Roll No.										

JSS MAHAVIDYAPEETHA
JSS ACADEMY OF TECHNICAL EDUCATION, NOIDA
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CIA-I [Even Semester-(AY 2023-24)]

Course	**:**	**B. Tech.**	**Date**	**:**	**11-05-2024**
Semester	**:**	**II**	**Subject Code**	**:**	**BEC-201**
Subject	**:**	**Fundamentals of Electronics Engineering**	**Max. Marks**	**:**	**20**
Time	**:**	**1 hrs=60 min**			

COURSE OUTCOMES		**BL/ KC***
CO122.1	***Comprehend PN junction diodes and apply its concept for different applications***	BL3
CO122.2	***Interpret construction and operation of BJT, FET and MOFET***	BL3
CO122.3	*Apply the concept of Operational amplifier to design linear and non-linear applications*	BL3
CO122.4	Perform number systems, conversions, binary arithmetic and minimize logic functions	BL3
CO122.5	Acquire the knowledge of communication system and their applications	BL3

Section-A

Attempt all the questions of this section **(1 X5=5)**

Q. No.		**Question**	**Marks**	**CO**	**BL/ KC***
1.	a	**What is PIV rating of Halfwave and Central Tap Full wave rectifier?** **Solution:** PIV of Halfwave rectifier is V_m and Full Wave rectifier with center tap transformer is $2V_m$ **[0.5 mark each]**	1	CO1	2/F
	b	**Briefly justify the statement that Intrinsic semiconductors works as an insulator at zero-degree kelvin.** **Solution:** At zero-degree Kelvin, electrons do not have energy to jump from valence band to conduction band. So intrinsic semiconductors are de-void of free charge carriers, thus behaves like an insulator. **[1 mark]**	1	CO1	2/C
	c	**Define 'Dark current' in photodiode. Is it a source of noise?** **Solution:** When no light is incident on the PN junction of photodiode, the reverse current I_λ is extremely small. This is called **dark current.** Yes, it is a source of noise. **[0.5 mark each]**	1	CO1	2/C
	d	**Find α_{dc}, β_{dc} for transistor with $I_c = 2.5$ mA and $I_E = 2.55$ mA.** **Solution:** $\alpha_{\mathrm{dc}} = \frac{\mathrm{I_C}}{\mathrm{I_E}} = \frac{2.5\text{ mA}}{2.55\text{ mA}} = 0.9804$ $\mathrm{I_B} + \mathrm{I_C} = \mathrm{I_E}$ $\mathrm{I_B} = \mathrm{I_E} - \mathrm{I_C} = 2.55\text{ mA} - 2.5\text{ mA} = 0.05\text{ mA}$ $\beta_{\mathrm{dc}} = \frac{\mathrm{I_C}}{\mathrm{I_B}} = \frac{2.5\text{ mA}}{0.05\text{ mA}} = 50$ α_{dc}, β_{dc} →**[0.5 mark each]**	1	CO2	3/C

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<table>
<tr>
<td></td>
<td>e</td>
<td>Define leakage current I_{CEO}? How is it related to leakage current I_{CBO}?
Solution:
I_{CEO} is the collector to emitter current keeping base open. It is related with I_{CBO} as:
$$I_{CEO} = \frac{I_{CBO}}{(1-\alpha)}$$
[0.5 mark each]</td>
<td>1</td>
<td>CO2</td>
<td>3/C</td>
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<tr>
<td colspan="6">Section-B</td>
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<tr>
<td colspan="5">Attempt all the questions of this section</td>
<td>(3X3=9)</td>
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<tr>
<td rowspan="3">2.</td>
<td colspan="1" rowspan="3"></td>
<td>a) Derive the expressions for the following considering Center tapped full wave rectifier. (i) Ripple Factor, (ii) Power Efficiency, (iii) Form Factor
Solution:
$$\gamma = \sqrt{\left(\frac{V_{\rm rms}}{V_{\rm dc}}\right)^2 - 1} = \sqrt{\left(\frac{\pi}{2\sqrt{2}}\right)^2 - 1} \approx 0.48$$
$$\eta = \frac{P_{\rm dc}}{P_{\rm dc}} = \left(\frac{V_{\rm dc}}{V_{\rm rms}}\right)^2 \times \left(1 + \frac{r_f}{R_L}\right) \approx 0.8106\left(1 + \frac{r_f}{R_L}\right)$$
$$\boxed{\eta_{\max} \approx 0.8106 = 81.06\%.}$$
$$\text{Form factor} = \frac{V_{\rm rms}}{V_{\rm dc}} = \frac{\pi}{2\sqrt{2}} \approx 1.11.$$
[1 mark each]</td>
<td rowspan="3">3</td>
<td rowspan="3">CO1</td>
<td rowspan="3">3/C</td>
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<td>OR</td>
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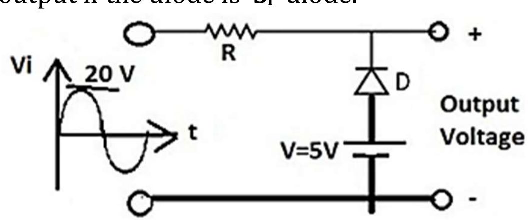
<td>b) Draw the output voltage of the given network as shown in Figure 1. Consider diode as ‘Ideal diode’. Also mention minimum and maximum voltage at the output if the diode is ‘S_i’ diode.


