1. When the reverse current in a particular zener diode increases from 20 mA to 30 mA, the zener voltage changes from 5.6 V to 5.65 V. What is the impedance of this device?

2. A certain zener diode has the following specifications: V_Z = 6.8 V at 25°C and T_C = +0.04%/°C. Determine the zener voltage at 70°C.

3. A certain 50 W zener diode must be derated with a derating factor of 0.5 W/ °C above 75°C. Determine the maximum power it can dissipate at 160°C.

4. A 9.1-V zener diode exhibits its nominal voltage at a test current of 28 mA. At this current the zener impedance is specified as 5 Ω. Find

i) V_{Zk} of the zener model.

ii) The zener voltage at a current of 10 mA and at 100 mA.

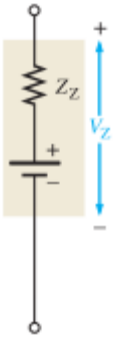

Figure 1

5. In figure 2, a 7.5-V zener regulator circuit using a 7.5-V zener specified at 12 mA. The zener has Z_z = 30 Ω and a knee current of 0.5 mA. The regulator operates from a 10-V supply and has a 1.2-kΩ load. Find V_{zk}, and what is the value of R you have chosen when the total current I is 10 mA?

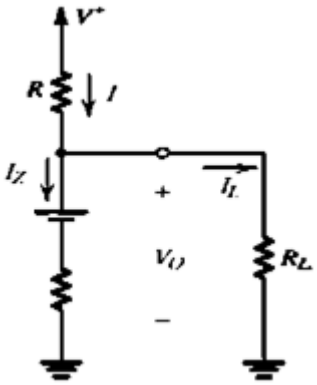

Figure 2

6. To what value must R be adjusted in Figure 3 to make I_z 40 mA? Assume V_z = 12 V at 30 mA and Z_z = 30 Ω. And draw the output waveform if 20 V peak sinusoidal voltage is applied to this circuit in place of the dc source.

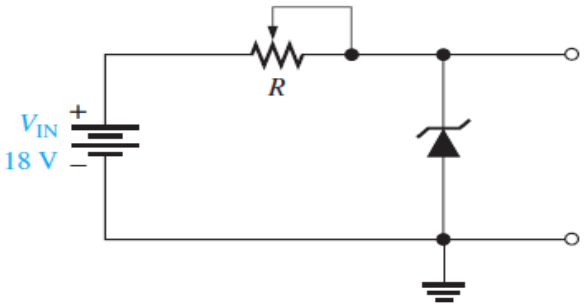

Figure 3

7. A loaded zener regulator is shown in Figure 4. Determine the minimum and maximum permissible load currents, minimum load resistance R_L that can be used. And also find the load regulation expressed as a percentage.

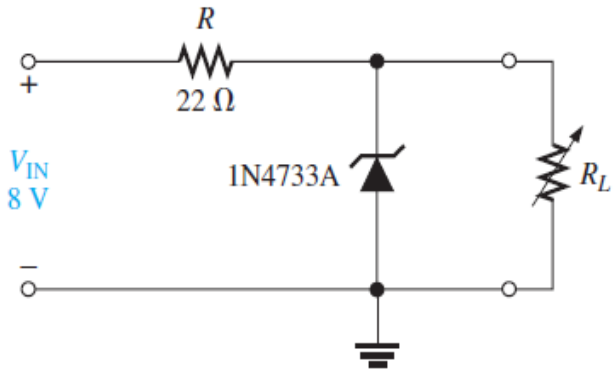

Figure 4

8. Draw the output voltage (V_{out}) for each zener limiting circuit in Figure 5.

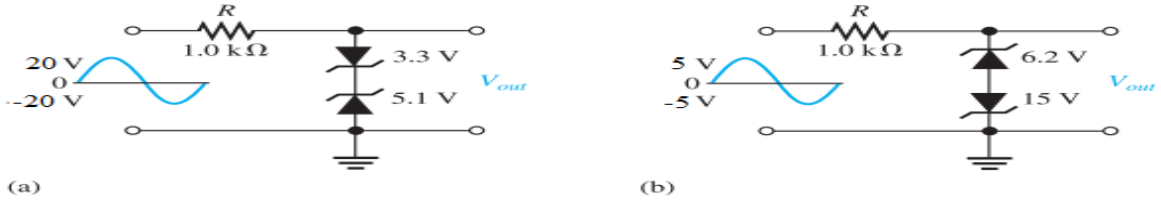

Figure 5

9. Develop a yellow LED traffic-light array using a minimum number of limiting resistors that operates from a 24 V supply and consists of 100 LEDs with I_F = 30 mA, voltage across each LED equal 2.5 V and an equal number of LEDs in each parallel branch. Show the circuit and the resistor values.

