


PAGE NUMBER INCORRECT OR MISSING PAGES IN MASTER COPY

Scoring Indicators

Course : BASIC ELECTRONICS

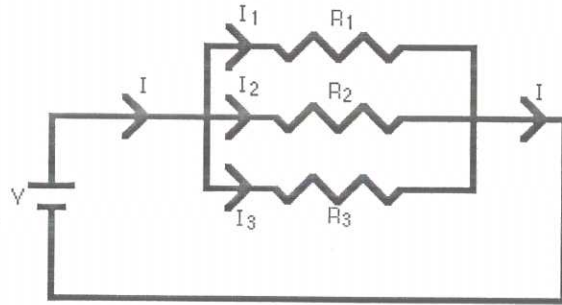
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Version :

Question No.	Scoring Indicators	Split Score	Sub Total	Total
I 1	<p><u>Capacitor</u> is an electronic component that stores electrical energy in the form of static electric field.</p> <p>Capacitors consist of two parallel electrical conductors separated by a non-conductive or insulating material called dielectric. Dielectric materials do not allow the electricity to flow through them</p> <div style="text-align: center;">  <p>Capacitor</p> </div>	2	2	2
I 2	<p>Pure semiconductors are called intrinsic semiconductors. Silicon and germanium are the most common examples of intrinsic semiconductors.</p> <p>In intrinsic semiconductor the number of electrons in the conduction band is equal to the number of holes in the valence band. Therefore the overall electric charge of a atom is neutral.</p>	2	2	2
I 3	<p>Ripple Factor is the ratio of <u>rms value of ac component</u> present in the rectified output to the <u>average value</u> of rectified output. It is a dimensionless quantity and denoted by γ. Its value is always less than unity.</p> $\text{Ripple Factor, } \gamma = \frac{\text{RMS value of AC component present in Rectifier Output}}{\text{Average Value of Rectifier Output}}$	2	2	2
I 4	$I_E = I_B + I_C$ $I_C = I_E - I_B$ $I_B = I_E - I_C$	2	2	2

II 2

Resistors in Parallel



The total resistance R_{total} is given by

$$1/R_{total} = 1/R_1 + 1/R_2 + 1/R_3.$$

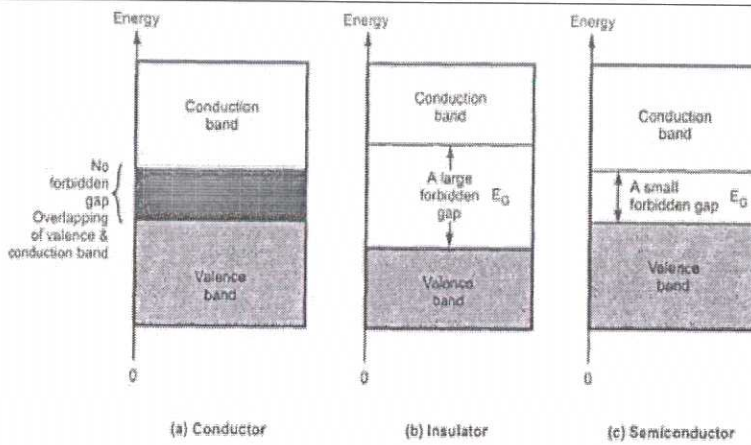
$$\text{Therefore, } R_{total} = R_1 * R_2 * R_3 / R_1 + R_2 + R_3$$

$$= 10 * 20 * 30 / 10 + 20 + 30$$

$$= 100\Omega$$

b b b

II 3

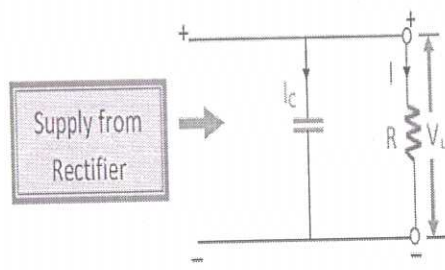
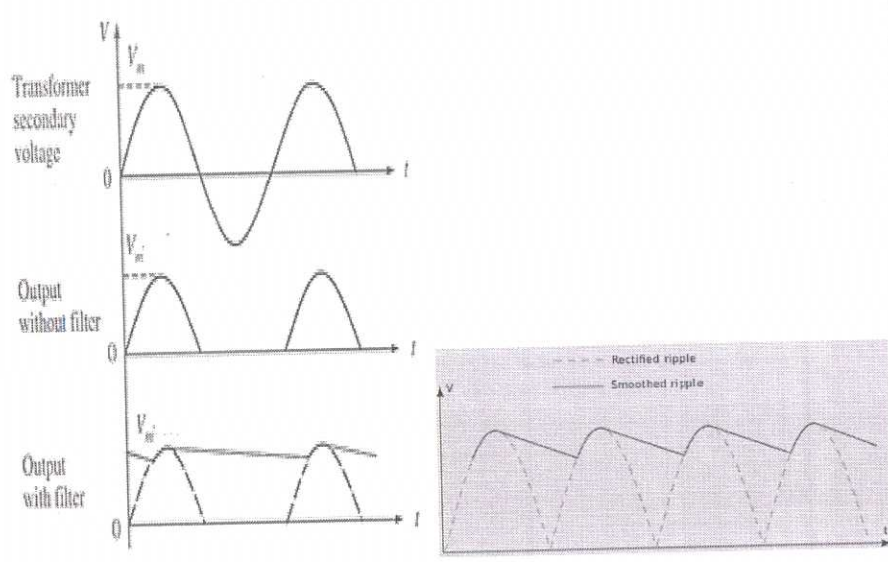


