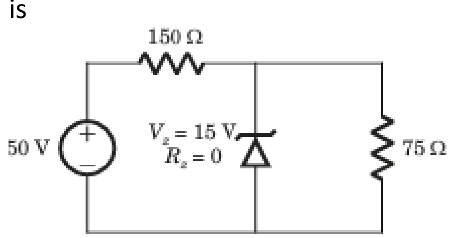
MANIPAL INSTITUTE OF TECHNOLOGY
BENGALURU
(A constituent unit of MAHE, Manipal)

**I Semester MIDTERM TEST**
**Fundamental of Electronics (ECE_1072)**

**Time Duration: 2 Hours** **Date: 25-10-2024** **Max marks: 30 MARKS**

| Q. No | Topic | Marks | BL | CO |
|---|---|---|---|---|
| **Q1** | How does the dynamic resistance of diode vary with temperature?<br>1. Directly proportional<br>2. Inversely proportional<br>3. Independent<br>4. directly to the square of temperature. | **1** | **1** | **1** |
| **Q2** | If N1/N2 = 2, and the primary voltage is 120 V, what is the secondary voltage<br>1. 0V<br>2. 36V<br>3. 60V<br>4. 240V | **1** | **1** | **2** |
| **Q3** | A sinusoidal voltage of peak value 10V and frequency 50Hz is applied to full wave rectifier. If the load resistance is 800 and diode forward resistance is 8Ω, and capacitor used is 1000µF. calculate the efficiency of the rectifier.<br>1. 100%<br>2. 81.2%<br>3. 80.3960%<br>4. 78.9923% | **1** | **2** | **2** |
| **Q4** | A half wave rectifier with capacitor filter is supplied from transformer having peak secondary voltage 20V and frequency 50Hz. The load resistance is 1KΩ and capacitor used is 1000µF. Calculate ripple factor.<br>1. 1.21<br>2. 0.00577<br>3. 1.0021<br>**4.** 0.00245 | **1** | **2** | **2** |
| **Q5** | In the voltage regulator shown in fig. the power dissipation in the Zener diode is<br><br><br>1. 1W<br>2. 1.5W<br>3. 2W<br>**4.** 0.5W | **1** | **2** | **2** |
| **Q6** | In the voltage regulator circuit in fig. the maximum load current $i_L$ that can be drawn is | **1** | **2** | **2** |

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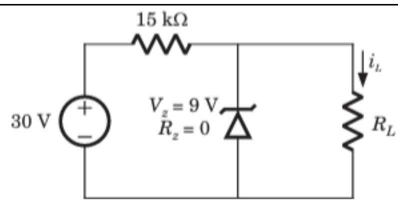
| | <br>1. 1.4 mA<br>2. 2.3 mA<br>3. 1.8 mA<br>**4.** 2.5 mA | | | |
| **Q7** | In the cut off region of MOSFET, the drain current is<br>1. Unity<br>2. Zero<br>3. Infinity<br>**4.** None of the above | **1** | **1** | **2** |
| **Q8** | Which of the following is not the part of Internal block diagram of Op-AMP<br>1. Differential Amplifier Stage<br>2. Intermediate Stage<br>3. Level Shifter Stage<br>**4.** Attenuator | **1** | **2** | **3** |
| **Q9** | A MOSFET can be used as an Amplifier in Its<br>1. Linear Region<br>2. Saturation Region<br>3. Cuttoff Region<br>**4.** Boundary Region | **1** | **2** | **3** |
| **Q10** | If a given voltage is applied to non-inverting terminal and another given voltage is applied to inverting terminal simultaneously to an operational amplifier, the output will be<br>1. difference of inputs<br>2. sum of inputs<br>3. average of inputs<br>4. exponential function of inputs | **1** | **2** | **3** |
| **Q.11(a)** | An rms AC voltage of 230V,60Hz is applied to transformer having turns ratio 10:1. The secondary of transformer is connected to half wave rectifier. The diode has cut in voltage of 0.7V and forward resistance 20 Ω. If the load resistance is 1KΩ, determine<br>a) Average output current<br>b) Average output voltage<br>c) RMS value of output current<br>d) RMS value of output voltage<br>e) Efficiency of rectifier<br>f) Ripple factor of rectifier<br>g) Output frequency of rectifier<br>h) PIV rating of rectifier<br><br>Solution : Vp/Vs=Np/Ns<br>Vs=23V------------------------------------------0.5M<br>Vm=23 square root(2) =32.5V---------------0.5M<br><br>Im = Vm-Vγ /RL+Rf = 31.17mA ------------------------0.5M | **5** | **3** | **2** |

