Tutorial-2

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B073 020[illegible]073

1) The diffusion constant for holes in Si is 13 cm²/s. What is the diffusion current density if the gradient hole concentration, $\frac{dp}{dx} = -2 \times 10^{14}$ holes/cm³/cm?

Ans) $J_p = -e D_p \frac{dp}{dx}$

Given → $D_p = 13 cm^2/sec$, $J_p = ?$, $\frac{dp}{dx} = -2 \times 10^{14}$ holes/cm³/cm.

→ $J_p = -e D_p \frac{dp}{dx}$

→ $J_p = -1.6 \times 10^{-19} \times 13 \times (-2 \times 10^{-19})$

→ $J_p = -41.6 \, mA/cm^2$

→ $J_p = -41.6 \, A/cm^2$

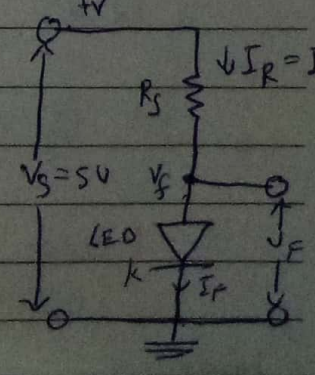
2) An amber coloured LED with a forward volt drop of 2 volts is to be connected to a 5V stabilised DC power supply. Using the circuit above calculate the value of the series resistor required to limit the forward current to less than 10mA. Also calculate the current flowing through the diode if a 100Ω series resistor is used instead of the calculated first.

Ans) $V_f = 2V$, $IR_S = ?$, $R_S = 300\Omega$

a) $I_f = 10mA$.

b) $I_F = ?$, $R_S = \frac{V_S - V_F}{I_F}$

$R_S = 100\Omega$



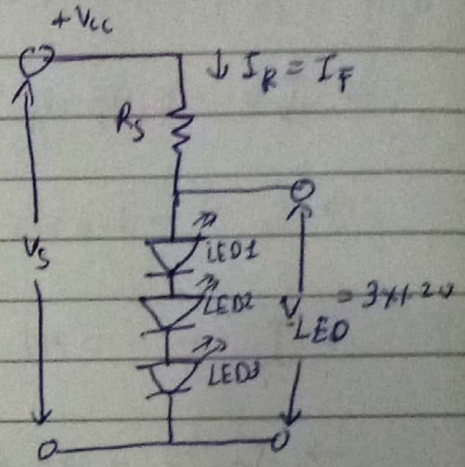
$\rightarrow I_f = \frac{5-2}{100\,\Omega}$

$\rightarrow I_f = 0.3\,A$

3) Connecting LED's in Series.

Ans) V_{LED} Using the formula →

$\rightarrow R_S = \frac{V_S - V_{LED}}{I_F}$

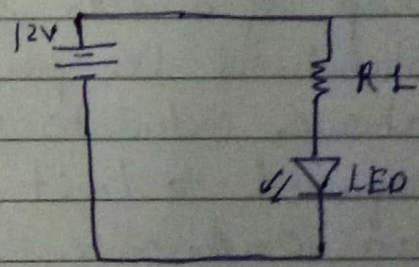


$\rightarrow V_{LED} = 3 \times 1.2\,V = 3 \times 1.2\,V = 3.6\,V$

$\rightarrow R_S = V_S - V_{LED} = 5 - 3.6 = 1.4\,V$

4) Calculate the power rating for resistor R1.

Ans) Given → LED forward voltage
$= 3.9\,V = V_f$
LED forward current
$= 1400\,mA = I_f$



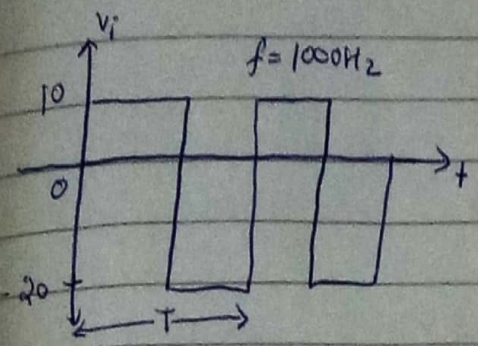
$\rightarrow 12\,V - V_f - V_R = 0$

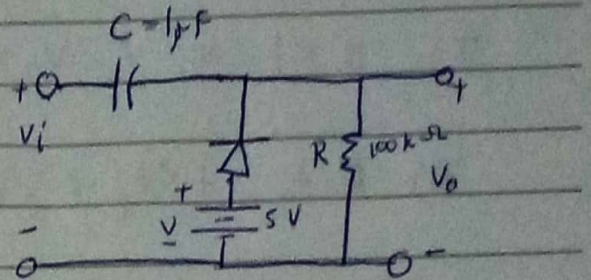
$\rightarrow 12\,V - 3.9\,V - V_R = 0$

$\rightarrow V_R = 8.1\,V$

$\rightarrow$ Power $= i \times V = 1.4 \times 8.1 = 11.34$ Watts

5) Determine V_o for the following network with the input shown (for ideal diode).



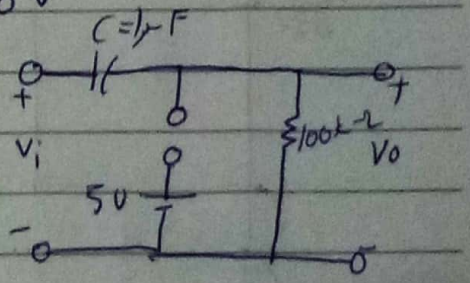


Ans) $T = \frac{1}{f} = \frac{1}{1000Hz} = 1m\,sec$, $t_1 = 0.5ms$, $t_2 = 0.5ms$.

a) V_i is $\Rightarrow 0 < t < t_1 \Rightarrow V_i = 10V$

First interval →

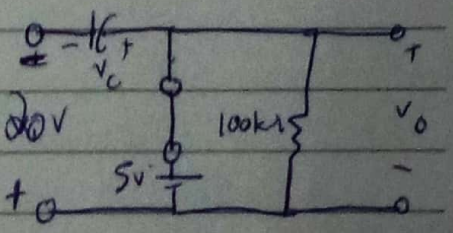
→ $I_o = 0A$, $V_o = 0V$



b) $V = -20 + V_C - 5V = 0$, $V_o = 5V$

Second interval →

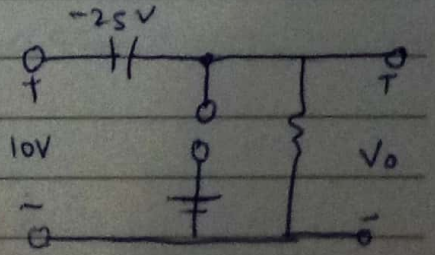
→ $V_C = \underline{25V}$



c) Applying KVL to circuit.

→ $10V + 25V - V_o = 0$

→ $V_o = \underline{35V}$



→ Discharge at time $t = RC$

→ $RC = 100 \times 10^3 \times 0.1 \times 10^{-3} = 10ms$

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Total discharge $= 5t \approx 5 \times 10\,ms = 50ms$.

Thus the cases can be concluded that →

I) $0 < t < t_1$: $V_o = 0V$

II) $t_1 < t < t_2$: $V_o = 5V$

III) $t_2 < t < t_3$: $V_o = 35V$

Thus we can plot the output as →