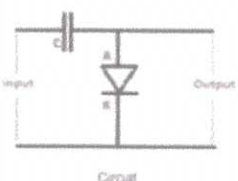
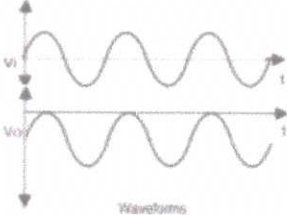
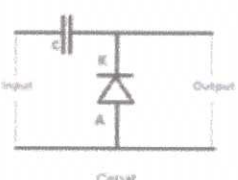
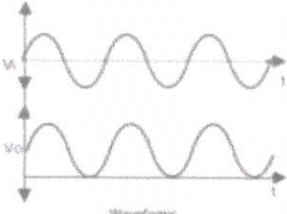
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b b.

<p>II 4</p>	<p>Zener Breakdown and Avalanche Breakdown</p> <p>There are two processes which can cause junction breakdown. One is called <i>zener breakdown</i> and the other is called <i>avalanche breakdown</i>. When reverse bias is increased, the electric field at the junction also increases. High electric field causes covalent bonds to break. Thus a large number of carriers are generated. This causes a large current to flow. This mechanism of breakdown is called <i>zener breakdown</i>.</p> <p>In case of avalanche breakdown, the increased electric field causes increase in the velocities of minority carriers. These high energy carriers break covalent bonds, thereby generating more carriers. Again, these generated carriers are accelerated by the electric field. They break more covalent bonds during their travel. A chain reaction is thus established, creating a large number of carriers. This gives rise to a high reverse current. This mechanism of breakdown is called <i>avalanche breakdown</i>.</p>	<p>3</p> <p>3</p>	<p>6</p>	<p>6</p>
<p>II 5</p>	<p>Shunt capacitor Filter</p>   <p><i>Explanation</i></p>	<p>2</p> <p>2</p> <p>2</p>	<p>6</p>	<p>6</p>

<p>II 6</p>	<p>The positive or negative peak of a signal can be positioned at the desired level by using the clamping circuits. As we can shift the levels of peaks of the signal by using a clamper, hence, it is also called as level shifter.</p> <p>The clamper circuit consists of a <u>capacitor</u> and diode connected in parallel across the load. The clamper circuit depends on the change in the time constant of the capacitor. The capacitor must be chosen such that, during the conduction of the diode, the capacitor must be sufficient to charge quickly and during the non conducting period of diode, the capacitor should not discharge drastically. The clammers are classified as positive and negative clammers based on the clamping method.</p> <p>1. Negative Clamper</p> <div style="display: flex; align-items: center;">  <div style="margin-left: 20px;">  </div> </div> <p style="text-align: right;">Negative Clamper</p> <p>During the positive half cycle, the input diode is in forward bias- and as the diode conducts-capacitor gets charged (up to peak value of input supply). During the negative half cycle, reverse does not conduct and the output voltage become equal to the sum of the input voltage and the voltage stored across the capacitor.</p> <p>2. Positive Clamper</p> <div style="display: flex; align-items: center;">  <div style="margin-left: 20px;">  </div> </div> <p style="text-align: right;">Positive Clamper</p> <p>It is almost similar to the negative clamper circuit, but the diode is connected in the opposite direction. During the positive half cycle, the voltage across the output terminals becomes equal to the sum of the input voltage and capacitor voltage (considering the capacitor as initially fully charged). During the negative half cycle of the input, the diode starts conducting and charges the capacitor rapidly to its peak input value. Thus the waveforms are clamped towards the positive direction as shown above.</p>	3		
<p>II 7</p>	<p>Depending upon the terminal which is used as a common terminal to the input and output terminals, the transistor can be connected in the following</p>	3	6	6

II 7

Depending upon the terminal which is used as a common terminal to the input and output terminals, the transistor can be connected in the following three configurations. They are:

- Common base (CB) configuration
- Common emitter (CE) configuration
- Common collector (CC) configuration

In every configuration, the base-emitter junction J_E is always forward biased and the collector-base junction J_C is always reverse biased to operate the transistor as a current amplifier.

