INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

Mid-Autumn Semester Examination 2022-23

Date of Examination: _____ **Session: (FN/AN)** ____ **Duration: 2 hrs** **Full Marks:** 100

Subject No. : EC 21201 **Subject :** Basic Electronics

Department/Center/School: Electronics & Electrical Communication Engg

Specific charts, graph paper, log book etc., required NO

Special Instructions (if any) : _____

Answer all questions. The marks for the individual parts of a question are indicated on the right.

1. A half-wave rectifier such as shown in Figure 1 has a load of R = 2 kΩ. The input is a 120 V (rms), 60 Hz signal and the transformer is a 10:1 stepdown transformer. The diode has a cut-in voltage of $V_\gamma = 0.7$ V with $r_f = 0\ \Omega$.
   (a) What is the peak output voltage? [3]
   (b) Determine the peak diode current. [2]
   (c) What is the fraction (percent) of a cycle that $v_O > 0$. [6]
   (d) Determine the average output voltage. [6]
   (e) Find the average current in the load. [3]

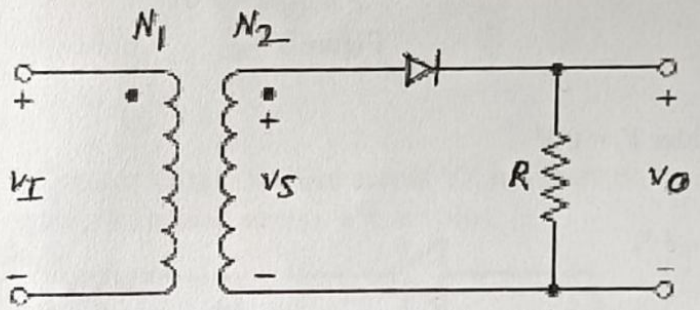

Figure 1

2. (a) Determine the steady-state output voltage v_o for the circuit in Figure 2(a), if the input waveform is as shown in Figure 2(b). Assume that the diode cut-in voltage is $V_\gamma = 0$. [8]

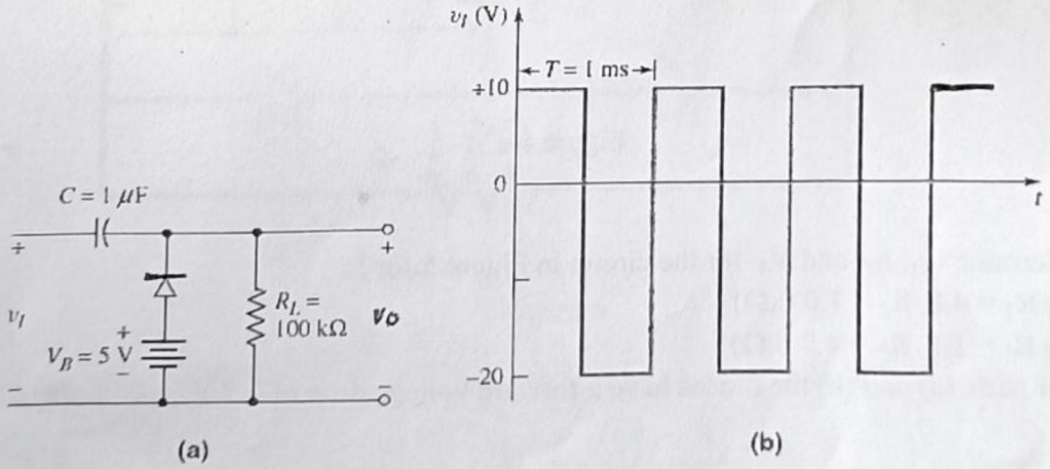

Figure 2

1

(b) Draw the output voltage versus time waveform for the following circuits in Figures 3 and 4 with the waveforms appropriately labelled for the input signal shown on the left.

