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Student ID. : ……………………

Date & Year: …………………. Working Table No. : ……. Section: …….. Group: ..………..…

Course: EEE 4384 (Electronic Devices and Circuits Lab)
Experiment no.: 01
Name of the experiment: Study of Different types of diode Characteristics and its Applications

OBJECTIVE

- To draw the Voltage-Current (V-I) Characteristics of PN Junction Diode.
- To draw the Voltage-Current (V-I) Characteristics of Zener Diode.
- To Construct the Circuit and observe the wave shapes of Half wave Diode Rectifier.
- To Construct the Circuit and observe the wave shapes of Full wave Diode Rectifiers.

Task 1: To draw the Voltage-Current Characteristics of PN Junction Diode

Objective:
To draw the voltage-current characteristics of PN junction diode under forward and reverse bias condition and to determine cut in voltage, reverse saturation current and forward dynamic resistance.

Theory:
A PN junction diode conducts only in one direction. It is an example of **unilateral element**. The V-I characteristics of the diode are curve between **voltage across the diode** (V_d) and **current through the diode** (I_d). When external voltage is zero, circuit is open and the potential barrier does not allow the current to flow. Therefore, the circuit current is zero.

When P-type (Anode is connected to +ve terminal and N type (cathode) is connected to -ve terminal of the supply voltage, is known as **forward bias**. The potential barrier is reduced, when diode is in the forward biased condition. At some forward voltage, the potential barrier altogether eliminated and current starts flowing through the diode and also in the circuit. The diode is said to be in ON state. The current increases with increasing forward voltage.

When N-type (cathode) is connected to +ve terminal and P-type (Anode) is connected to the –ve terminal of the supply voltage is known as **reverse bias** and the potential barrier across the junction increases. Therefore, the junction resistance becomes very high and a very small current (reverse saturation current) flows in the circuit. The diode is said to be in OFF state. The reverse bias current is due to minority charge carriers.

An ideal PN junction Diode is a two terminal polarity sensitive device that has zero resistance (diode conducts) when it is forward biased and infinite resistance (diode doesn't conduct) when it is reverse biased.

Due to this characteristic, the diode finds number of applications as 1. Rectifiers in DC power supply, 2. Switch in digital circuits, 3. Clamping, Clipping circuits network used in TV Receiver, 4. Demodulation (detector) circuits.

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Apparatus required:

S.NO.	NAME OF THE EQUIPMENT	TYPE	RANGE	QUANTITY (NO.S)
1.	Diode	IN 4007		1
2.	Zener Diode		5.6V or Suitable	1
3.	Resistor		10k Ω	1
4.	Voltmeter	MC	(0 – 30V)	1
5.	Ammeter	MC	(0 – 50mA) , (0 - 500μA)	1
6.	Bread Board			1
7.	Connecting wires			Required

Circuit diagram: (Draw)