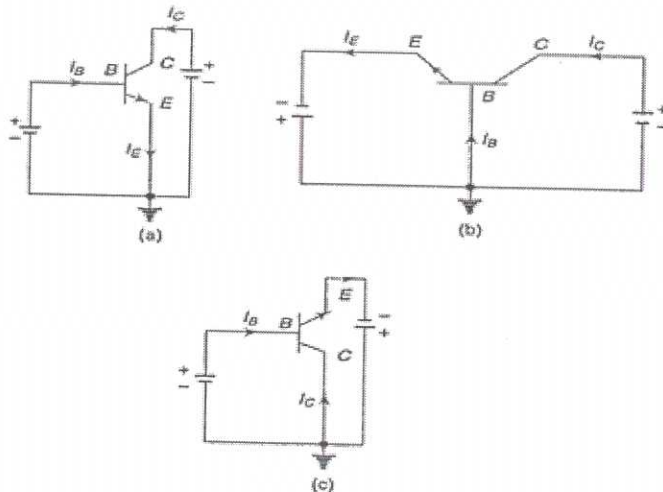
In common base configuration, emitter is the input terminal, collector is the output terminal, and base is the common terminal. The base terminal is grounded in the common base configuration. So the common base configuration is also known as grounded base configuration.

In common emitter configuration, base is the input terminal, collector is the output terminal, and emitter is the common terminal. The emitter terminal is grounded in the common emitter configuration. So the common emitter configuration is also known as grounded emitter configuration.

In common collector configuration, base is the input terminal, emitter

is the output terminal, and collector is the common terminal. The collector terminal is grounded in the common collector configuration. So the common collector configuration is also known as grounded collector configuration

Transistor configuration: (a) common emitter (b) common base
(c) common collector

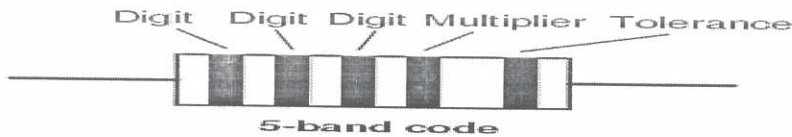
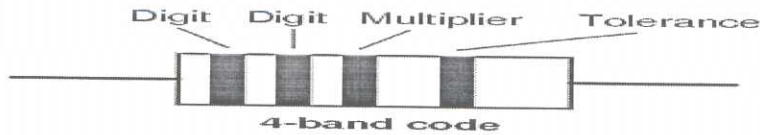


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III a

Color	Digit	Multiplier	Tolerance (%)
Black	0	10^0 (1)	
Brown	1	10^1	1
Red	2	10^2	2
Orange	3	10^3	
Yellow	4	10^4	
Green	5	10^5	0.5
Blue	6	10^6	0.25
Violet	7	10^7	0.1
Grey	8	10^8	
White	9	10^9	
Gold		10^{-1}	5
Silver		10^{-2}	10
(none)			20

The colors brown, red, green, blue, and violet are used as tolerance codes on 5-band resistors only. All 5-band resistors use a colored tolerance band. The blank (20%) "band" is only used with the "4-band" code (3 colored bands + a blank "band").



A resistor colored *Yellow-Violet-Orange-Gold* would be 47 k Ω with a tolerance of +/- 5%.



A resistor colored *Green-Red-Gold-Silver* would be 5.2 Ω with a tolerance of +/- 10%.



A resistor colored *White-Violet-Black* would be 97 Ω with a tolerance of +/- 20%.

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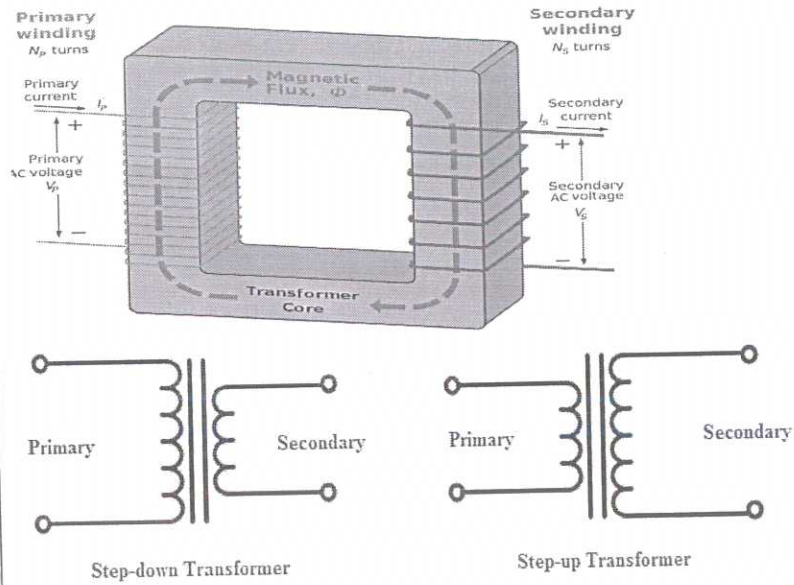
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III b

A Transformer is an electrical device that can be used to transfer the power from one circuit and another circuit without physical contact and without changing its characteristics like frequency, phase. It is an essential device in every electrical network circuitry. It consists majorly two circuits, namely primary circuit and one or more secondary circuit.