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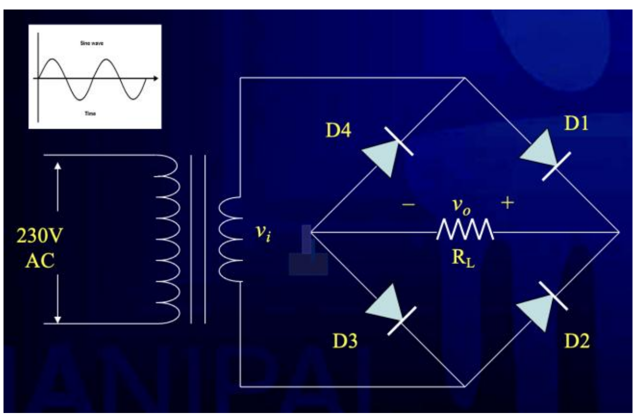
| | Idc = Im/ π = 9.9288mA----------------------------------0.5M<br>Vdc= Idc*RL= 9.9288V-------------------------0.5M<br>Irms =Im/2 =15.585mA------------------------0.5M<br>Vrms= Irms*RL = 15.585V-------------------------0.5M<br>Efficiency = 0.406/(1+ RF/RL)*100 = 39.80%---------------------0.5M<br>Ripple factor= 1.21-------------------------0.5M<br>PIV> 32.5V-------------------------------------------0.5M | | | |
| **Q.11(b)** | Find the static and dynamic resistances of a Germanium diode with 0.3 V forward bias applied, if reverse saturation current is 2μA and temperature is $30^0$C .<br><br>**Given Data**<br>• **Forward bias voltage, VV**: 0.3 V<br>• **Reverse saturation current, Io**: 2 μA ($2 \times 10^{-6}$ A)<br>• **Temperature, T**: 300 K<br><br>The diode current II is described by the equation: | **3** | **3** | **1** |
| **Q.11(c)** | Draw a neat circuit diagram of full wave bridge rectifier. Derive the expressions for the ripple factor and efficiency.<br><br><br><br>**1(Marks)** | **2** | **4** | **3** |

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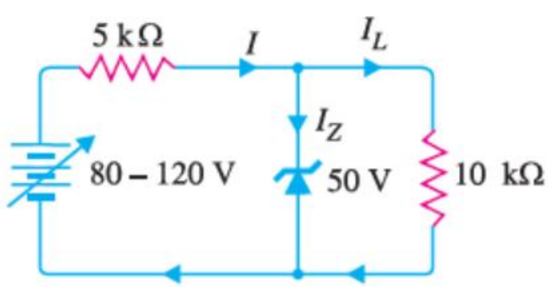
| | • *At any point of time, two diodes are conducting, and remaining two are not conducting*<br>• *Load current* $i = I_m sin(\omega t)$<br>• *So, peak value of load current is:* $I_m = \frac{V_m - 2V_\gamma}{R_L + 2R_F} \approx \frac{V_m}{R_L}$<br>• *Since output waveform is same as earlier,*<br>$I_{dc} = \frac{1}{\pi}\int_0^{\pi} i\, d(\omega t)$ $= \frac{2I_m}{\pi}$<br>• *Average output voltage is* $V_{dc} = I_{dc}R_L$<br>• *RMS load current is:* $I_{rms} = \left[\frac{1}{\pi}\int_0^{\pi} i^2\, d(\omega t)\right]^{1/2}$ $= \frac{I_m}{\sqrt{2}}$<br>• *RMS output voltage is* $V_{rms} = I_{rms}R_L$<br>• *Ripple factor is* $\gamma = \frac{\sqrt{I_{rms}^2 - I_{dc}^2}}{I_{dc}}$ $= 0.48$<br>• *Efficiency is* $\eta = \frac{P_{dc}}{P_{ac}}$ $= \frac{0.81}{1 + \frac{2R_F}{R_L}}$<br>**(1 Marks)** | | | |
| **Q.12(a)** | For the circuit shown in Fig. find the maximum and minimum values of zener diode current<br><br>Voltage across 5 kΩ = 120 – 50 = 70 V<br>Current through 5 kΩ, $I = \frac{70\text{ V}}{5\text{ k}\Omega} = 14\text{ mA}$<br>Load current, $I_L = \frac{50\text{ V}}{10\text{ k}\Omega} = 5\text{ mA}$<br>Applying Kirchhoff's first law, $I = I_L + I_Z$<br>$\therefore$ Zener current, $I_Z = I - I_L = 14 - 5 = 9\text{ mA}$<br>**2.5Marks** | **5** | **3** | **2** |