Fig 1.a : Forward Bias Condition

Fig 1.b: Reverse Bias Condition

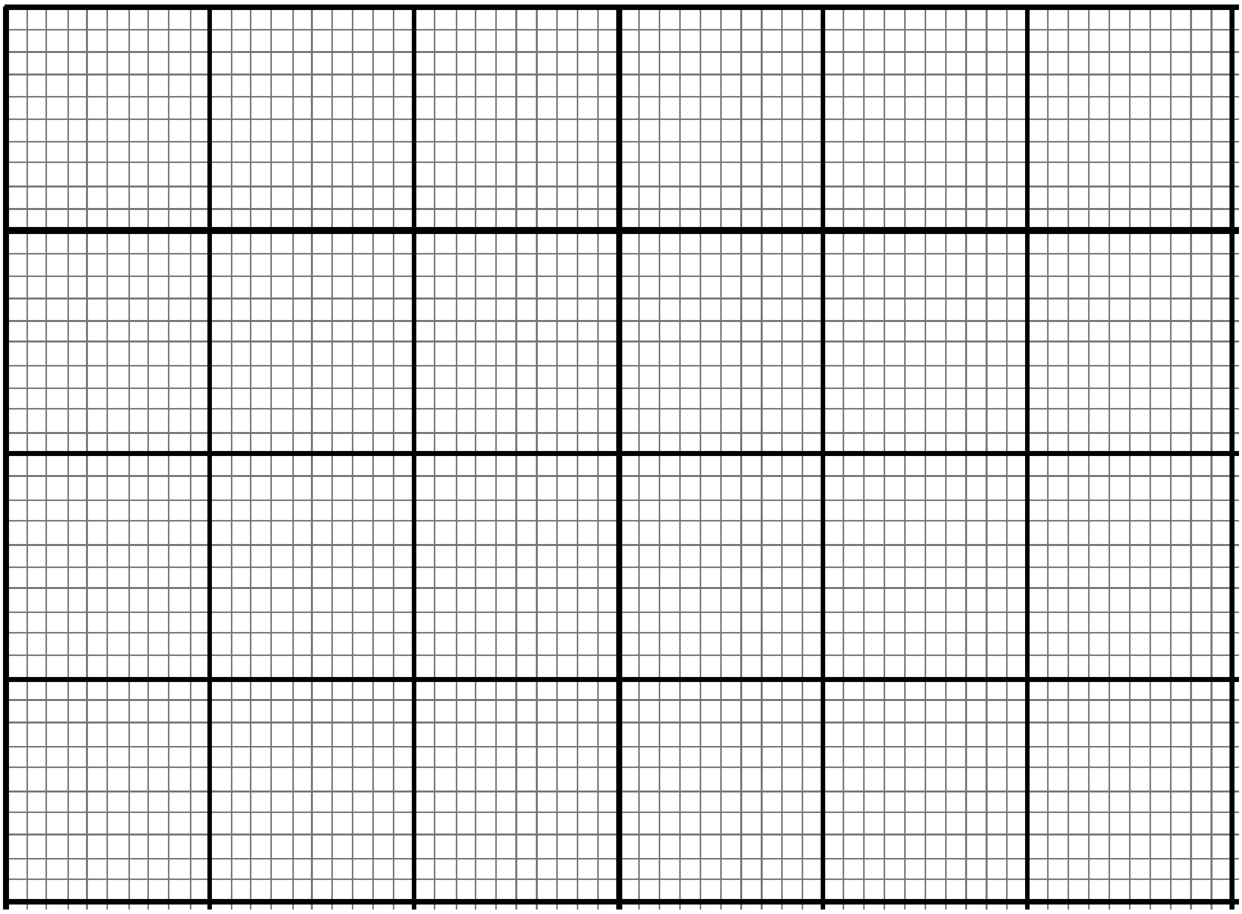
Procedure:

1. Identify the anode and cathode terminals of a 1N4007 diode (or equivalent silicon diode such as BY126) and test it using a multi-meter. Set up the circuit on breadboard as shown in figure.
2. Wire the circuit as shown in figure. By varying the input voltage the ammeter and voltmeter readings are noted down for forward bias condition.
3. Wire the circuit as shown in figure. By varying the input voltage the ammeter and voltmeter readings are noted down for reverse bias condition.
4. Plot all the readings curves on a single graph sheet.

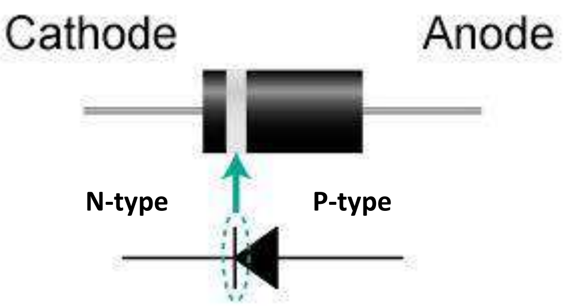
Tabulation:

Forward Bias				Reverse Bias		
Sl.No	**V_f (V)**	**I_f (mA)**		**Sl.No**	**V_r (V)**	**I_r (µA)**
1				**1**		
2				**2**		
3				**3**		
4				**4**		
5				**5**		
6				**6**		
7				**7**		
8				**8**		
9				**9**		
10				**10**		

RESULT: Plot the forward and reverse V-I characteristics of a diode and determine knee voltage, Static Resistance and Dynamic Resistance.



Graph 1: V-I Characteristics of PN Junction Diode



V$_{knee}$ = ______

Task 2: To Construct the Circuit and observe the wave shapes of Half wave Diode Rectifier.

Objective:
To construct half wave & full wave rectifier circuits using diodes & observe the input & output wave forms with & without filter.

To calculate, compare, and measure the DC output voltages of half-wave and full-wave rectifier circuits.