Working Principle of Transformer

The transformer working depends upon Faraday's electromagnetic induction law. The mutual induction phenomenon between two or more winding is responsible for power transformation.

According to Faraday's laws, "The Rate of change of flux linkage with respect to time is directly proportional to the EMF induced in a conductor or coil".

$$E = N \frac{d\phi}{dt}$$

Where,

E = Induced EMF

N = the number of turns

$d\phi$ = Change in flux

dt = Change in time

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IV a

Paper Capacitor

Such type of capacitors is very cheap, hence extensively employed fixed capacitors. The dielectric (insulating material between plates) is Kraft paper, a comparatively dense and very high durability sulfate paper, between the plates of aluminum plates, rolled up collectively and instilled with resin. The whole arrangement is enclosed in a plastic or metal case in order to avoid wet environment and contaminations. Axial leads are generally got out of each end. Normal capacitances of such type run from 0.0001 to 2 μF , with 200 to 600 V voltage ratings.

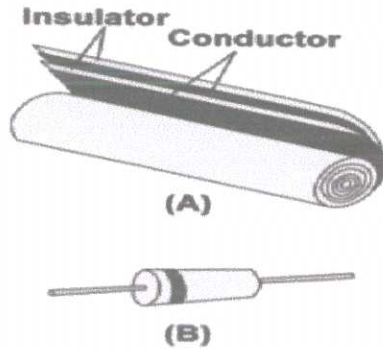


Fig.3: Paper Capacitor (a) Schematic Diagram (b) Symbol

Ceramic Capacitor

Such type of capacitors comprises a ceramic-made disc with silver electrodes linked to each flat surface. Leads are attached to these electrodes for allowing connection to the unit. Figure 8 exhibits the ceramic disc capacitor structure. these type of capacitors are utilized in certain applications ranging from low to very high frequency through 1000 Mega-Hz. Dielectric materials are formed from barium and strontium titanates mixtures, combined with rare earth and other additives in order to enhance electric characteristic.

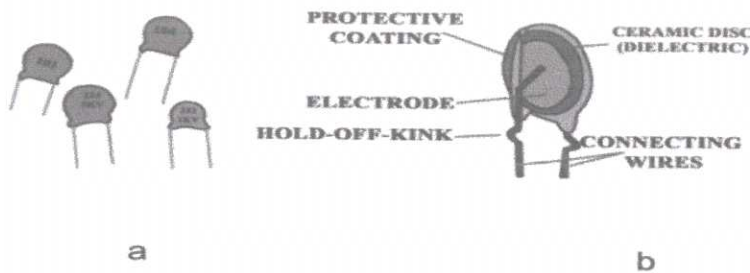


Fig.8: (a) Ceramic Disc Capacitor (b) Construction of a ceramic disc

IV b

Inductance

It is the current production in a coil due to change in magnetic flux in itself or new coil. Whenever there is a coil, and you have a change in magnetic flux or change in magnetic field, an induced emf is generated in that coil or wire. This very property is **inductance**.

Here $\Phi \propto I$, where, Φ is the magnetic flux and I is the current. In 'n' turns of the coil, $N \Phi \propto I$. It is a scalar quantity and it's SI unit is Henry. It is denoted by H.

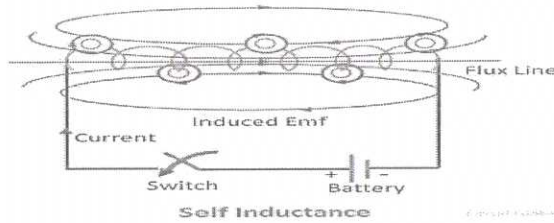
Self-induction means the coils induce the emf themselves. There is a change in the magnetic flux through that coil and because of this, the current will be induced in the coil by itself. So once the current get induced, the current tries to oppose the flux. Here $N\Phi \propto I$

$$N\Phi = LI \text{ (L is the self-induction)}$$

$$\text{Induced emf, } E = -N \frac{d\Phi}{dt} = -N \frac{dI}{dt} \text{ [L/N]}$$

$$E = -L \frac{dI}{dt}$$

This is the self-induced emf. A coil having self-inductance "L" is said to be the induction coil.



Here, there are two coils placed near each other. The first coil will make turns and carry the current which results in the magnetic field. As both the coils nearly close to each other, the magnetic field through one coil will all pass through the other coil. So one coil causes the change in magnetic flux because of which current is induced in the other coil.