10. For a TEMD1000 photodiode, determine the reverse light current for an irradiance of 1 mW/cm2 at a wavelength of 1050 nm and the angle is 0°.

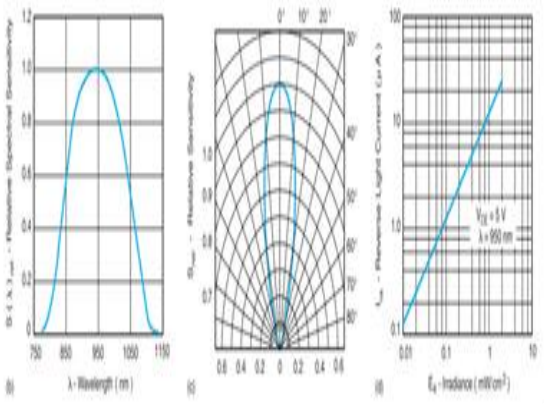

Figure 6

Design problems

11. Design a 12 V red LED array with minimum limiting resistors, a forward current of 30 mA, and voltage across each LED equal 2.3 V, containing 64 diodes and 16 parallel branches.

12. The Zener diode in the voltage-regulator circuit of figure 7 has a constant reverse breakdown voltage V_Z = 8.2 V, for 75mA≤ $i_Z \leq$ 1 A. If R_L = 9Ω, size R_S so that $v_L = V_Z$ is regulated to (maintained at) 8.2 V while V_b varies by ±10 percent from its nominal value of 12 V.

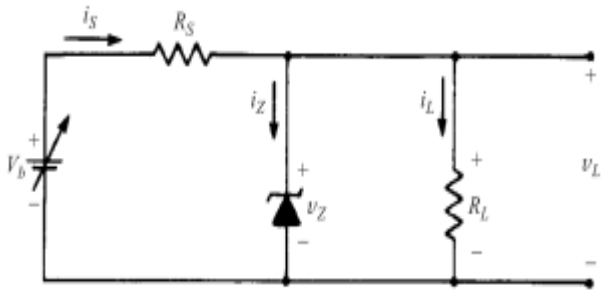

Figure 7

13. Design of a zener regulator, the parameters of a 6.3-V zener diode for the voltage regulator circuit of figure 8 are V_Z = 6.3 V at I_Z = 40 mA and Z_Z= 2Ω. The supply voltage v_S= V_S can vary between 12 V and 18 V. The minimum load current is 0 mA. The minimum zener diode current I_{Zk} is 1 mA. The power dissipation P_D of the zener diode must not exceed 750 mW at 25°C.

Determine:

(a) The maximum permissible value of the zener current $I_{ZM,}$

(b) The value of R_s that limits the zener current I_{ZM} to the value determined in part (a),

(c) The power rating P_R of R_s, and

(d) The maximum load current $i_{L(max)}$

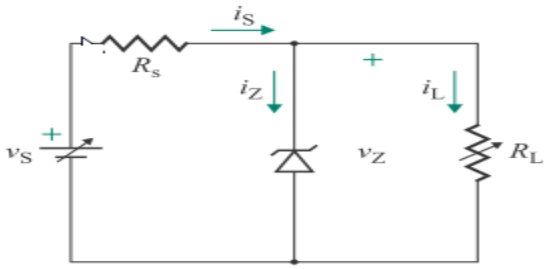

Figure 8

14. A designer requires a well-regulated DC supply of 3 V on no load for an application where a poorly regulated supply voltage (V_s) with nominal voltage of 10 V is available. The supply voltage varies between 6 V and 15 V, and the load current varies over the range 0 to 5 mA. A Zener diode (with V_z =3 V at 10 mA, Z_z = 15 Ω and I_{ZK} = 0.5 mA) and several 1 mA diodes (with 0.7 V drop at 1 mA and n = 1)

are available. Also, all resistor values in designs are to be selected from the standard values given in the list of multiples (for 5% resistor values) specified as follows[1]: 10, 11, 12, 13, 15, 16,·18, 20, 22, 24, 21, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91.

a) Sketch two possible regulator circuits that the designer could use for the design. Clearly label all circuit elements and variables.

b) Select one of the circuits in (a) to complete the design. Specify the standard values and ratings of resistors used in your design. Design for worst case scenario.

c) For your design, determine the percentage change in V_o (i.e. $\Delta V_o/V_o$) corresponding to the change in load current from 0 to 5 mA.

[1] Standard base resistor values are given in http://www.rfcafe.com/references/electrical/resistor-values.htm for the most commonly used tolerances (1%, 5%, 10%), along with typically available resistance ranges. To determine values other than the base, multiply the base value by 10; 100; 1,000; or 10,000.