Theory:
The process of converting AC to DC is called Rectification. The primary function of half-wave and full-wave rectification systems is to establish a DC level from a sinusoidal input signal that has zero average (DC) level.

APPARATUS REQUIRED:

S.NO.	NAME OF THE EQUIPMENT	TYPE	RANGE	QUANTITY (NO.S)
1.	Diode	IN 4007		4
2.	Resistor		10 kΩ	1
3.	Transformer	Step-down	230 V /(12 – 0 – 12) V	1
4.	Voltmeter	MC	(0 – 30V)	1
5.	Capacitor	Electrolytic	1μF,2200μF	2
6.	Standard Project Board			1
7.	Connecting wires			Required

Half-Wave Rectifier:
It requires only single diode. Only positive cycle of the current is passed through the diode i.e only half of the AC wave is passed and hence the name half wave. Current flowing through the diode during the positive half-cycle produces approximately a half sine wave of voltages across the load resistor.

On the negative half-cycle of the input voltage, the diode is reverse-biased. Ignoring the reverse leakage current of the diode, the load current drops to zero, resulting in zero load voltage (output voltage). Thus, the diode circuit has rectified the input ac voltage, converting the ac voltage to a dc voltage.

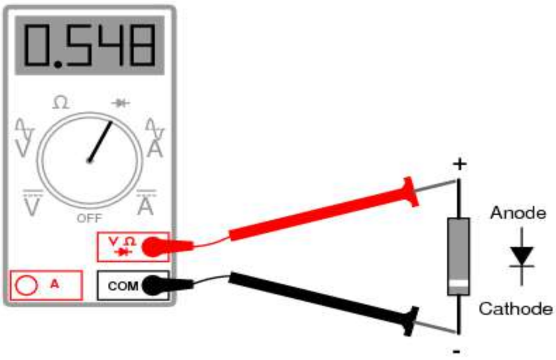
Circuit Diagram: (Draw)

Fig 2.a: A Half-wave rectifier:

Procedure:

Part-1: Threshold Voltage

Choose one of the four silicon diodes and determine the threshold voltage, V_T, using the diode-checking capability of the DMM.

