# Solved Problems in:

# ELECTRONIC DEVICES AND CIRCUITS – 1

By:

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# SOLVED PROBLEMS
# ON DIODES

1. A silicon diode, the forward resistance of which is 400 ohm, supplies power to a load resistance 1200 ohm from a 250 V (rms) mains. Calculate (i) the dc load current, (ii) the ac load current, (iii) the dc voltage across the diode, (iv) the dc output power, (v) the conversion efficiency, and (vi) the percentage regulation

**Ans.** As one silicon diode is employed, the circuit is a half-wave rectifier. The peak load current is

$$I_m = \frac{V_m}{R_f + R_L} = \frac{250\sqrt{2}}{400 + 1200} = 0.221 \text{ A}$$

(i) The dc load current is

$$I_{dc} = \frac{I_m}{\pi} = 0.0703 \text{ A}$$

(ii) The rms ac load current is

$$I'_{rms} = (I_{rms}^2 - I_{dc}^2)^{1/2},$$

where $\quad I_{rms}$ = rms load current $= \dfrac{I_m}{2} = 0.1105$ A

Hence $\quad I'_{rms} = [(0.1105)^2 - (0.0703)^2]^{1/2} = 0.0854$ A

(iii) The dc voltage across the diode is

$$I_{dc} R_f = 0.0703 \times 400 = 28.1 \text{ V}$$

(iv) The dc output power is

$$P_{dc} = I_{dc}^2 R_L = (0.0703)^2 \times 1200 = 5.93 \text{ W}$$

(v) The conversion efficiency is

$$\eta = \frac{40.6}{1 + R_f/R_L} = \frac{40.6}{1 + 400/1200} = 40.6 \times \frac{3}{4} = 30.45 \text{ percent}$$

(vi) The percentage regulation is

$$\frac{V_{NL} - V_{RL}}{V_{RL}} \times 100 = \frac{I_{dc} R_f}{I_{dc} R_L} \times 100 = \frac{R_f}{R_L} \times 100 = 33.3\%$$

2. A full-wave rectifier uses a double-diode, the forward resistance of each element being 200 ohm. The rectifier supplies current to a load resistance of 1000 ohm. The primary-to-total secondary turns ratio of the centre-tapped transformer is 1 : 3. The transformer primary is fed from a supply of 240 V (rms). Find (i) the dc load current, (ii) the direct current in each diode. (iii) the dc power output, (iv) the ripple voltage across the load resistance, (v) the percentage regulation, and (vi) the efficiency of rectification.

**Ans.** The rms secondary voltage is $V_s = V_p/n$, where $V_p$ is the rms primary voltag of the transformer and $n$ is the primary-to-secondary turns ratio. Here $V_s$ = 24 × 3 = 720 V. The secondary voltage from the centre tap is 720/2 = 360 V (rms The corresponding peak voltage is $V_m = 360\sqrt{2} = 509$ V.

(i) The dc load current is $I_{dc} = 2\,I_m/\pi$, where $I_m$ is the peak current throug the load resistance. We have

$$I_m = \frac{V_m}{R_f + R_L} = \frac{509}{200 + 1000} = 0.424 \text{ A}.$$

Hence $$I_{dc} = \frac{2\,I_m}{\pi} = \frac{2 \times 0.424}{3.14} = 0.27 \text{ A}.$$

(ii) The direct current supplied by each diode is $I_{dc}/2 = 0.135$ A

(iii) The dc power output is $P_{dc} = I_{dc}^2 R_L = (0.27)^2 \times 1000 = 72.9$ W

(iv) The ripple voltage across the load is $I'_{rms} R_L = (I_{rms}^2 - I_{dc}^2)^{1/2} R_L$.

Here $$I_{rms} = I_m/\sqrt{2} = 0.424/\sqrt{2} = 0.3 \text{ A}$$

So, $$I'_{rms} R_L = (0.3^2 - 0.27^2)^{1/2} \times 1000 = 130.8 \text{ V}$$

(v) The percentage regulation is $\dfrac{R_f}{R_L} \times 100 = \dfrac{200}{1000} \times 100 = 20\%$

(vi) The efficiency of rectification is

$$\frac{81.2}{1 + R_f/R_L} = \frac{81.2}{1.2} = 67.7\%$$

**3.** A bridge rectifier feeds a load resistance of 2500 Ω from a 100 V (rms) supply. Each diode of the rectifier has a forward resistance of 50 Ω. Calculate (i) the dc load voltage, (ii) the ripple voltage at the output, and (iii) the percentage regulation.