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

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

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

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

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

**2.5 Marks**

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<td>Q.12(b)</td>
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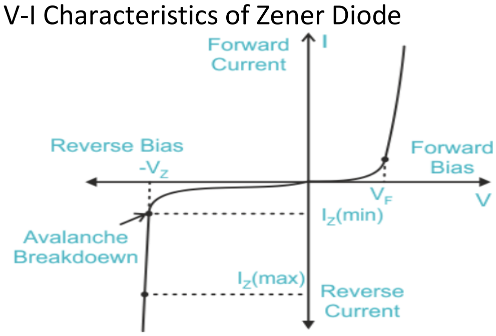
With a neat sketch and explain the VI characteristics of a zener diode and illustrate that it can be used as a voltage regulator.

Ans. A Zener diode, also known as a breakdown diode, is a heavily doped semiconductor device that is designed to act in the opposite direction. Zener diode is commonly used as a voltage regulator to maintain a constant DC output voltage.

**Zener Diode as a Voltage Regulator**
When provided reverse bias feedback, the Zener diode operates as a voltage regulator, generating a little leakage current till a constant voltage is achieved. The Zener diode behaves like a general-purpose diode with a silicon PN junction whenever loaded in a forward direction. This forward flow can be reversed if the voltage surpasses a particular limit. The constant voltage aids the Zener diode's voltage regulation.
V-I Characteristics of Zener Diode




A voltage regulator's main job is to provide a consistent output voltage to a load connected in parallel, regardless of variations in the load current or fluctuations in the supply voltage. As long as the current stays within the minimum and maximum reverse limits, the Zener diode will deliver a stable voltage.

(2 Marks)

To control the current flowing through the Zener diode, a resistor (Rs) is placed in series with it, while the input voltage (Vin) is applied across the setup. The output voltage (Vout) is measured across the Zener diode and is equal to its Zener voltage (Vz). The Zener diode is configured in reverse bias mode, with its cathode connected to the positive side of the circuit, which allows it to effectively regulate the voltage

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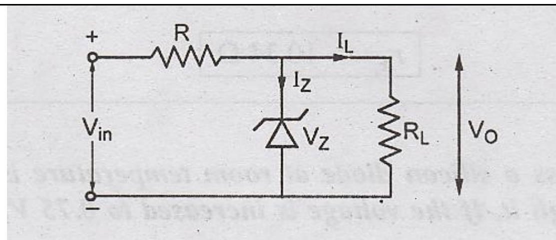
| | <br>*Fig. 1.32. Zener diode as voltage regulator*<br>(1 Marks) | | | |
| **Q.12(c)** | Given k = 0.5 mA/$V^2$, $I_D$ = 3 mA and $V_{GS}$ = 4 V, determine the value of $V_{Th}$.<br><br>Given:<br>• $k = 0.5\,\text{mA/V}^2 = 0.5 \times 10^{-3}\,\text{A/V}^2$<br>• $I_D = 3\,\text{mA} = 3 \times 10^{-3}\,\text{A}$<br>• $V_{GS} = 4\,\text{V}$<br><br>Substituting the values into the equation:<br>$$3 \times 10^{-3} = 0.5 \times 10^{-3} \cdot (4 - V_{Th})^2$$ 1 Marks<br>Now, divide both sides by $0.5 \times 10^{-3}$:<br>$$\frac{3 \times 10^{-3}}{0.5 \times 10^{-3}} = (4 - V_{Th})^2$$<br>This simplifies to:<br>$$6 = (4 - V_{Th})^2$$<br>$$V_{Th} = 4 - 2.45 \approx 1.55\,\text{V}$$ 1 Marks | **2** | **3** | **1** |

**Note: BL refers to Bloom's Taxonomy Level.**