Here there is the primary coil and another one is the secondary coil. This type of induction mainly depends upon the number of turns, size, and shape of the coil and medium between the two coils.

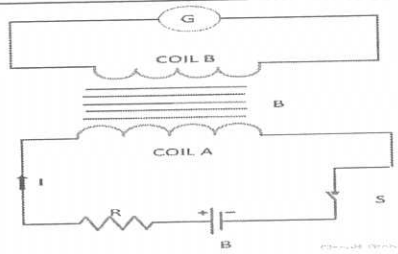
$$E = -M \frac{dI}{dt}$$

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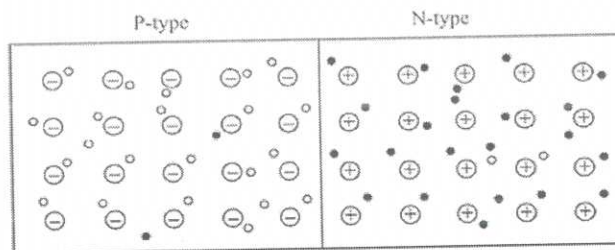
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V a

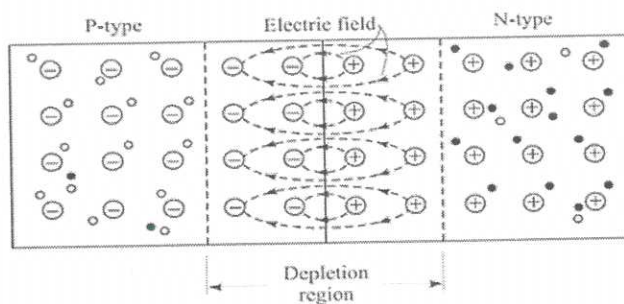
Formation of a PN-Junction

1. Joining n-type material with p-type material causes excess electrons in the n-type material to diffuse to the p-type side and excess holes from the p-type material to diffuse to the n-type side.
2. Movement of electrons to the p-type side exposes positive ion cores in the n-type side while movement of holes to the n-type side exposes negative ion cores in the p-type side, resulting in an electric field at the junction and forming the depletion region.
3. A voltage results from the electric field formed at the junction.



A PN-junction when just formed

Note that no external voltage has been connected to the PN-junction



Space-charge region or depletion region is formed in the vicinity of the junction

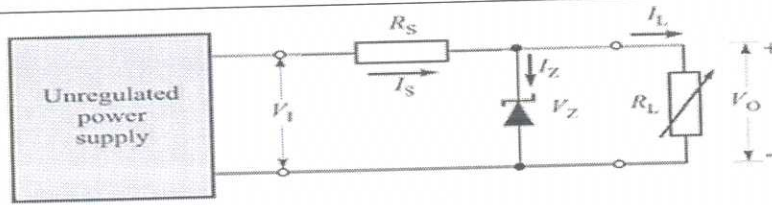
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V b



The zener-diode voltage regulator

The simplest regulator circuit consists merely of a resistor R_S connected in series with the input voltage, and a zener diode connected in parallel with the load. The voltage from an unregulated power supply is used as the input voltage V_1 to the regulator circuit. As long as the voltage across R_L is less than the zener breakdown voltage V_Z , the zener diode does not conduct. If the zener diode does not conduct, the resistors R_S and R_L make a potential divider across V_1 . At an increased V_1 , the voltage across R_L becomes greater than the zener breakdown voltage. It then operates in its breakdown region. The resistor R_S limits the zener current from exceeding its rate maximum I_{Zmax} .

The current from the unregulated power supply splits at the junction of the zener diode and the load resistor. Therefore,

$$I_S = I_Z + I_L \quad (4.33)$$

When the zener diode operates in breakdown region, the voltage V_Z across it remains fairly constant even though the current I_Z flowing through it may vary considerably.