**Ans.** (i) The bridge circuit gives full-wave rectification. So, the dc load current is $I_{dc} = 2\,I_m/\pi$, where $I_m$ is the peak load current. Since two diodes in series conduct simultaneously, we have

$$I_m = \frac{V_m}{2\,R_f + R_L} = \frac{100\sqrt{2}}{2 \times 50 + 2500} = 0.0544 \text{ A}.$$

Therefore, $I_{dc} = \frac{2 I_m}{\pi} = 0.0346 \text{ A}$

The dc load voltage is $V_{dc} = I_{dc} \times R_L = 0.0346 \times 2500 = 86.5 \text{ V}$.

(ii) The ripple voltage at the output is

$$I'_{rms} R_L = (I_{rms}^2 - I_{dc}^2)^{1/2} R_L .$$

Here, $I_{rms} = I_m / \sqrt{2} = 0.0385 \text{ A}$

Hence, $I'_{rms} R_L = (0.0385^2 - 0.0346^2)^{1/2} \times 2500$

$$= 43.3 \text{ V}$$

(iii) The percentage regulation is

$$\frac{2 R_f}{R_L} \times 100 = \frac{2 \times 50}{2500} \times 100 = 4\% .$$

**4. In the circuit of Fig. 5.11, the supply voltage is $V = 15$ volt. The 12 V, 0.36 W Zener diode operates at a minimum diode current of 2 mA. Calculate the series resistance $R$ and the range over which the load resistance $R_L$ can be varied.**

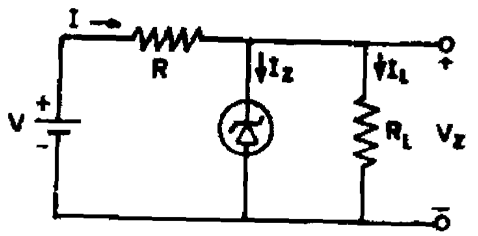



**Fig. 5.11**

**Ans.** The maximum allowable Zener current is $\frac{0.36 \text{ W}}{12 \text{ V}} = 0.03 \text{ A} = 30 \text{ mA}$. If the load resistance $R_L$ is infinite, the Zener current $I_z$ attains its maximum value of $I = 30$ mA. The voltage drop across the series resistance $R$ is $V_R = V - V_Z = 15 - 12 = 3$ volt. Since the current through $R$ is $I = 30 \text{ mA} = 30 \times 10^{-3}$ A, we have

$$R = \frac{V_R}{I} = \frac{3}{30 \times 10^{-3}} = 100 \text{ ohm} .$$

As $R_L$ is decreased, the current $I_L$ through it increases and the Zener current $I_Z$ decreases correspondingly, since $I_L + I_Z = I = 30$ mA.

For the minimum value $R_{Lm}$ of $R_L$, the Zener current $I_Z$ attains is minimum value of 2 mA.

Hence, $$I_L = 30 - 2 = 28\text{mA}.$$

Therefore, $$R_{Lm} = \frac{12 \text{ volt}}{28 \text{ mA}} = 428.6 \text{ ohm}.$$

Hence the allowable range of variation of $R_L$ is $428.6\ \Omega \le R_L < \infty$.

**5.** In the circuit of Fig.5.11, the Zener diode has the same specification as in problem 4. In the circuit, $R = 100\ \Omega$ and $R_L = 1$ kΩ. Determine the limits between which the supply voltage $V$ can vary without loss of regulation in the circuit.

(cf. C.U. 2001)

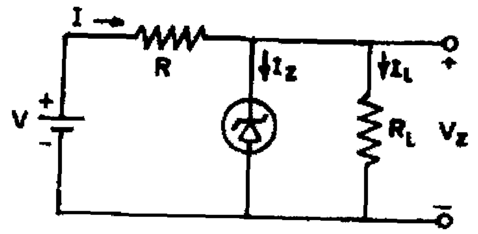
**Ans.** When $V$ is a minimum, the Zener current $I_z$ attains its minimum value of 2 mA. The load current is $I_L$ = 12 volt/1 kΩ = 12 mA. Hence the minimum allowable value of $I$ is 12 + 2 = 14 mA. The corresponding voltage drop across $R$ is $V_R = IR = 14 \times 10^{-3} \times 100 = 1.4$ volt. Thus the minimum value of $V$ is

$$V_{min} = V_Z + V_R = 12 + 1.4 = 13.4 \text{ volt}.$$

At the maximum value $V_{max}$ of $V$, the Zener current becomes a maximum, i.e. 30 mA. Now $I = 30 + 12 = 42$ mA and $V_R = 42 \times 10^{-3} \times 100 = 4.2$ volt. Therefore,

$$V_{max} = 4.2 + 12 = 16.2 \text{ volt}.$$

So, $V$ can vary between 13.4 volt and 16.2 volt.