Figure 1
Solution:
The output of above circuit is as shown below:</td>
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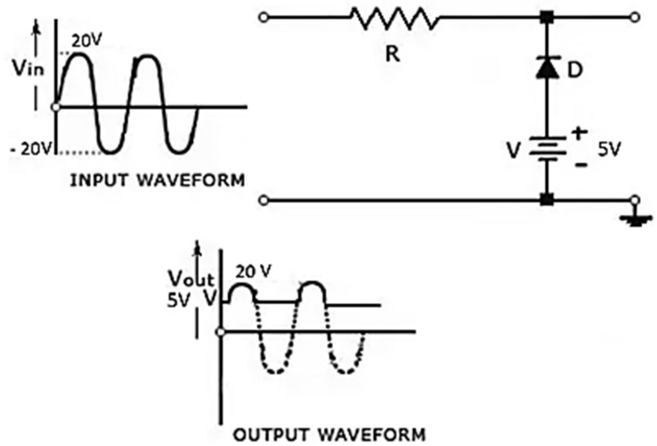

The minimum and maximum voltage for the case when diode is Si diode will become: 4.3 Volt – 20 Volt.

[2+1 mark]

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<td>3.</td>
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a) Derive the relation between amplification factors α and β.

Solution:

We know that

$$\alpha = \left(\frac{\Delta i_C}{\Delta i_E}\right)$$

$$\text{and } \beta = \left(\frac{\Delta i_C}{\Delta i_B}\right) = \frac{\Delta i_C}{\Delta i_E} \times \frac{\Delta i_E}{\Delta i_B}$$

$$= \alpha \frac{\Delta i_E}{\Delta i_B}$$

But $\Delta i_B = \Delta i_E - \Delta i_C$

So,

$$\beta = \alpha \frac{\Delta i_E}{\Delta i_E - \Delta i_C} = \frac{\alpha}{1 - \frac{\Delta i_C}{\Delta i_E}}$$

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

[2+1 Mark]

OR

Why two diodes connected back-to-back cannot behave as a transistor? List the two important applications of Transistor usage.

Solution:

Two p-n junction diodes are connected back-to-back cannot be used as a transistor due to

(i) Transistors terminals width constraints.
(ii) Doping concentration variation in each region.
(iii) Large base width formation in back-to-back structure.

Applications:

(i) Switch
(ii) Amplifier

(2 – Reason + 1- Applications = 3)

</td>
<td>3</td>
<td>CO2</td>
<td>3/C</td>
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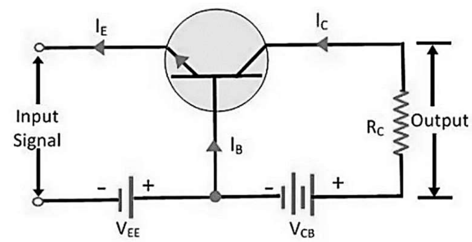
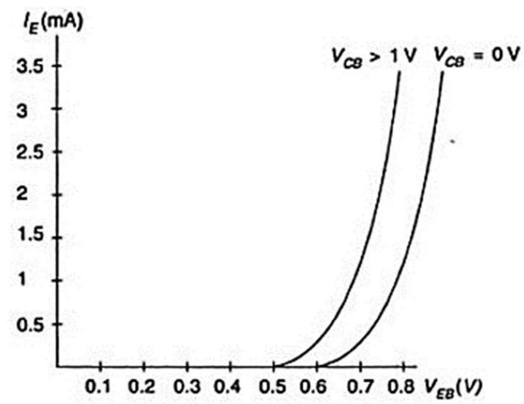
4.