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7 7

VI a

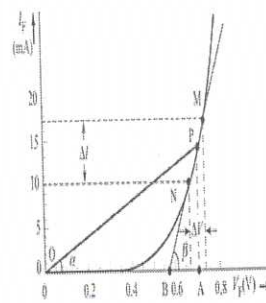
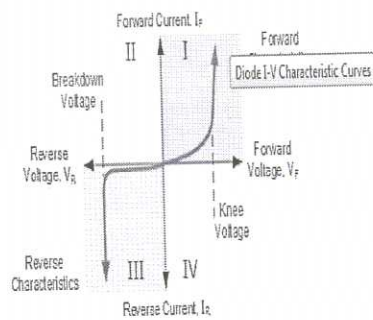
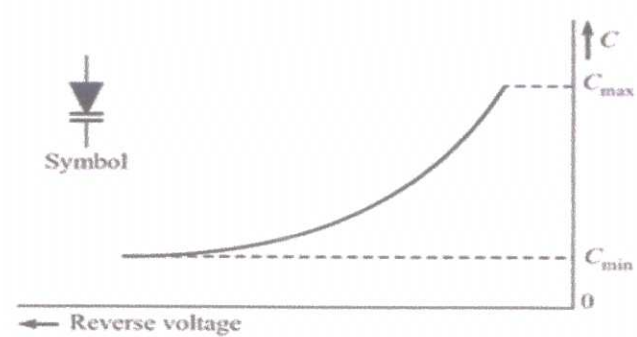
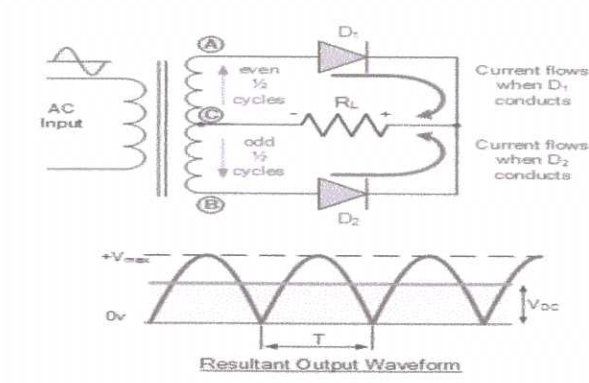


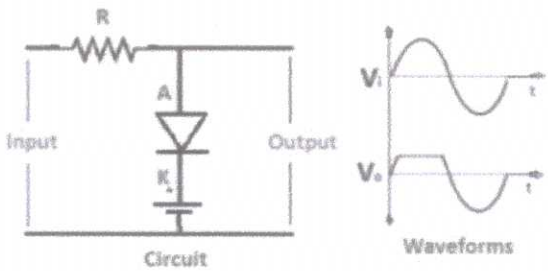
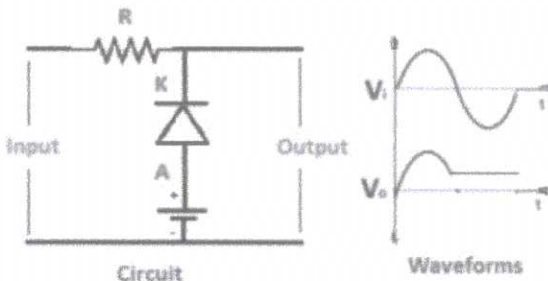
Fig. 4.10 Calculation of static and dynamic resistance of a diode

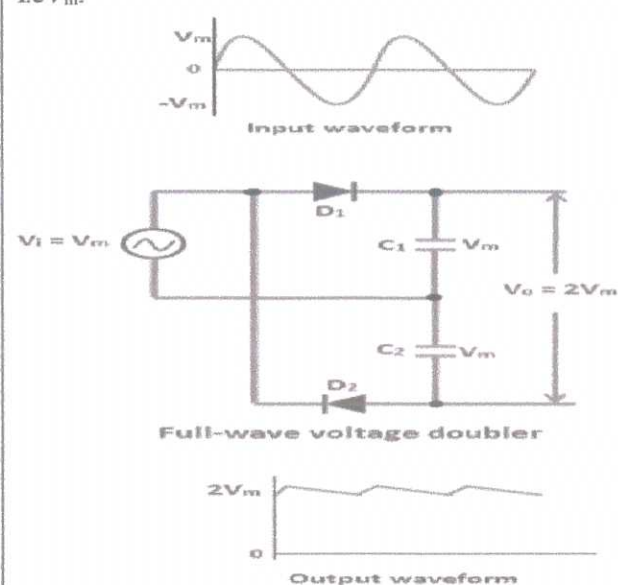
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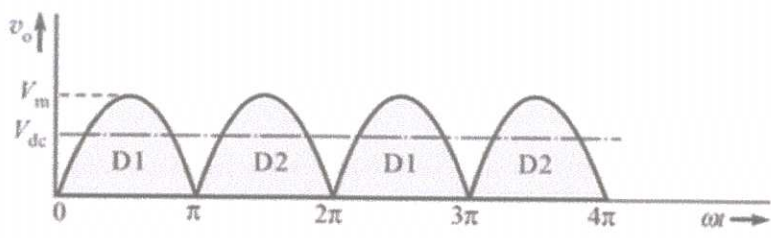
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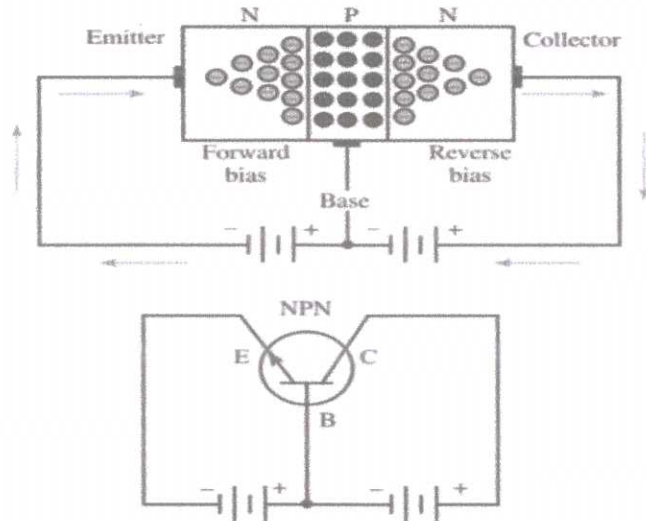
<p>VI b</p>	<p>A reversed-biased PN-junction can be compared to a charged capacitor. The P and N regions (away from the space charge region) are essentially low resistance areas due to high concentration of majority carriers. The space-charge region, which is depleted of majority carriers, serves as an effective insulation between the P and N regions. The P and N regions act as the plates of the capacitor while the space-charge region acts as the insulating dielectric. The reverse-biased PN-junction thus has an effective capacitance, whose value is given as</p> $C = \frac{\epsilon A}{W}$ <p>where ϵ (the Greek letter "epsilon") is the permittivity of the semiconductor material, A is the area of the junction, and W is the width of the space-charge region. The width W of the space-charge region is approximately proportional to the square root of the reverse bias voltage V. The area A and permittivity ϵ being constant,</p> $C = \frac{K}{\sqrt{V}}$ <p>As the reverse bias increases, the space-charge region becomes wider, thus effectively increasing the plate separation and decreasing the capacitance. Silicon diodes optimised for this variable-capacitance effect are called <i>varactors</i>. Figure 4.30 shows the symbol used to represent a varactor diode. It also shows graphically how the capacitance of a varactor diode varies with the reverse-bias voltage.</p>  <p style="text-align: center;"><i>Varactor diode characteristic and its symbol</i></p>	<p style="text-align: center;">4</p>	<p style="text-align: center;">3</p>	<p style="text-align: center;">7</p>
<p>VII a</p>		<p style="text-align: center;">3</p>	<p style="text-align: center;">2</p>	