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(vi) The percentage regulation is

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# *BJT Solved Problems*

1. A Transistor having $\alpha = 0.99$ is used in a common-base amplifier. If the load resistance is 4.5 k Ω and the dynamic resistance of the emitter junction is 50 Ω. Find the voltage gain and the power gain.

**Ans.** The voltage gain is

$$A_v = \alpha \frac{R_L}{r_e}$$

Here $\alpha = 0.99$, $R_L = 4.5 \text{ k}\Omega = 4500\ \Omega$, and $r_e = 50\ \Omega$.

Hence $$A_V = 0.99 \times \frac{4500}{50} = 89.1.$$

The power gain is

$$A_P = \text{current gain} \times \text{voltage gain}$$
$$= 0.99 \times 89.1 = 88.2.$$

2. An *n-p-n* transistor with $\alpha = 0.98$ is operated in the CB configuration. If th emitter current is 3 mA and the reverse saturation current is $I_{CO} = 10\ \mu\text{A}$, wha are the base current and the collector current?

**Ans.** The collector current $I_C$ for an emitter current $I_E$ is given by

$$I_C = -\alpha I_E + I_{C0}$$

For an *n-p-n* transistor, $I_E$ is negative. Therefore,

$$I_C = \alpha I_E + I_{C0}$$

Since $\alpha = 0.98$, $I_E = 3$ mA, and $I_{C0} = 10\ \mu\text{ A} = 10 \times 10^{-3}$ mA, we have

$$I_C = 0.98 \times 3 + 10^{-2}$$
$$= 2.95 \text{ mA}.$$

Also, from Kirchhoff's current law,

$$I_E + I_C + I_B = 0$$

For an *n-p-n* transistor, $I_E$ is negative. Hence

$$-I_E + I_C + I_B = 0$$

or, $$I_B = I_E - I_C = 3 - 2.95 = 0.05 \text{ mA} = 50\ \mu\text{A}.$$

3. A transistor having $\alpha = 0.975$ and a reverse saturation current $I_{C0} = 10\ \mu\text{A}$, is operated in CE configuration. What is $\beta$ for this configuration? If the base current is 250 µ A, calculate the emitter current and the collector current.

**Ans.** We have

$$\beta = \frac{\alpha}{1-\alpha} = \frac{0.975}{0.025} = 39.$$

Also, the collector current is

$$I_C = \beta I_B + (\beta+1)I_{CO}$$
$$= 39 \times 0.25 + (39 + 1) \times 0.01\text{mA}$$
$$= 10.2 \text{ mA}$$

Since $$\alpha = \left| \frac{I_C - I_{CO}}{I_E} \right|,$$

we have $0.975 = \dfrac{10.2 - 0.01}{I_E}$

whence $I_E = 10.4$ mA.

4. A transistor is operating in the CE mode (Fig. 7.16). Calculate $V_{CE}$ if $\beta = 125$, assuming $V_{BE} = 0.6$ V. (cf. C.U. 1991)

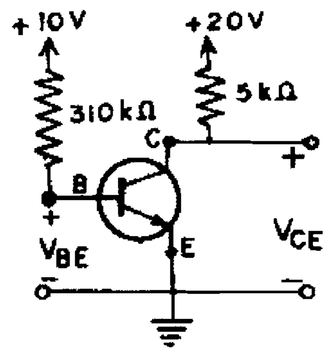



Fig. 7.16. Figure for Problem 4

**Ans.** When $V_{BE} = 0.6$ V, the base current is

$$I_B = \frac{10 - V_{BE}}{310\text{k}\,\Omega} = \frac{10-0.6}{310} \text{ mA}$$
$$= 0.0303 \text{ mA}$$

Now, $\beta = 125$. Therefore, $I_C = \beta\, I_B = 125 \times 0.0303$ mA

$$= 3.79 \text{ mA} = 3.79 \times 10^{-3} \text{ A}.$$

Again $V_{CE} = 20 - I_C \times 5 \times 10^3$ V

$$= 20 - 3.79 \times 5 = 1.05 \text{ V}.$$

5. A silicon *n-p-n* transistor having $\beta = 100$ and $I_{CO} = 22$nA is operated in the CE configuration (Fig. 7.17). Assuming $V_{BE} = 0.7$ V, determine the transistor