I. Consider $V_\gamma = 0.6$ V [6]

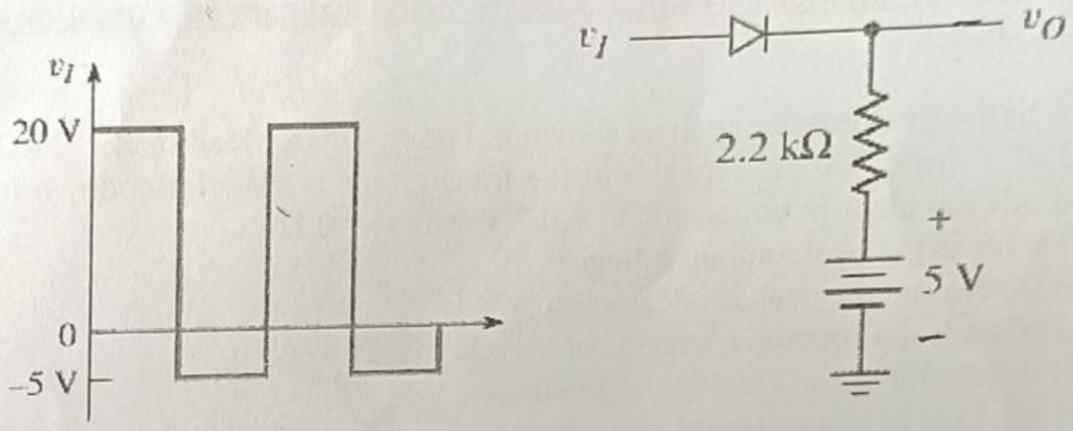

Figure 3

II. Consider $V_\gamma = 0$ V [6]

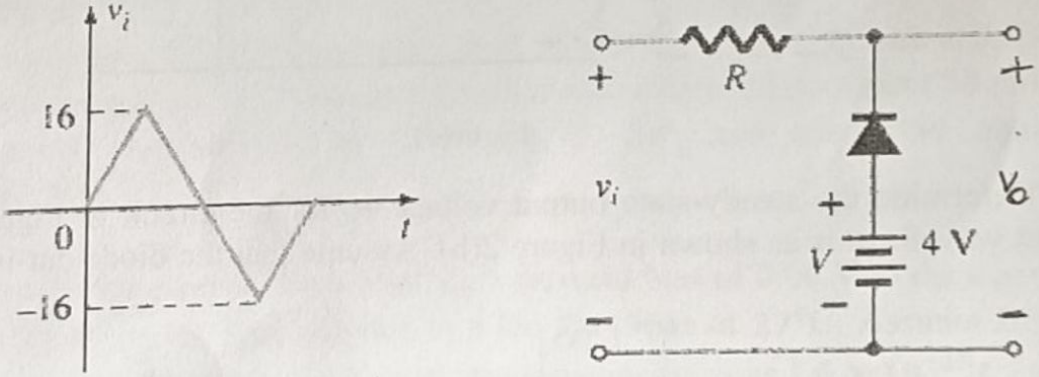

Figure 4

3. Determine I_{D1}, I_{D2} and V_4 for the circuit in Figure 5 for :
   (a) $R_1 = 4.0$, $R_2 = 1.0$ (kΩ)
   (b) $R_1 = 1.0$, $R_2 = 4.0$ (kΩ)
   For parts (a) and (b) the diodes have a forward voltage drop of 0.7 V [6+6]