	<p>The full wave rectifier circuit consists of two <i>power diodes</i> connected to a single load resistance (R_L) with each diode taking it in turn to supply current to the load. When point A of the transformer is positive with respect to point C, diode D_1 conducts in the forward direction as indicated by the arrows.</p> <p>When point B is positive (in the negative half of the cycle) with respect to point C, diode D_2 conducts in the forward direction and the current flowing through resistor R is in the same direction for both half-cycles. As the output voltage across the resistor R is the phasor sum of the two waveforms combined, this type of full wave rectifier circuit is also known as a "bi-phase" circuit.</p>	3	8	8
VII b	<p>Positive Clipper with Positive V_r</p>  <p>During the positive half cycle the diode conducts causing the positive reference voltage appear as output voltage; and, during the negative half cycle, the entire input is generated as the output as the diode is in reverse biased.</p> <p>Negative Clipper with Positive V_r</p>  <p>A series positive reference voltage is added to the diode as shown in the figure. During the positive half cycle, the input is generated as output, and during the negative half cycle, a positive reference voltage will be the output voltage as shown above.</p>	4	7	7

<p>VIII a</p>	<p>• Full-wave voltage doubler</p> <p>The full-wave voltage doubler consists of two diodes, two capacitors, and input AC voltage source.</p> <p>During the positive half cycle of the input AC signal, diode D_1 is forward biased. So the diode D_1 allows electric current through it. This current will flow to the capacitor C_1 and charges it to the peak value of input voltage i.e. V_m.</p>  <p>The diode D_2 does not allow electric current through it. Therefore, the capacitor C_2 is uncharged.</p> <p>During the negative half cycle of the input AC signal, the diode D_2 is forward biased. So the diode D_2 allows electric current through it. This current will flow to the capacitor C_2 and charges it to the peak value of the input voltage i.e. V_m.</p> <p>On the other hand, diode D_1 is reverse biased during the negative half cycle. So the diode D_1 does not allow electric current through it. Thus, the capacitor C_1 and capacitor C_2 are charged during alternate half cycles. The output voltage is taken across the two series connected capacitors C_1 and C_2. The output voltage is equal to the sum of capacitor C_1 voltage and capacitor C_2 voltage i.e. $C_1 + C_2 = V_m + V_m = 2V_m$.</p> <p>The circuit is called full-wave voltage doubler because one of the output capacitors is being charged during each half cycle of the input voltage.</p>	<p>4</p>	<p>8</p>	<p>8</p>