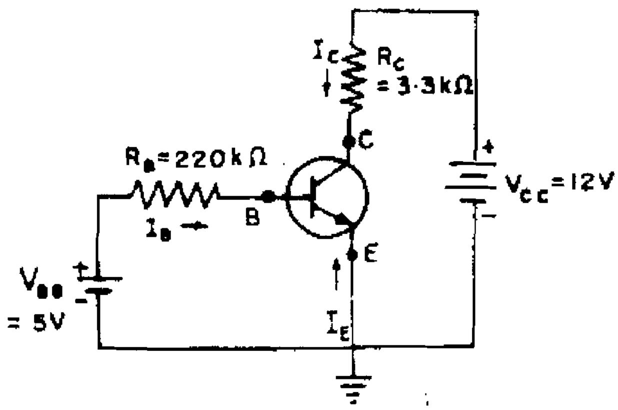



Fig. 7.17 Figure for Problem 5

currents and the region of operation of the transistor. What happens if the resistance $R_C$ is indefinitely increased? (cf. C.U. 1994)

Ans. Since the base is forward-biased, the transistor is not cutoff. So it is either or the active region or in the saturation region.

Let us assume that the transistor is in the active region. Application of Kirchhoff's voltage law to the base circuit gives

$$I_B R_B + V_{BE} = V_{BB}$$

or, $$I_B = \frac{V_{BB} - V_{BE}}{R_B} = \frac{5 - 0.7}{220} \text{ mA} = 0.0195 \text{ mA}$$

$$= 19.5 \ \mu \text{A}.$$

Here $I_{C0} << I_B$. Therefore,

$$I_C \approx \beta I_B = 100 \times 19.5 \times 10^{-3} \text{ mA} = 1.95 \text{ mA}.$$

To justify the assumption that the transistor operates in the active region, we must show that the collector junction is reverse-biased. Applying Kirchhoff's Voltage law to the collector circuit, we get

$$I_C R_C + V_{CB} + V_{BE} = V_{CC}$$

or, $$V_{CB} = V_{CC} - I_C R_C - V_{BE}$$

$$= 12 - 1.95 \times 3.3 - 0.7$$

$$= 4.86 \text{ V}.$$

A positive value of $V_{CB}$ implies that for the *n-p-n* transistor, the collector junction is reverse-biased. Therefore, the transistor is actually in the active region.

The emitter current is

$$I_E = -(I_C + L_B) = -(1.95 + 0.0195) \text{ mA}$$

$$= -1.97 \text{ mA}.$$

The negative sigh indicates that $I_E$ actually flows in the direction opposite to the arrowhead shown in Fig. 7.17.

In the active region, $I_B$ and $I_C$ do not depend on the collector circuit resistance $R_C$. So, if $R_C$ is gradually increased, we see from the collector circuit equation that at one stage $V_{CB}$ becomes negative. The transistor is then no longer in the active region; it goes over to the saturation region.

6. Refer to the circuit of Fig. 7.18. At saturation, $V_{BE}$ and $V_{CE}$ are $V_{BE, sat} = 0.85$ V and $V_{CE, sat} = 0.22$ V. If $h_{FE} = 110$, is the transistor operating in the saturation region? (cf. C.U. 1998)

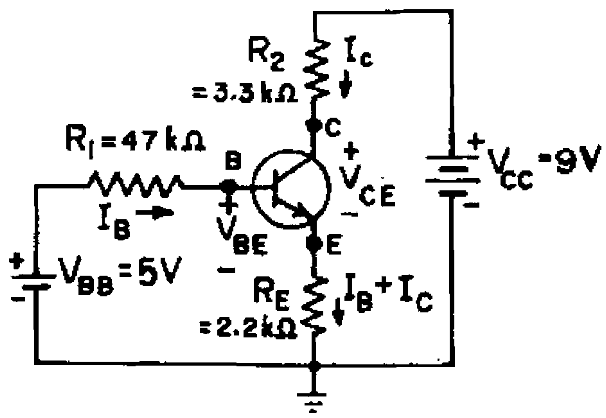



Fig. 7.18 Figure for Problem 6

**Ans**. Let us assume that the transistor operates in the saturation region. Applying Kirchhoff's voltage law to the base circuit we get

$$R_l I_B + V_{BE} + R_E (I_C + I_B) = V_{BB} \quad \text{(i)}$$

Applying the same to the collector circuit we obtain

$$R_2 I_C + V_{CE} + R_E (I_C + I_B) = V_{CC} \quad \text{(ii)}$$

Substituting the numerical values, expressing $I_B$ and $I_C$ in mA, and rearranging, (i) and (ii) are written as

$$49.2\ I_B + 2.2\ I_C = 4.15. \quad \text{(iii)}$$

and

$$2.2\ I_B + 5.5\ I_C = 8.78. \quad \text{(iv)}$$

Solving (iii) and (iv) for $I_B$ and $I_C$ gives

$$I_B = 0.0132 \text{ mA}, I_C = 1.591 \text{ mA}.$$

The minimum base current required for saturation is

$$(I_B)_{min} = \frac{I_C}{h_{FE}} = \frac{1.591}{110} = 0.0145 \text{ mA}.$$

Since $I_B$ = 0.0132 mA, $I_B < (I_B)_{min}$. So, the transistor is not in the saturation region,. It must be in the active region.

