INDIAN INSTITUTE OF TECHNOLOGY

Date: _ Feb 2013, FN/AN, Time: 2 Hrs., Full Marks: 60, No. of Students : 660 (Non-ECE branches); Mid Spring Semester,
Sub. No.: EC21101, Sub. Name: Basic Electronics

Instructions

- **All waveform sketches / diagrams must be neatly drawn and clearly labeled.** Answers must be brief and to the point.
- The final answers (numerical values with unit) should be **underlined** or enclosed within box with unit.
- For every Question No., start your answer from a new page.
- Avoid writing answers of the various parts of a single question at different locations in your answer-script.
- **Given parameters which you might require**: mass of electron: 9.11×10^{-31}kg, Boltzmann constant : 1.38×10^{-23} J/K, charge o electron : 1.6×10^{-19} C
- For any value related to any device parameter or circuit parameter, which you may find not given with a problem, assum suitable value for such parameter.
- **Answer any FOUR questions (out of SIX)**

1A. For the circuit shown in Fig. 1 consider V_{PS}=16 V, R_1=20 KΩ, R_2=10 KΩ, V_γ=0.7 V, and v_i= 0.5sinωt. Determine the dc and ac output voltage as well as the diffusion capacitance considering the following two conditions

(i) when R_2 decreases from 10 KΩ to 5 KΩ
(ii) when V_{PS} increases from 16 V to 20 V

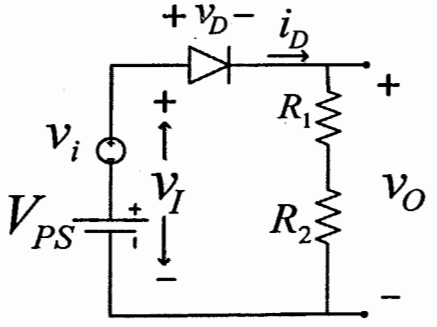

Fig. 1.

1B. Calculate the junction capacitance for Ge pn junction when 6 V reverse voltage is applied. Doping concentrations of N_a=5 x 10^{16} /cm^3, N_d=2 x 10^{15}/cm^3 and let C_{jo}= 0.8 pF. Given the value of coefficient for Ge (B) is 1.66 x 10^{15} cm^{-3}K$^{-3/2}$ and band gap (E_g) is 0.66 eV at 300 K.

(8+7)

2A. For the circuit in Fig. 2 the cut in voltage of diode is V_γ= 0.7 V. Plot the v_o versus v_i.

Given: R_1=2kΩ, R_2=R_3= 1kΩ, V_1=15V

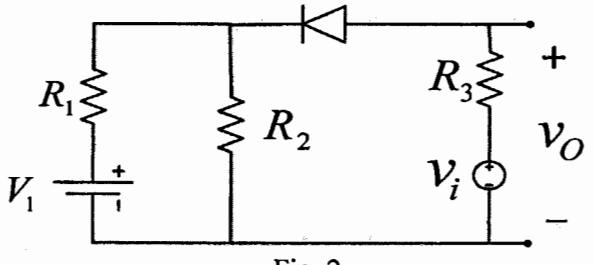

Fig. 2

2B. In the voltage regulator shown in Fig. 3, calculate the dissipated power in the Zener diode.

Given: V_1=50V, R_1=150Ω, Vz=15V (assume Rz=0) and R_2=75Ω

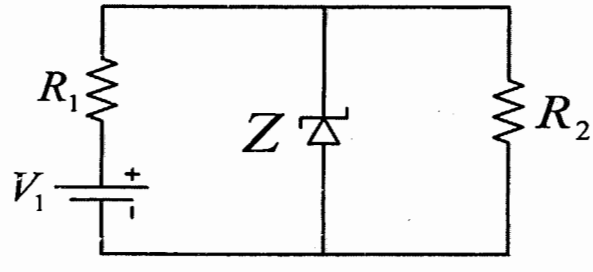

Fig. 3

(8+7)

3A. In the circuit shown Fig. 4, the switch is closed at $t = 0$. Calculate the time t when the output voltage is 9 V.