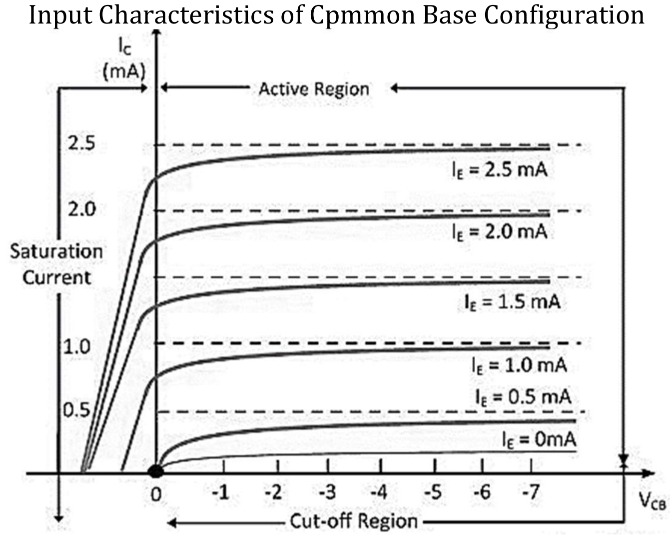
For the NPN BJT in Common Base Configuration, i) Make the Circuit Diagram in active mode, ii) Draw the Input Characteristic Curve, iii) Draw the Output Characteristic Curve and show Active, Cut-off and Saturation Regions.

Solution:





Input Characteristics of Cpmmon Base Configuration



Output Characteristics of Commin Base Configuration

(1-Circuit + 1- Input Char + 1 – Output Char = 3)

3 | CO2 | 2/F

OR

Discuss the construction of PNP Transistor. Why is Transistor called a current controlled device? Justify.

Solution:

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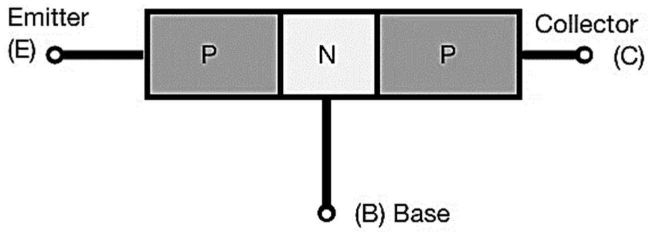
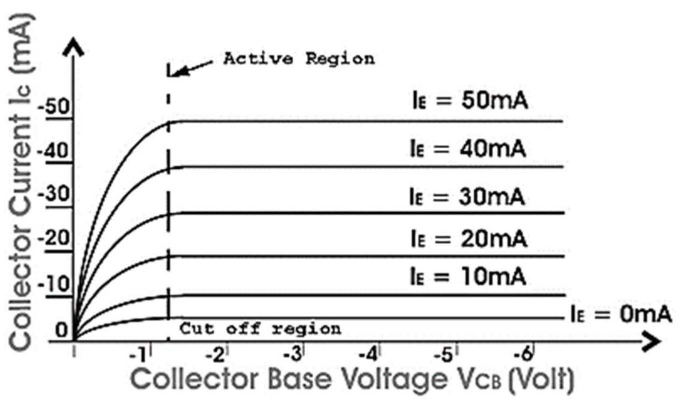


A transistor is a three terminal two junction device. It has three regions that are emitter, base and collector. The width of collector region is higher than that of the base and emitter because it must dissipate more heat. Doping of the emitter is higher than that of the base and the collector.

As the output current in the transistor is dependent on the input current (Keeping other parameters fixed), that is why it is called a current controlled device. This can be seen from the output characteristics of transistor in any configuration. As can be seen from below figure that the output current 'I_c' is increasing with increase in input current 'I_E', keeping V_{CB} fixed.



(1.5+1.5)

Section-C

Attempt all the questions of this section **(6X1=6)**

5. **a) i) Show that Zener diode works as voltage regulator, ii) For the following circuit (Figure 2), find the maximum and minimum current flowing through Zener diode.** — 6 — CO1 — 3/C

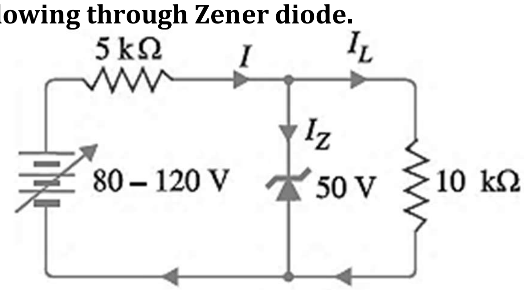
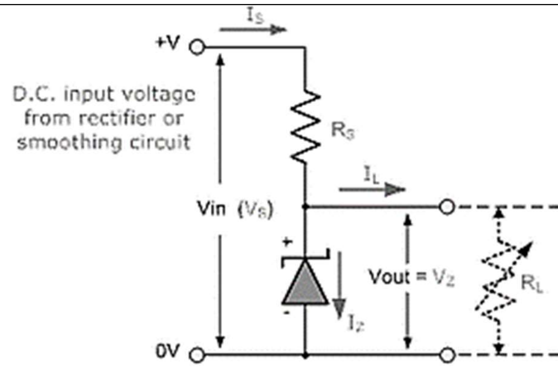


Figure 2

Solution:

a) i) Circuit diagram of Zener Diode as voltage regulator



Resistor, R_S is connected in series with the zener diode to limit the current flow through the diode with the voltage source, V_S being connected across the combination. The stabilized output voltage V_{out} is taken from across the zener diode.