7. A transistor operating in the CE mode draws a constant base current $I_B$ of 30 μA. The collector current $I_C$ is found to change from 3.5 mA to 3.7 mA when the collector-emitter voltage $V_{CE}$ changes from 7.5 V to 12.5 V. Calculate the output resistance and β at $V_{CE}$ = 12.5 V. What is the value of α?

**Ans:** The change in the collector current is $\Delta I_C = 3.7 - 3.5 = 0.2$ mA. The corresponding change in the collector-emitter voltage is $\Delta V_{CE} = 12.5 - 7.5 = 5$V.

So, the output resistance is $\frac{\Delta V_{CE}}{\Delta I_C} = \frac{5}{0.2 \times 10^{-3}}\,\Omega = 25\,\text{k}\Omega$.

Since the base current is $I_B = 30\,\mu\text{A} = 0.03$ mA,

we have $$\beta = \frac{I_C}{I_B} = \frac{3.7}{0.03} = 123.3$$

Also, $\beta = \frac{\alpha}{1-\alpha}$, so that $\alpha = \frac{\beta}{\beta+1} = \frac{123.3}{124.3} = 0.992$.

8. In the circuit of Fig. 7.19, the transistors $Q_1$ and $Q_2$ have β = 100. The Zener diode voltage is $V_Z$ = 4V. Given, $I_L$ = 2 mA, $I_Z$ = 5 mA, $V_{EB1} = V_{EB2}$ = 0.7V. Find $R_1$, $R_2$, and the range of $R_L$ for $Q_1$ to remain in the active region. (GATE 2001)

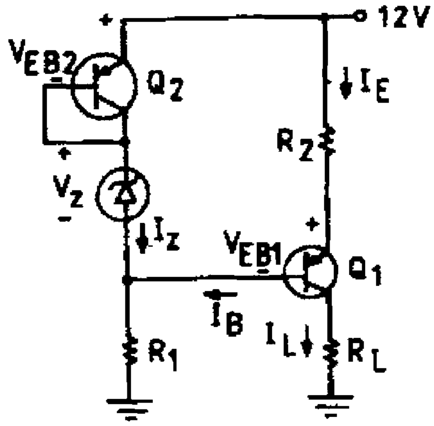


**Fig. 7.19** Figure for Problem 8.

**Ans.** Let $I_E$ and $I_B$ be the emitter and the base currents, respectively, of $Q_1$. Since $I_L$ is the collector current of $Q_1$, we have $I_B = I_L/\beta$ = 2/100 = 0.02 mA.

Also, $I_E = I_B + I_L = 0.02 + 2 = 2.02$ mA.

If $V_{R1}$ is the voltage drop across $R_1$, we obtain

$$V_{R1} = 12 - V_{EB2} - V_Z = 12 - 0.7 - 4 = 7.3\text{ V}$$

The resistance $R_1$ is

$$R_1 = \frac{V_{R1}}{I_B + I_Z} = \frac{7.3}{0.02+5} = \frac{7.3}{5.02} = 1.45\,\text{k}\Omega,$$

The voltage drop across $R_2$ is

$$V_{R2} = V_{EB2} + V_Z - V_{EB1} = 4\text{ V}.$$

$$\text{So, } R_2 = \frac{V_{R2}}{I_E} = \frac{4}{2.02} = 1.98\,\text{k}\Omega$$

The base-collector voltage drop for $Q_1$ is

$$V_{BC} = 12 - V_{R2} - V_{EB1} - I_L R_L = 7.3 - 2R_L$$

where $R_L$ is in kΩ. For $Q_1$ to remain in the active region, $V_{BC} \geq 0$. i.e.. $R_L \leq \frac{7.3}{2}$ kΩ, or $R_L \leq 3.65$ kΩ. So, $0 \leq R_L \leq 3.65$ kΩ.

