 1500.00 # For consumption above 300 units
        }
    }

# Validate customer type
if customer_type not in fixed_charges_structure:
    raise ValueError(f"Invalid customer type: {customer_type}. Must be Domestic, Commercial, or Industrial")

# Determine consumption category based on units consumed
if units_consumed <= 100:

```

```

category = "low"

elif units_consumed <= 200:
    category = "medium"

elif units_consumed <= 300:
    category = "high"

else:
    category = "very_high"

# Get and return the fixed charges for this customer type and category

fixed_charges = fixed_charges_structure[customer_type][category]

return fixed_charges

def calculate_customer_charges(customer_type, units_consumed):
    customer_charges_structure = {

        "Domestic": {

            "low": 25.00,    # For consumption up to 100 units

            "medium": 35.00, # For consumption 101-200 units

            "high": 50.00,   # For consumption 201-300 units

            "very_high": 75.00 # For consumption above 300 units

        },

        "Commercial": {

            "low": 100.00,   # For consumption up to 100 units

            "medium": 150.00, # For consumption 101-200 units

            "high": 200.00,   # For consumption 201-300 units

            "very_high": 300.00 # For consumption above 300 units

        },

        "Industrial": {

            "low": 250.00,   # For consumption up to 100 units

            "medium": 400.00, # For consumption 101-200 units

            "high": 600.00,   # For consumption 201-300 units

            "very_high": 900.00 # For consumption above 300 units

        }

    }

```

```

    }
}

# Validate customer type

if customer_type not in customer_charges_structure:
    raise ValueError(f"Invalid customer type: {customer_type}. Must be Domestic,
Commercial, or Industrial")

# Determine consumption category based on units consumed

if units_consumed <= 100:
    category = "low"
elif units_consumed <= 200:
    category = "medium"
elif units_consumed <= 300:
    category = "high"
else:
    category = "very_high"

# Get and return the customer charges for this customer type and category

customer_charges = customer_charges_structure[customer_type][category]
return customer_charges

def calculate_electricity_duty(energy_charges, customer_type):
    duty_percentage = {
        "Domestic": 5.0,    # 5% of EC for Domestic customers
        "Commercial": 8.0,   # 8% of EC for Commercial customers
        "Industrial": 10.0   # 10% of EC for Industrial customers
    }

# Validate customer type

if customer_type not in duty_percentage:
    raise ValueError(f"Invalid customer type: {customer_type}. Must be Domestic,
Commercial, or Industrial")

# Validate energy charges

if energy_charges < 0:

```

```

    raise ValueError("Energy Charges cannot be negative")

# Calculate electricity duty as percentage of energy charges

duty_percent = duty_percentage[customer_type]

electricity_duty = energy_charges * (duty_percent / 100.0)

return electricity_duty

def calculate_total_bill(previous_units, current_units, customer_type):

    # Validate inputs

    if previous_units < 0:

        raise ValueError("Previous Units cannot be negative")

    if current_units < 0:

        raise ValueError("Current Units cannot be negative")

    if current_units < previous_units:

        raise ValueError("Current Units cannot be less than Previous Units")

    # Calculate units consumed (difference between current and previous readings)

units_consumed = current_units - previous_units

# Calculate Energy Charges (EC)

energy_charges = calculate_energy_charges(units_consumed, customer_type)

# Calculate Fixed Charges (FC)

fixed_charges = calculate_fixed_charges(customer_type, units_consumed)

# Calculate Customer Charges (CC)

customer_charges = calculate_customer_charges(customer_type, units_consumed)

# Calculate Electricity Duty (ED) as percentage of Energy Charges

electricity_duty = calculate_electricity_duty(energy_charges, customer_type)

# Calculate total bill (EC + FC + CC + ED)

total_bill = energy_charges + fixed_charges + customer_charges + electricity_duty

# Return all calculated values as a dictionary

return {

    "previous_units": previous_units,

    "current_units": current_units,
}

```

```
        "units_consumed": units_consumed,  
        "customer_type": customer_type,  
        "energy_charges": energy_charges,  
        "fixed_charges": fixed_charges,  
        "customer_charges": customer_charges,  
        "electricity_duty": electricity_duty,  
        "total_bill": total_bill  
  
    }  
  
}
```

```
def get_user_input():  
  
    print("=" * 70)  
    print("ELECTRICITY BILL CALCULATOR")  
    print("Calculates: EC, FC, CC, ED, and Total Bill")  
    print("=" * 70)  
  
    # Get Previous Units (PU) with validation  
  
    while True:  
  
        try:  
            previous_units = float(input("\nEnter Previous Units (PU): "))  
            if previous_units < 0:  
                print("Error: Previous Units cannot be negative. Please try again.")  
                continue  
            break  
        except ValueError:  
            print("Error: Please enter a valid number.")  
  