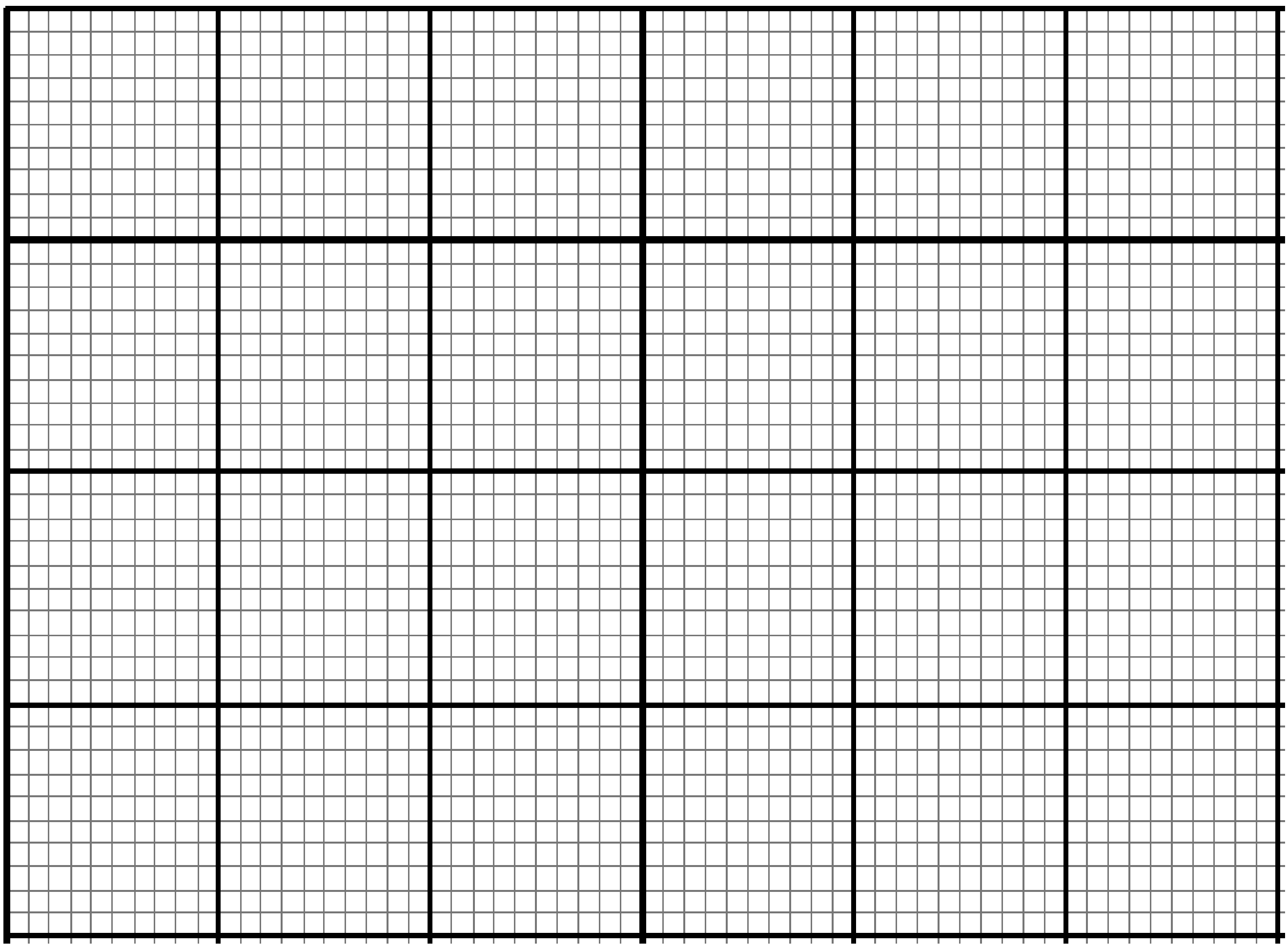


V_T = - - - - - - -

[N.B. some digital multi-meter manufacturers equip their meters with a special "diode check" function which displays the actual forward voltage drop of the diode in volts, rather than a "resistance" figure in ohms. These meters work by forcing a small current through the diode and measuring the voltage dropped between the two test leads. (Figure)]

Part-2: Half-Wave Rectification

1. Construct the circuit. Record the measured value of the resistance R(R= 10KΩ). Set the function generator to 1000 Hz, 8 V_{p-p} sinusoidal voltage (or suitable) using the oscilloscope.
2. Using the oscilloscope with the DC position, obtain the voltage v_o and sketch the waveform. Before viewing v_o be sure to set the v_o = 0 V line using the GND position of the coupling switch.
3. Reverse the diode of fig.b and sketch the output waveform obtained using the oscilloscope on graph sheet. Be sure the coupling is in the DC position.



Graph 2: Half-wave (Positive) Rectifier

Graph 3: Half-wave (Negative) Rectifier

Calculation:

Calculate the DC level of the half-wave rectifier signal using eq. $\mathbf{V_{dc} = 0.318\ .V_{peak}}$ volts (half-wave)

V_{DC} (calculated) =

For large sinusoidal inputs ($V_m >> V_T$) the forward-biased transition voltage V_T of a diode can be ignored. However, for situations when the peak value of the sinusoidal signal is not that much greater than V_T, V_T can have a noticeable effect on V_{DC}.

In rectification systems the **Peak Inverse Voltage (PIV)** must be considered carefully. The PIV voltage is the maximum reverse-bias voltage that a diode can handle. For typical single diode half-wave rectification systems, the required PIV level is equal to the peak value of the applied sinusoidal signal.

Task 3: To Construct the Circuit and observe the wave shapes of Full wave Diode Rectifiers.

Objective:
To construct full wave rectifier circuits using diodes & observe the input & output wave forms with & without filter.

To calculate, compare, and measure the DC output voltages of half-wave and full-wave rectifier circuits.

Full-Wave Bridge Configuration:

Theory: It requires 4 diodes. In both case positive and negative AC cycle is passed through the diode alternatively as per their forward bias condition (only positive cycle of the current is passed through the diode). Figure d shows a full-wave bridge rectifier with a load resistor R_L and an input sine wave derived from a transformer. During the positive half-cycle of the input voltage, diodes D2 and D3 are forward biased and diodes D1 and D4 are reverse biased.