## SBLIMENTARY **PROBLEMS** on BJT

1. For a *p-n-p* transistor in CE mode, $\beta = 100$. What is the value of $\alpha$? If $I_{CO} = 10\ \mu$ A, what is the collector current for an emitter current of 2 mA? (**Ans.** 0.99, 1.99 mA)

2. If $\beta = 16.5$, $I_E = 1.8$ mA and $I_{CO} = 12\ \mu$ A, calculate $I_C$ and $I_B$ when the transistor is used in the CE configuration. (**Ans.** 1.71 mA, 90 μA)

3. For a *p-n-p* transistor operating in CE configuration, it is found that when $V_{CE}$ is kept at –20 V, a change in the base current from 100 to 150 μA causes a change in the collection current from 2 to 3.8 mA. Find $h_{fe}$. (**Ans.** 36)

4. A silicon *n-p-n* transistor with $\alpha = 0.995$ and $I_{CO} = 15$ nA, operates in the CE configuration. What is the collector current for a base current of 20 μA? (**Ans.** 3.983 mA)

5. A *p-n-p* transistor working in the CB mode has an input dynamic resistance of 50Ω. The current gain on the amplifier is 0.98 and the load resistance in the collector circuit is 3 k Ω. Calculate the voltage gain and the power gain. (*cf.* C.U. 1993) (**Ans.** 58.8, 57.6)

6. An *n-p-n* transistor with $\alpha = 0.96$ and negligible $I_{CO}$ carries a base current of 0.2 mA in the active region. Determine the emitter and the collector currents. (**Ans.** 5mA, 4.8 mA)

7. For a transistor, $I_C = 7$mA, $I_{CO} = 25$ μA and $I_B = 0.1$ mA. Calculate $\alpha$, $\beta$ and $I_E$. (**Ans.** 0.98, 49, 7.1 mA)

8. For the transistor in Fig. 7.20, $\beta = 100$ and the values of $V_{BE}$ and $V_{CE}$ at saturation are $V_{BE,sat} = 0.8$ V and $V_{CE,sat} = 0.2$ V. What is the minimum value of $R_2$ for the transistor to operate in the saturation region? (**Ans.** 5.13 k $\Omega$)

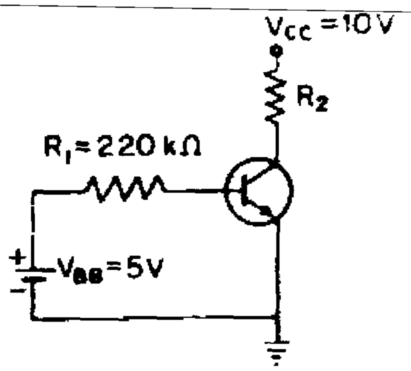



**Fig. 7.20** Figure for problem 8

9. Consider an *n-p-n* transistor in the CE configuration with negligible $I_{CO}$. Given: $\beta = 50$, $V_{BB} = 4$V. $R_B = 100$ k $\Omega$, $R_C = 4$ k$\Omega$ and $V_{CC} = 10$V. Draw the circuit diagram. Calculate the currents $I_B$ and $I_C$, assuming $V_{BE} = 0.7$ V in the active region. Find the value of $R_C$ for which the transistor will no longer be in the active region.

(C.U. 1991)

(**Ans.** 33$\mu$A, 1.65 mA, 5.64 k$\Omega$)

10. Draw the circuit diagram of a common-emitter *n-p-n* transistor with the following parameters: $V_{BB} = 5$ V, $R_B = 100$ k$\Omega$, $R_C = 1$ k$\Omega$, $V_{CC} = 10$ V. $V_{BE} = 0.7$ V, $I_{CO} = 0$, and $h_{FE} = 100$. Find $I_B$ and $I_C$. Is the transistor operating in the saturation region?

(C.U. 1993) (**Ans.** 43 $\mu$A, 4.3 mA. No.)

11. Calculate $\beta$ of a transistor for which $\alpha = 0.95$. If $\alpha$ changes by 0.1%. what is the per cent change in $\beta$? (**Ans.** 19, 2%)

12. In the circuit of Fig. 7.18, $V_{BB} = 3$V, $R_1 = 7$k $\Omega$, $R_E = 500$ $\Omega$, $R_2 = 3$k$\Omega$ and $V_{CC} = 10$V. Assume $\beta = h_{FE} = 100$. (i) Determine if the Si transistor is in cutoff, saturation or in the active region. (ii) Calculate the voltage $V_0$ between the collector $C$ and ground. (iii) Obtain the minimum value of $R_E$ for which the transistor is in the active region. (*cf.* C.U. 1997)

