Benha University
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Sheet 2

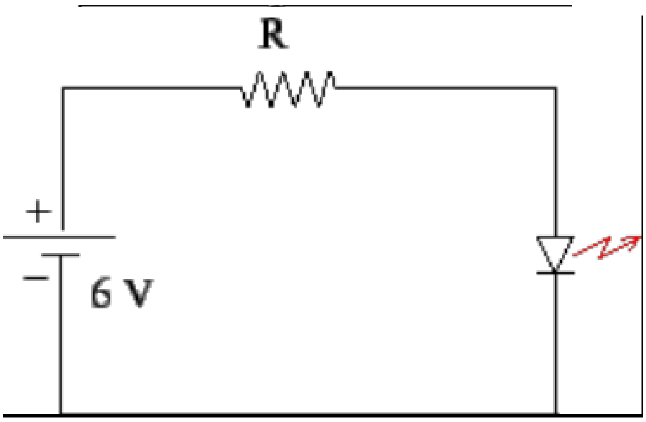
1. A GaAs LED radiates at 900 nm. If the forward current in the LED is 20 mA, calculate the power output, assuming an internal quantum efficiency of 2%.

The energy of the photon (in eV) is

$$\frac{hc}{e\lambda} = \frac{6.62 \times 10^{34} \times 3 \times 10^{8}}{1.6 \times 10^{-19} \times 9 \times 10^{-7}} = 1.38$$

Thus the power output is $P = 0.02 \times 1.38 \times 20 = 0.55$mW.

2. In the circuit shown, the forward biased LED has a voltage drop of 1.5 volts. If the battery voltage is 6 V, calculate the resistance to be connected to the circuit, if the current through the LED is 15 mA. How much power is dissipated in the resistor?



If r is the internal resistance of the LED he current through the resistors is $V/(R+r) = 0.015$which gives $R + r = 6/0.015 = 400\ \Omega$. As the drop across LED is 1.6 V, the internal resistance r is $1.5/0.015 = 100\ \Omega$. The external resistance to be connected is $R = 400 - 100 = 300\ \Omega$. The power rating of the resistor should at least be $RI^2 = 300 \times 2.25 \times 10^{-4} = 77.5$mW.

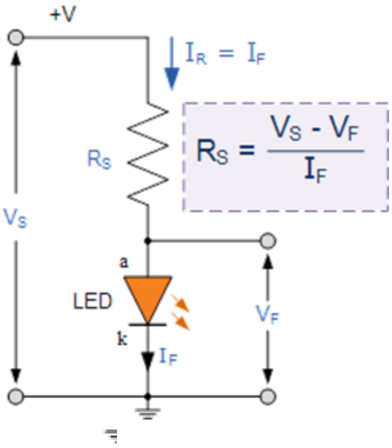
3. For the theoretical power spectrum of LED, calculate the linewidth $\Delta\lambda$ at half the maximum intensity for λ=870nm at room temperature

As $\lambda = hc/E$, on differentiating, we get

$$\Delta\lambda = \frac{hc}{E^2}\Delta E = \frac{\lambda^2}{hc} \times 1.8kT$$

Substituting $\lambda = 870$nm and $T = 300$K, $\Delta\lambda = 28.4$nm.

4. ALED with a forward volt drop of 2 volts is to be connected to a 5.0v DC power supply. Using the circuit shown, 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.



1). series resistor required at 10mA.

$$R_S = \frac{V_S - V_F}{I_F} = \frac{5v - 2v}{10mA} = \frac{3}{10 \times 10^{-3}} = 300\Omega$$

2). with a 100Ω series resistor.

$$R_S = \frac{V_S - V_F}{I_F}$$

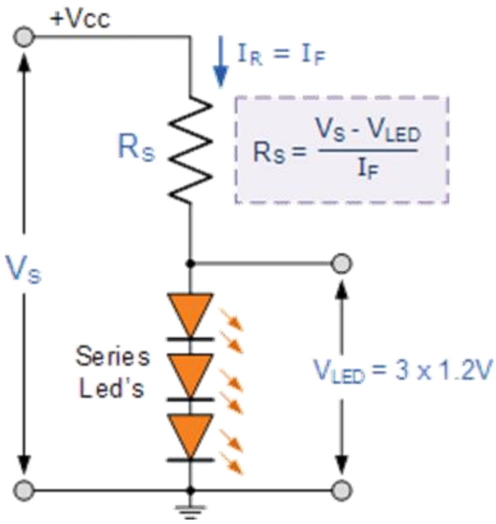
$$\therefore\ I_F = \frac{V_S - V_F}{R_S} = \frac{5 - 2}{100} = 30mA$$

5. If we also assume that the three LEDs are to be illuminated from the same 5 volt logic device or supply with a forward current of about 10mA, the same as above. calculate the voltage drop across the resistor, RS and its resistance value

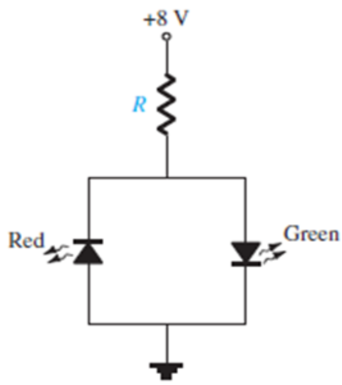
$$V_{LED} = 3 \times 1.2\text{volts} = 3 \times 1.2\text{v} = 3.6\text{v}$$

$$R_S = V_S - V_{LED} = 5 - 3.6 = 1.4\text{volts}$$

$$\therefore R_S = \frac{1.4\text{v}}{10\text{mA}} = 140\Omega$$

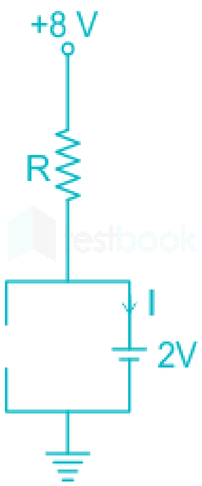


6. Find the resistor R to ensure a current of 20 mA through the "on" diode for the configuration shown. Both LEDs have a reverse breakdown voltage of 3 V and an average turn-on voltage of 2 V.