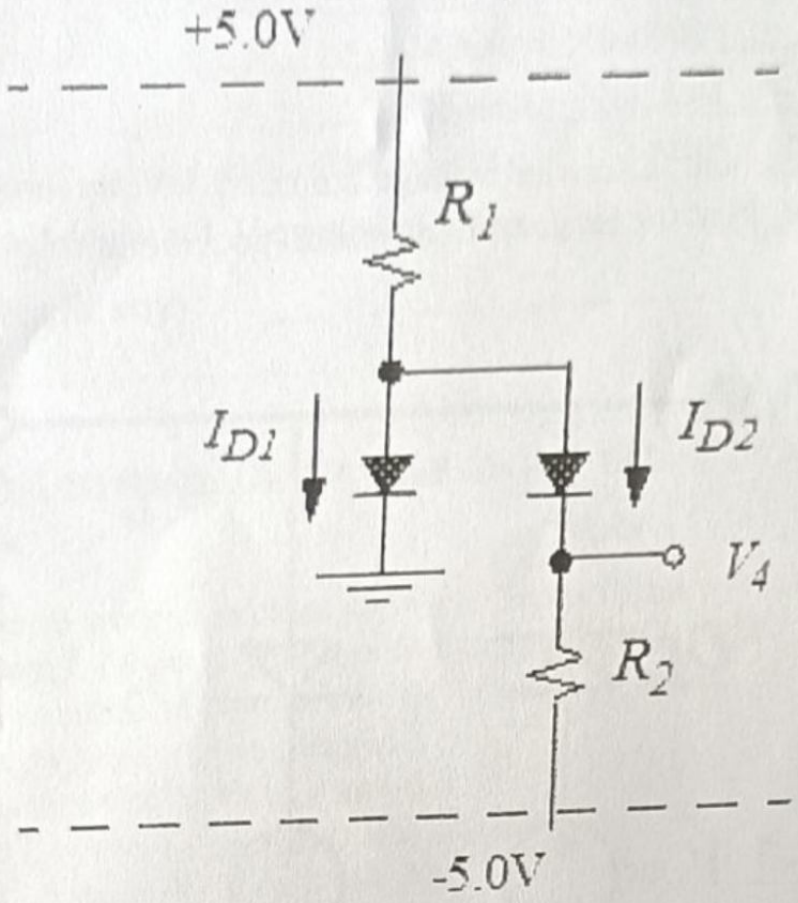

Figure 5

(c) A voltage 1000 sin(ωt) volts is applied across YZ in Figure 6. Assuming ideal diodes, find the voltage measured across WX in volts. [2]

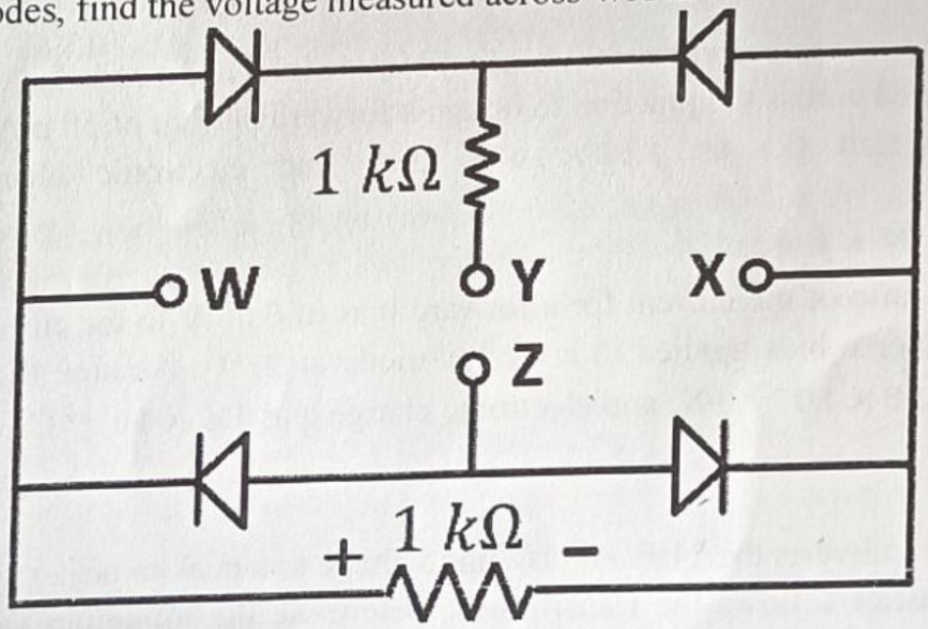

Figure 6

(d) Two silicon diodes, with a forward voltage drop of 0.7 V, are used in the circuit shown in the Figure 7. Find the range of input voltage V_i for which the output voltage $V_0 = V_i$ [6]