Therefore, terminal A is positive and terminal B is negative, as shown in Figure. During the negative half-cycle, diodes D1 and D4 conduct, and again terminal A is positive and terminal B is negative. Thus, on either half-cycle, the load voltage has the same polarity and the load current is in the same direction, no matter which pair of diodes is conducting. The full-wave rectified signal is shown in Figure, with the Vo being the output voltage. Since the area under the curve of the full-wave rectified signal is twice that of the half-wave rectified signal, the average or dc value of the full-wave rectified signal, V_{dc}, is twice that of the half-wave rectifier.

Configuration:

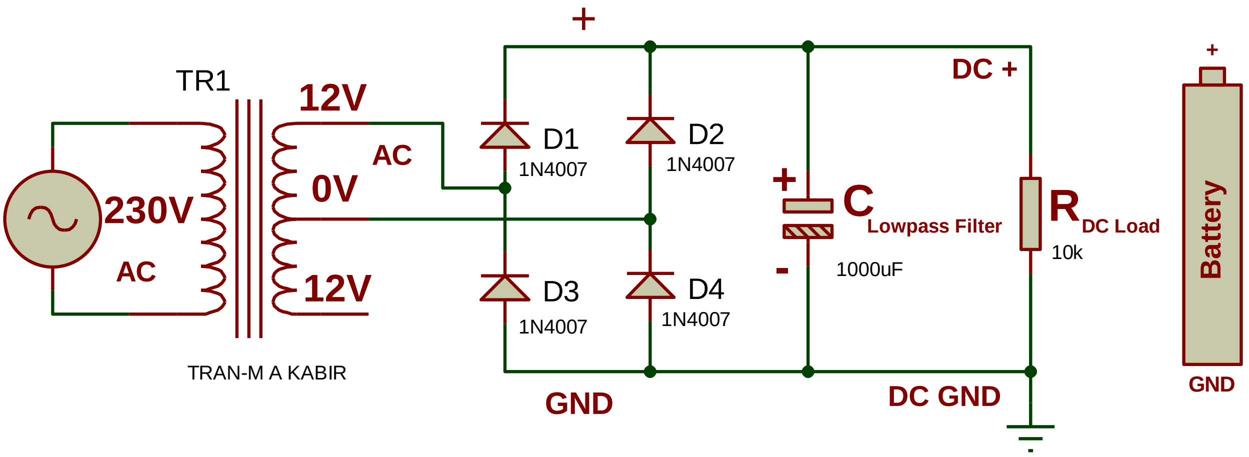
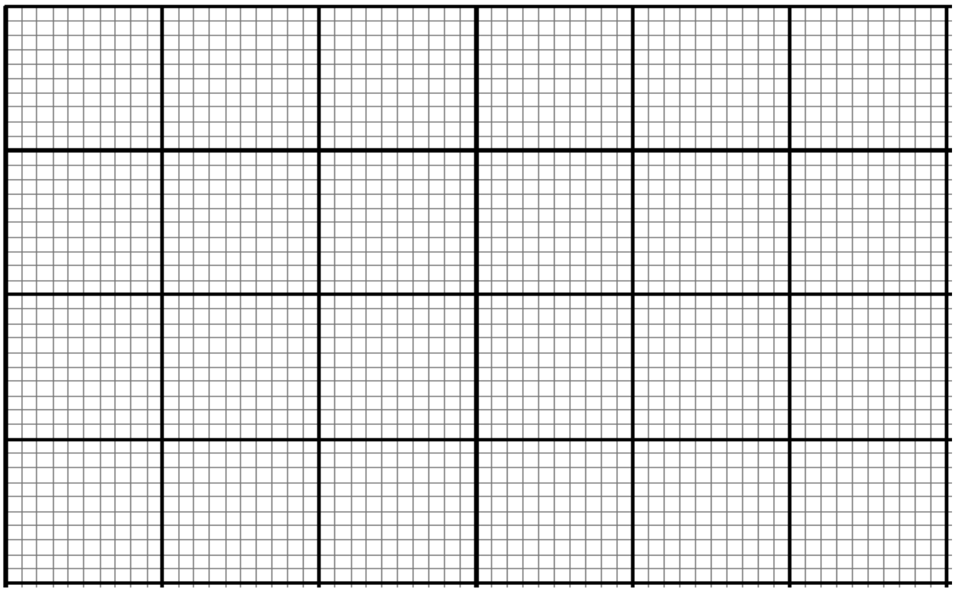