The 8V DC battery is connected to the anode of the Green LED and the cathode of the Red LED.

∴ The Green LED will be forward-biased and Red LED will be reverse-biased.



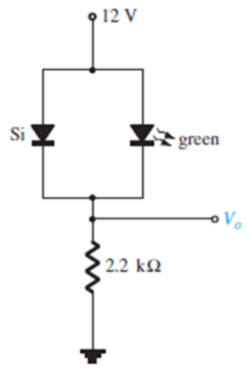
The value of R is given by:

$$R = \frac{8-2}{20 \times 10^{-3}}$$

R = 300 Ω

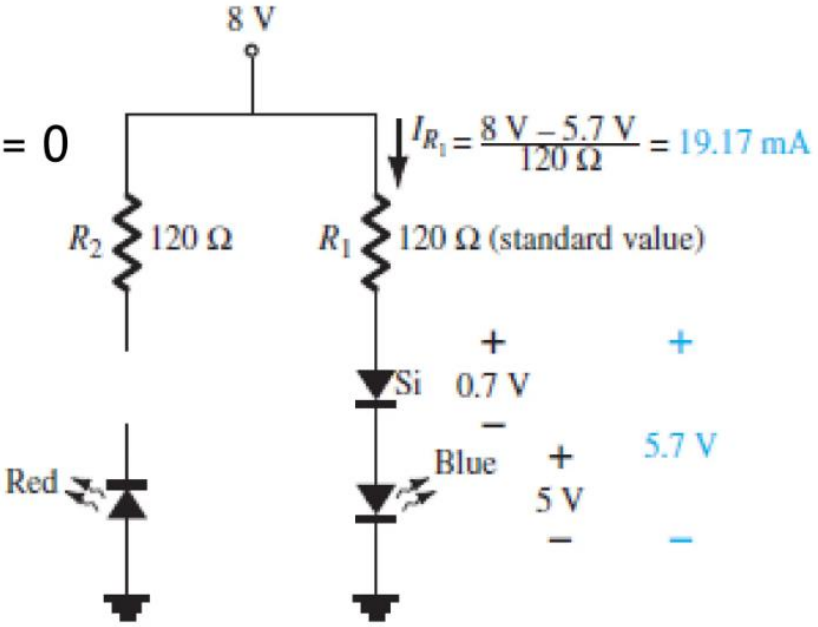
7. Determine the voltage Vo if the turn on voltage of LED is 2.2V

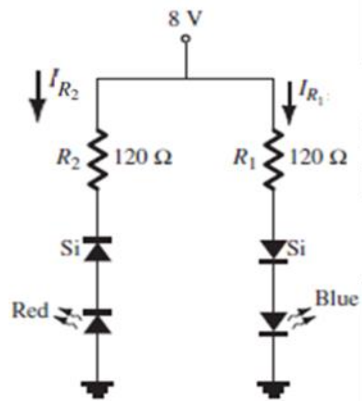
The least diode – voltage drop is
on and the other is off
So , Si is on
Vo = 12-0.7=11.3
I = 11.3/2.2*10^3



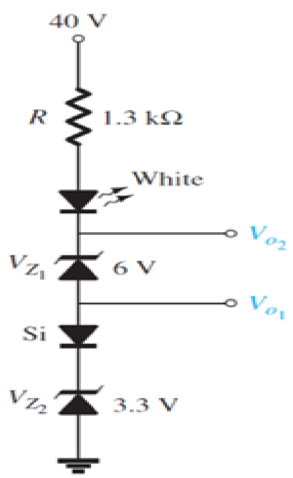
8. Calculate the currents IR1 & IR2 in the configuration shown. Both LEDs have a reverse breakdown voltage of 3 V and an average turn-on voltage of 5 V.

$I_{R2} = 0$



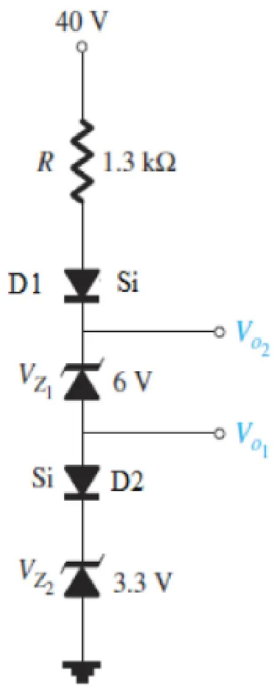


9. Determine Vo1 & Vo2 , IR , power absorbed by LED and Zener



Solution

- D1 is FB is replaced by 0.7 V
- Z1 is Reverse Bias on state is replaced by 6 V
- D2 is FB is replaced by 0.7 V
- Z2 is Reverse Bias on state is replaced by 3.3 V



Solution

- $V_{o1} = 3.3 + 0.7 = 4\ V$
- $V_{o2} = 3.3 + 0.7 + 6 = 10\ V$
- $40 - IR - 0.7 - 6 - 0.7 - 3.3 = 0$
- $I = \frac{40-10.7}{1.3\times10^3} = 22.5\ mA$
- $P_{Z1} = V_{Z1} \times I = 22.5m \times 6 = 135.2\ mw$
- $P_{Z2} = V_{Z2} \times I = 22.5m \times 3.3 = 74.4\ mw$