The load is connected in parallel with the zener diode, so the voltage across R_L is always the same as the zener voltage, ($V_R = V_Z$).

So, even after the input increases beyond Zener breakdown, the output remains fixed at Vz, the breakdown voltage. This is how it stabilizes the output from input variations.

ii) Maximum Zener current: The Zener will conduct maximum current when the input voltage is maximum i.e. 120 V. Under such conditions:

$$\text{Voltage across } 5\text{ k}\Omega = 120 - 50 = 70 \text{ V}$$

$$\text{Current through } 5\text{ k}\Omega,\ I = \frac{70\text{ V}}{5\text{ k}\Omega} = 14 \text{ mA}$$

$$\text{Load current, } I_L = \frac{50\text{ V}}{10\text{ k}\Omega} = 5 \text{ mA}$$

$$\text{Applying Kirchhoff's first law, } I = I_L + I_Z$$

$$\therefore \quad \text{Zener current, } I_Z = I - I_L = 14 - 5 = 9 \text{ mA}$$

Minimum Zener current: The Zener will conduct minimum current when the input voltage is minimum i.e. 80 V. Under such conditions, we have,

$$\text{Voltage across } 5\text{ k}\Omega = 80 - 50 = 30 \text{ V}$$

$$\text{Current through } 5\text{ k}\Omega,\ I = \frac{30\text{ V}}{5\text{ k}\Omega} = 6 \text{ mA}$$

$$\text{Load current, } I_L = 5 \text{ mA}$$

$$\text{Zener current, } I_Z = I - I_L = 6 - 5 = 1 \text{ mA}$$

(3+3)

OR

b)

i) Discuss working-principle and operation of Varactor Diode. Mention any two applications of Varactor diode.

ii) Find the output of a clamper circuit shown below for the square wave as an input with peak voltage ‘V’ volts. Name the type of Clamper. Consider diode as ‘**Ideal diode**’.

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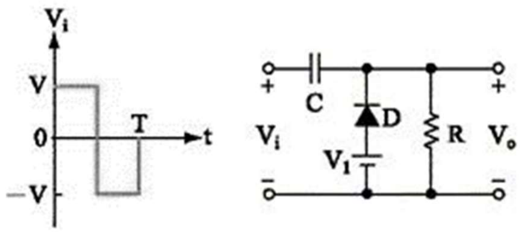
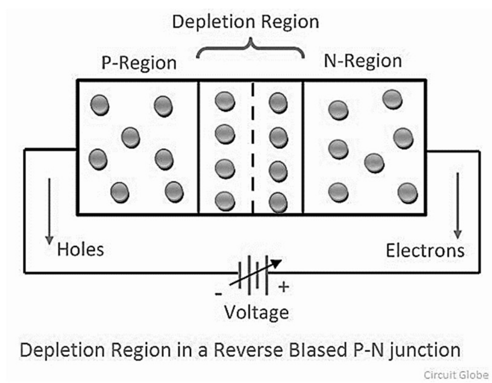
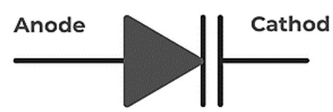


Solution:
i)

A varactor diode, also known as a Varicap or volt-cap, is a type of PN junction diode primarily utilized in the reverse-biased mode. It is a device whose capacitance varies with the variation in the applied reverse bias potential.





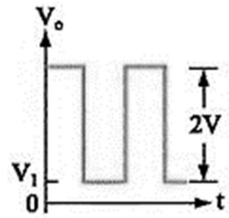
The formula gives the capacitance of varactor diode,

$$C_T = \frac{\in A}{W}$$

Where, ε – Permittivity of the semiconductor material.
A – area of PN-junction
W – width of depletion region

The capacitance of the varactor diode decreases with the increases of the depletion region.

Its ability to change its capacitance with applied voltage makes it valuable in oscillator circuits and various tuning applications.

	ii) The output of Clamper is as shown below:  **The clamper is positive biased clamper.** **(3+3)**			