    # Get Current Units (CU) with validation  
  
    while True:  
  
        try:  
            current_units = float(input("Enter Current Units (CU): "))  
            if current_units < 0:
```

```
    print("Error: Current Units cannot be negative. Please try again.")

    continue

if current_units < previous_units:

    print("Error: Current Units cannot be less than Previous Units. Please try again.")

    continue

break

except ValueError:

    print("Error: Please enter a valid number.")

# Get Customer Type with validation

print("\nCustomer Types:")

print("1. Domestic")

print("2. Commercial")

print("3. Industrial")

customer_types = {"1": "Domestic", "2": "Commercial", "3": "Industrial"}

while True:

    choice = input("\nEnter Customer Type (1/2/3): ").strip()

    if choice in customer_types:

        customer_type = customer_types[choice]

        break

    print("Error: Please enter 1, 2, or 3.")

return previous_units, current_units, customer_type

def display_bill(bill_details):

    print("\n" + "=" * 70)

    print("ELECTRICITY BILL STATEMENT")

    print("=" * 70)

    print(f"Previous Units (PU): {bill_details['previous_units']:.2f} units")

    print(f"Current Units (CU): {bill_details['current_units']:.2f} units")

    print(f"Units Consumed: {bill_details['units_consumed']:.2f} units")

    print(f"Customer Type: {bill_details['customer_type']}")
```

```

print("-" * 70)

print("CHARGE BREAKDOWN:")

print(f" Energy Charges (EC): ₹{bill_details['energy_charges']:.2f}")
print(f" Fixed Charges (FC): ₹{bill_details['fixed_charges']:.2f}")
print(f" Customer Charges (CC): ₹{bill_details['customer_charges']:.2f}")
print(f" Electricity Duty (ED): ₹{bill_details['electricity_duty']:.2f}")

print("-" * 70)

print(f"TOTAL BILL AMOUNT: ₹{bill_details['total_bill']:.2f}")

print("=" * 70)

def main():

    try:

        # Step 1: Get user input

        previous_units, current_units, customer_type = get_user_input()

        # Step 2: Calculate bill with all components

        bill_details = calculate_total_bill(previous_units, current_units, customer_type)

        # Step 3: Display the calculated bill

        display_bill(bill_details)

    except ValueError as e:

        print(f"\nError: {e}")

    except Exception as e:

        print(f"\nUnexpected error: {e}")

if __name__ == "__main__":
    main()

```

Output:

ELECTRICITY BILL STATEMENT

Previous Units (PU): 56.00 units
 Current Units (CU): 56.00 units
 Units Consumed: 0.00 units
 Customer Type: Domestic

CHARGE BREAKDOWN:

Energy Charges (EC): ₹0.00

Fixed Charges (FC): ₹50.00

Customer Charges (CC): ₹25.00

Electricity Duty (ED): ₹0.00

TOTAL BILL AMOUNT: ₹75.00

```
def calculate_energy_charges(units_consumed, customer_type):
    rate_structure = {
        "domestic": [
            (0, 500, 3.50),  # 0-500 units at ₹3.50 per unit
            (501, 200, 4.50), # Next 200 units (501-700) at ₹4.50 per unit
            (201, 300, 5.50), # Next 300 units (701-1000) at ₹5.50 per unit
            (301, float('inf'), 6.50) # Above 1000 units at ₹6.50 per unit
        ],
        "commercial": [
            (0, 500, 3.50),  # 0-500 units at ₹3.50 per unit
            (501, 200, 4.50), # Next 200 units (501-700) at ₹4.50 per unit
            (201, 300, 5.50), # Next 300 units (701-1000) at ₹5.50 per unit
            (301, float('inf'), 6.50) # Above 1000 units at ₹6.50 per unit
        ],
        "industrial": [
            (0, 500, 3.00),  # 0-500 units at ₹3.00 per unit
            (501, 200, 4.00), # Next 200 units (501-700) at ₹4.00 per unit
            (201, 300, 5.00), # Next 300 units (701-1000) at ₹5.00 per unit
            (301, float('inf'), 6.00) # Above 1000 units at ₹6.00 per unit
        ]
    }
    return sum([rate[2] * min(rate[1], units_consumed) for rate in rate_structure[customer_type] if rate[1] <= units_consumed])
```

ELECTRICITY BILL STATEMENT

previous units (PU):	56.00 units
current units (CU):	56.00 units
units consumed:	0.00 units
customer type:	Domestic

CHARGE BREAKDOWN:

Energy Charges (EC):	₹0.00
Fixed charges (FC):	₹50.00
Customer Charges (CC):	₹25.00
Electricity duty (ED):	₹0.00

TOTAL BILL AMOUNT: ₹75.00

Explanation:

- `calculate_energy_charges()` — Calculates EC using slab-based rates
- `calculate_fixed_charges()` — Calculates FC based on consumption category
- `calculate_customer_charges()` — Calculates CC based on consumption category
- `calculate_electricity_duty()` — Calculates ED as a percentage of EC
- `calculate_total_bill()` — Orchestrates all calculations
- `get_user_input()` — Handles user input with validation
- `display_bill()` — Displays formatted bill statement
- `main()` — Main program entry point