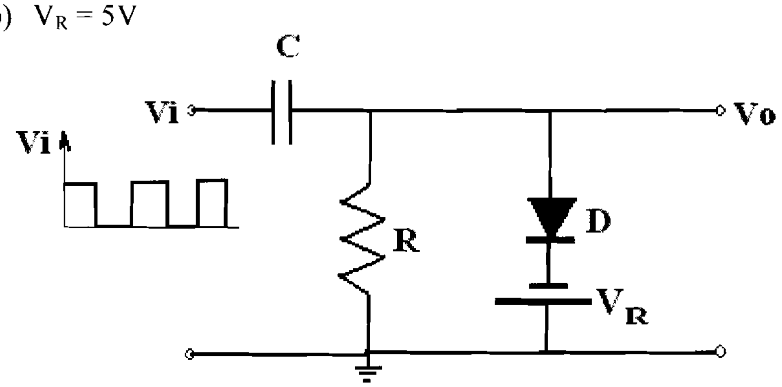
[**Hint.** (i) Take $V_{BE,sat} = 0.8$V and $V_{CE,sat} = 0.2$ V. Assume that the transistor is in saturation and proceed as in worked-out problem no. 6 (Sec. 7.13). (ii) ~~Note~~ that $V_0 = V_{CC} - I_C R_2$. (iii) At the cross-over to the active region, take $V_{CB} = 0$ and $V_{BE} = 0.8$V. Write Kirchhoff's voltage law equations for the base and collector circuits and solve for $R_E$ taking $I_C = \beta I_B$.] (**Ans.** saturation, 1.66V, 842 $\Omega$)

13. A transistor in the CE configuration is connected with a power supply. The voltage drop across a 5 k$\Omega$ resistance connected in the collector circuit is 5V. Find the base current. (Given, $\alpha = 0.998$).

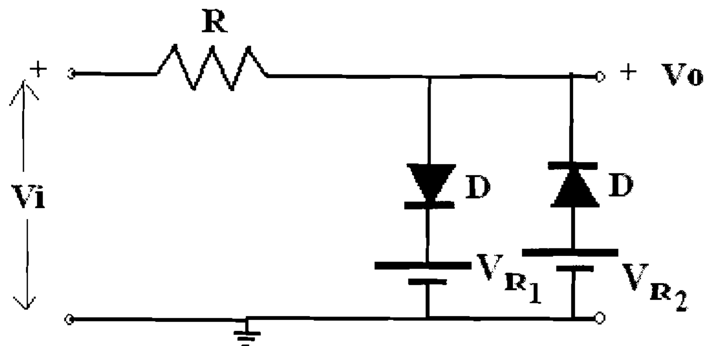
(C.U. 2000) (**Ans.** 2.004 $\mu$A)

# Devices-1, Quiz (4)

1. Draw the full wave voltage-doubler circuit and explain how it works.
2. For the clamping circuit, shown below, if the input wave form is rectangular of peak voltage value of 55 volts; draw the output waveform for
   a) $V_R = 0V$
   b) $V_R = 5V$




3. A sinusoidal wave of 12 volts peak is applied to the clipping circuit shown below (fig.2) providing that $V_{R1} = 6V$ and $V_{R2} = 4V$ plot the output wave form against time.




(Fig. 2)

| Name | |
|---|---|
| I.D# | |

AJMAN UNIVERSITY OF SCIENCE & TECHNOLOGY

Faculty of Engineering

Quiz Test-1, First Semester 2005/6

Electronic Devices & Circuits (I) #211212

**A. Chose the correct answer in the following:**

1. The depletion layer width of p-n junction **increases/decreases** when the junction is reverse-biased.
2. The load line of the triode valve defines the amplification working area above the line **(True / False).**
3. In the p-n junction the depletion layer
   **(a) contains electrons (b) contains no electrons or holes**
   **(c) occurs in the N-zone (d) occurs in the P-zone**

Using the complex model, Determine the reverse voltage in the circuit Fig.1 below, Assume Ir =1μA: (a) 6.3 V (b) 6996.5 mV (c) 7000 mV (d) 3.5 mV

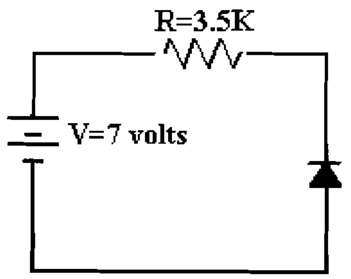



**Fig.1**

4. If a voltage signal of the waveform shown below, Fig.2, is applied to the input of a half-wave rectifier then the output DC component is:

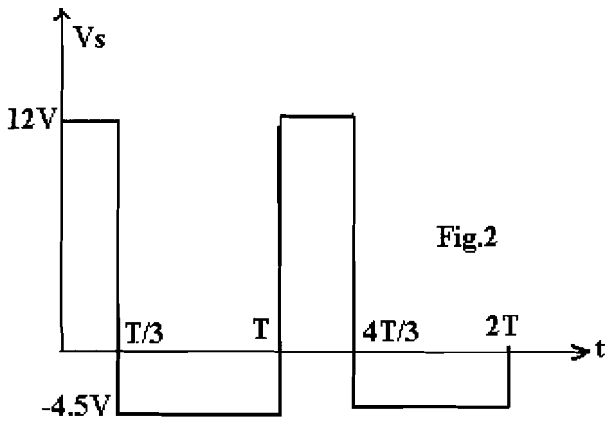



**Fig.2**

(a) 4 V (b) 36 V (c) -1.5 V (d) 8 V

5. In the circuit, Fig.3, if **Vz** = 200V, **Vi** = 260V, and $\mathbf{P_{max}}$ = 4W, the value of **Rs** will be (minimum specified zener current = 5 mA):