VIII b	 <p style="text-align: center;">(d)</p> <p style="text-align: center;"><i>Centre-tap full-wave rectifier</i></p> <p>The output voltage of full wave rectifier is described as</p> $v_o = V_m \sin \omega t \quad 0 \leq \omega t \leq \pi$ $= -V_m \sin \omega t \quad \pi \leq \omega t \leq 2\pi$ <p>A minus sign appears in the second equation because during the second half-cycle the wave is still sinusoidal, but inverted. The average or the dc value of voltage is</p> $V_{dc} = \frac{1}{2\pi} \int_0^{2\pi} v_o d(\omega t)$ $= \frac{1}{2\pi} \left[\int_0^{\pi} (V_m \sin \omega t) d(\omega t) + \int_{\pi}^{2\pi} (-V_m \sin \omega t) d(\omega t) \right]$ $= \frac{1}{2\pi} \left[-V_m \cos \omega t \Big _0^{\pi} + V_m \cos \omega t \Big _{\pi}^{2\pi} \right]$ $= \frac{V_m}{2\pi} [-\cos \pi + \cos 0 + \cos 2\pi - \cos \pi] = \frac{2V_m}{\pi}$	7	7	7

IX a



- ☒ Two batteries are used to simplify operation theory. Most applications require one voltage source. The negative terminal of the battery is connected to the N emitter.
 - ☒ The positive terminal of the same battery is connected to the P-type base.
- Therefore, the emitter-base circuit is forward biased

- In the collector circuit, the N collector is connected to the positive battery terminal. The P base is connected to the negative terminal.
- The collector-base circuit is reverse biased.
- Electrons enter the emitter from the negative battery source and flow toward the junction. The forward bias has reduced the potential barrier of the first junction.
- The electrons then combine with the hole carriers in the base to complete the emitter-base circuit. However, the base is a very thin section, about 0.001 inches.
- Most of the electrons flow on through to the collector. This electron flow is aided by the low potential barrier of the second PN junction.

Approximately 95 to 98 percent of the current through the transistor is from an emitter to collector. About two to five percent of the current moves between emitter and base.

A small change in emitter to base bias voltage causes a somewhat larger change in emitter-collector current. This is what allows transistors to be used as amplifiers. The emitter-base current change, however, is quite small.

4

4 8 8

IX b	<table border="1"> <thead> <tr> <th>Characteristic</th> <th>Common Base</th> <th>Common Emitter</th> <th>Common Collector</th> </tr> </thead> <tbody> <tr> <td>Input Impedance</td> <td>Low</td> <td>Medium</td> <td>High</td> </tr> <tr> <td>Output Impedance</td> <td>Very High</td> <td>High</td> <td>Low</td> </tr> <tr> <td>Phase Shift</td> <td>0°</td> <td>180°</td> <td>0°</td> </tr> <tr> <td>Voltage Gain</td> <td>High</td> <td>Medium</td> <td>Low</td> </tr> <tr> <td>Current Gain</td> <td>Low</td> <td>Medium</td> <td>High</td> </tr> <tr> <td>Power Gain</td> <td>Low</td> <td>Very High</td> <td>Medium</td> </tr> </tbody> </table>	Characteristic	Common Base	Common Emitter	Common Collector	Input Impedance	Low	Medium	High	Output Impedance	Very High	High	Low	Phase Shift	0°	180°	0°	Voltage Gain	High	Medium	Low	Current Gain	Low	Medium	High	Power Gain	Low	Very High	Medium			
	Characteristic	Common Base	Common Emitter	Common Collector																												
	Input Impedance	Low	Medium	High																												
	Output Impedance	Very High	High	Low																												
	Phase Shift	0°	180°	0°																												
	Voltage Gain	High	Medium	Low																												
	Current Gain	Low	Medium	High																												
Power Gain	Low	Very High	Medium																													
		7	7	7																												
X a																																
			3	3																												
			3	8	8																											
X b	<p>What are α, β and γ in a transistor ?</p> <p>ALPHA (α): It is a large signal current gain in common base configuration. It is the ratio of collector current (output current) to the emitter current (input current).</p>																															

$$\alpha = \frac{\text{Collector current}}{\text{Emitter current}}$$

$$\alpha = \frac{I_C}{I_E}$$

It is a current gain in CB amplifier and it indicates that the amount of emitter current reaching to collector. Its value is unity ideally and practically less than unity.

Beta (β): It is a current gain factor in the common emitter configuration. It is the ration of collector current (output current) to base current (input current).

$$\text{beta} = \frac{I_C}{I_B}$$

normally Its value is greater than 100.

Gama (γ): It is a current gain in common collector configuration and it is the ration of emitter current (output current) to base current (input current).

$$\gamma = \frac{I_E}{I_B}$$

It is also called emitter efficiency that how much current is injected from the emitter to base after recombination of minority charge carriers in base. It's value is high compared to α, β .

What is the relation between α, β and γ in a transistor?

α, β and γ are the current gain factors in three CB, CE and CC configurations respectively.

Relation between α, β and γ :

$$\alpha = \frac{\beta}{\beta + 1}$$

$$\beta = \frac{\alpha}{1 - \alpha}$$

$$\gamma = \beta + 1$$

7 7 7.