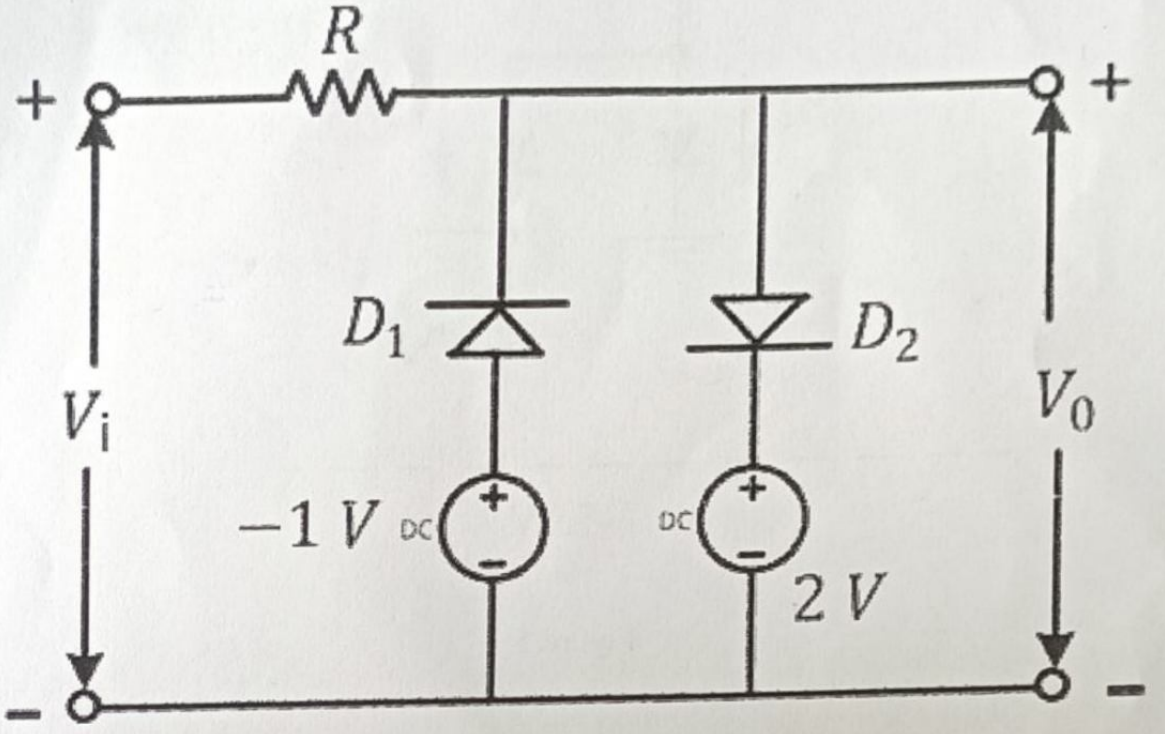

Figure 7

4. (a) The reverse saturation current at 300 K of a PN-junction Ge diode is 5μA. Find the voltage to be applied across the junction to obtain a forward current of 50 mA. Assume Boltzmann's constant (k) as 1.38×10^{-23} J/K, and electronic charge q as 1.6×10^{-19} C. [10]

(b) Calculate the ratio of the current for a forward bias of 0.06 V to the current for the same value of reverse bias applied to a Ge PN-diode at 27°C. Assume Boltzmann's constant (k) as 1.38×10^{-23} J/K, and electronic charge q as 1.6×10^{-19} C. [10]

5. (a) A transformer converts the 110V, 60 Hz line voltage to a peak to peak swing of 9V. A half-wave rectifier follows the transformer. Determine the minimum value of the filter capacitor that maintains the ripple below 0.1 V. Assume cut-in voltage of diode V_γ=0.8V and load resistance R_L=0.436 ohm. [10]

(b) A piece of Si is 2 μm long. The electron concentration is decaying exponentially (due to concentration gradient) from x=0 to x=2μm as $n(x) = N\,exp(-x)$. Find out the current in the semiconductor at x=2μm. Assume cross sectional area as 1 μm x1 μm, concentration of electron at x=0 as $5x10^{16}/cm^3$, and diffusion coefficient of electron as 34 cm^2/sec. Consider electronic charge q as 1.6×10^{-19} C. [10]