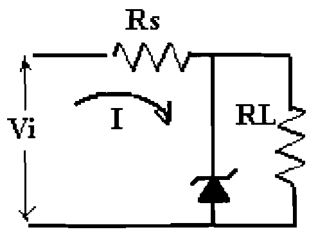



**Fig. 3**

(a) 6 KΩ (b) 12 KΩ (c) 3 KΩ (d) 5 KΩ

6. The input resistance of a triode valve is large because -------------
7. The cathode of a Zener diode in a voltage regulator is normally:
   a) more positive than the anode,
   b) more negative than the anode,
   c) at 0.7 V,
   d) grounded

B. Solve TWO of the following problems:

1. Complete the following rectifying table:

| Spec. Rectifying Descriptions | Half-Wave | Full-Wave (C.T) | Full-Wave (Bridge) |
|---|---|---|---|
| Number of Diodes | 1 | ------------ | ----------- |
| Vdc | ---------- | 0.637 Vp | -------------- |
| The Diode PIV | ---------- | -------------- | Vp |
| Frequency of Output | input freq. **f** | ---------- | **2f** |

2. Sketch the output waveforms expected when 100 Hz sine wave (10 Vp) is applied to each of the shown in the ( Fig.4 ):

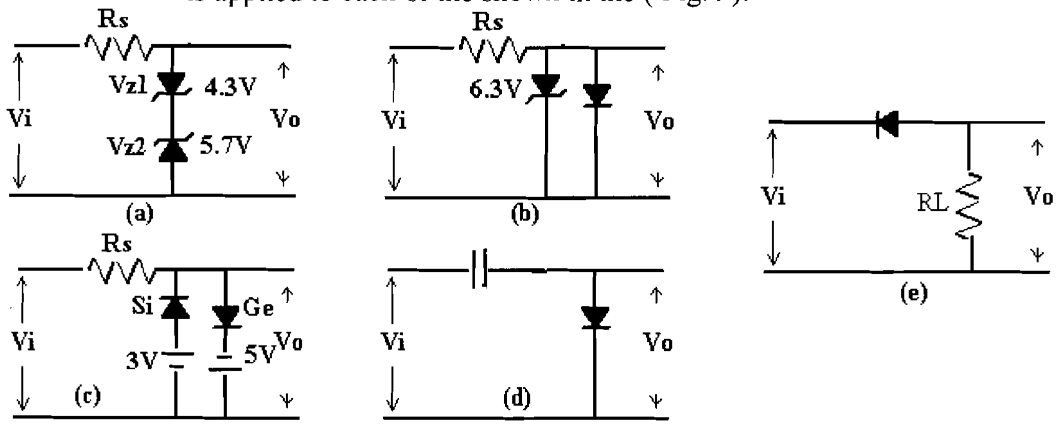



**Fig. (4)**

3. In the circuit, of Fig. (5), the supply voltage V=15V, the zener diode operates at Vz = 12 volts, $P_{Max}$ = 0.36 watts and minimum diode current of 2 mA. Calculate:
   a) The series resistance R, and
   b) The range over which the load resistance $R_L$ varies (i.e. $R_{L(max)}$ and $R_{L(min)}$ ).

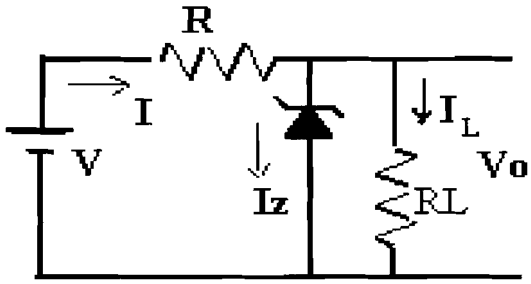



Fig.5

4. For a certain triode the anode current is expressed as:
$I_p = 8.5 \times 10^{-5} (18\ v_g + v_p)$ amps.
Where $v_p$ & $v_g$ are the grid and plate voltage in volts respectively. With the operating point at $V_G = -6$ V and $V_P = 208$ V, determine: $I_p$, $r_p$, $g_m$ and $\mu$.