Fig 3.a: Full-Wave Bridge Rectifier

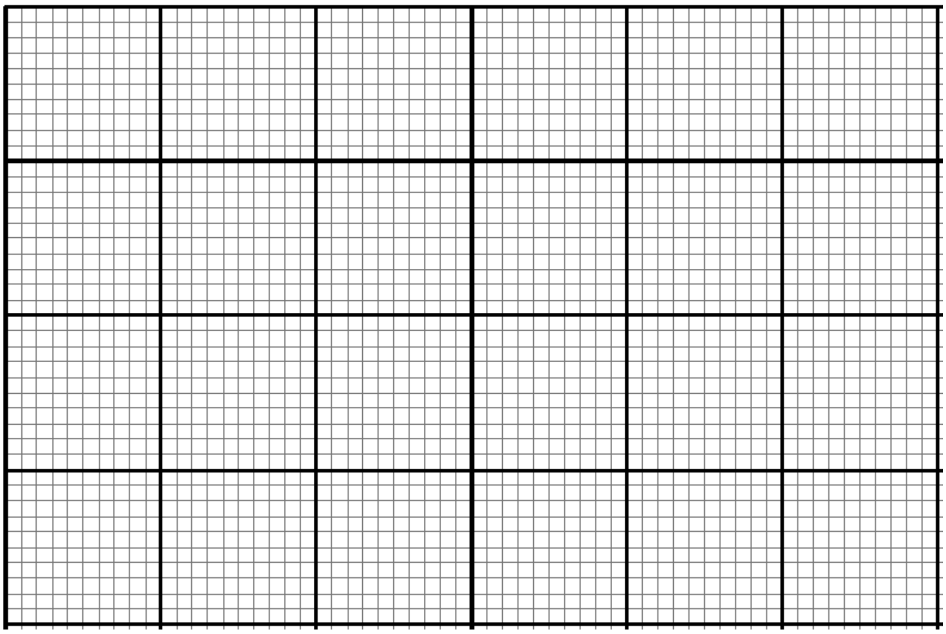
Procedure:

1. Construct the circuit shown in the **Fig 3.a:** (without filter capacitor C). Connect oscilloscope prove Ch-1 and Gnd at the secondary side of the transformer at the point 12V-0V to observe the AC signal wave shape.
2. Disconnect oscilloscope probe from secondary side of the transformer. Connect oscilloscope Ch-1 to "+" point where two cathodes of diode D1 and D2 are interconnected (used as DC + /System +/ Circuit +) and oscilloscope Gnd to "GND" point where two anodes of diode D3 and D4 are interconnected (used as DC GND /System GND/Circuit GND). Sketch the Pulsating DC waveform.
3. Explain why AC signal waveform and Pulsating DC waveform cannot observe in same time in the oscilloscope.

4. Connect 1μF filter Capacitor across the load and sketch the output DC waveform.
5. Connect 2200μF filter Capacitor across the load and sketch the output DC waveform explain the differences.



Graph 4: Full-Wave Bridge Rectifier (for 1μF Filter Capacitor)



Graph 5: Full-Wave Bridge Rectifier (for 2200μF Filter Capacitor)

Discussions:

Questions

QUIZ-1:

Q.1 Define semiconductor diode?
Q.2 Define depletion layer?
Q.3 what do you mean by forward biased?
Q.4 what do you mean by reverse biased?
Q.5 Define Knee voltage?
Q.6 Define breakdown voltage?
Q.7 Define max. Forward current?
Q.8 Define max. Power rating?
Q9. What is ideal diode?
Q10.What are the application of PN diodes?

QUIZ-2:

Q.1 Define Full wave rectifier?

Q.2 Which are different types of Full Wave rectifier?

Q.3 How many numbers of diodes are used in full wave rectifier?

Q.4 Give disadvantage of centre-tap wave rectifier?

Q.5 Write ripple factor for FW rectifier?

Q.6 What is the efficiency of FW rectifier?

Q.7 Write advantages of bridge rectifier?

Q.8 Write one feature of Full wave rectifier?

Q.9 Define Transformer Utilization Factor?

Q.10 Write the equation for DC current?

QUIZ-3:

Q.1 What is filter?

Q.2 Give commonly used filters?

Q.3 What is the equation of dc output voltage?

Q.4 When we can use inductor as a filter?

Q.5 What happens when the filter capacitor value larger?