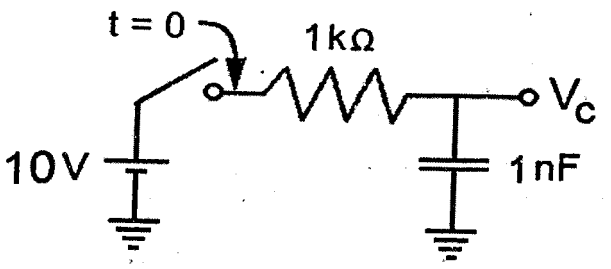

Fig. 4

3B. What is the equivalent Thevenin's voltage and Thevenin's resistance of the circuit shown in Fig. 5?

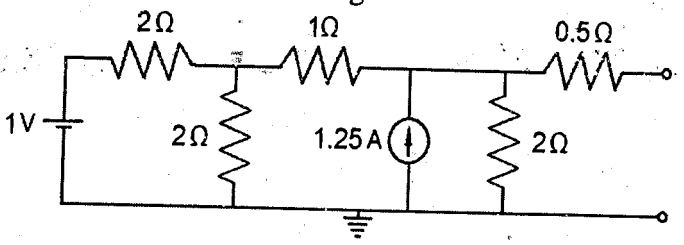

Fig. 5

3C. In the circuit shown in Fig. 6 a sinusoidal signal generator with internal resistance 50 Ω is connected to a series LR circuit. If $v_i = 12 \sin 2\pi ft$, calculate the linear frequency at which the rms value of the output voltage v_0 is 6 V.

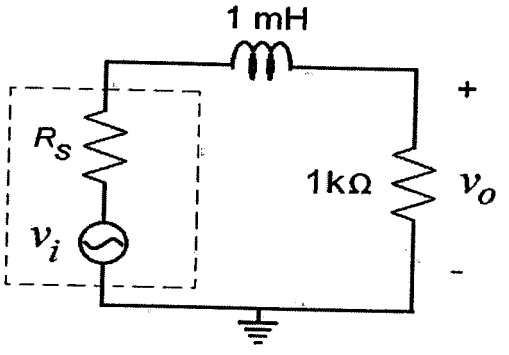

Fig. 6

(5+5+5)

4A. In the circuit shown in Fig. 7, v_{IN}=5 sinωt [volt], V_b=2V and V_γ=0.7 V.

(i) Draw the output waveform v_{OUT} with respect to t.

(ii) Draw the transfer characteristics (v_{OUT} vs v_{IN}).

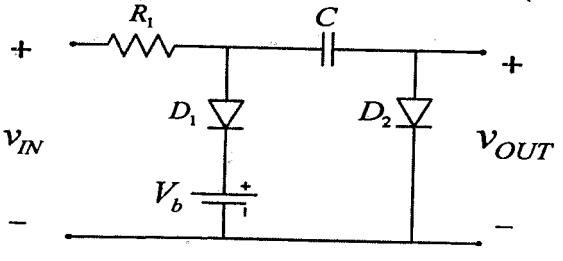

Fig. 7

4B. In the circuit shown in Fig. 8, find out I_1 (current through D1) and I_2 (current through D2).

Given: $R_1=R_2=R_3=R_4=R_5=R_6=1k\Omega$

V_1=5V, V_2=3V and V_γ=0.7V (for both the diodes)

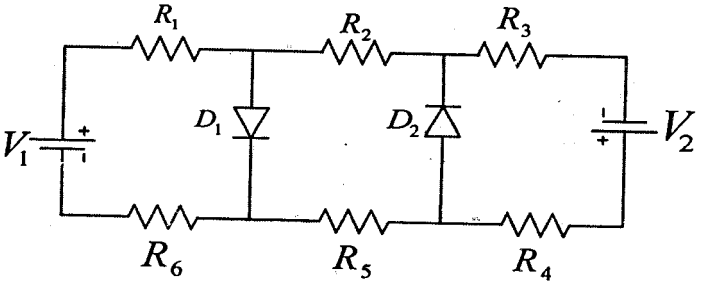

Fig. 8

(8+7)

5A. In the circuit shown in Fig. 9, Find R_2 and R_4.

Given: V_{DD}=5V, R_1=6kΩ, R_3=4kΩ, I_{DS}=0.25 mA, V_{DS}=3.5V, W=20 μm, L=1 μm, $\mu_n C_{ox}$=100 μA/V^2, V_{th} (threshold voltage) =1 V.

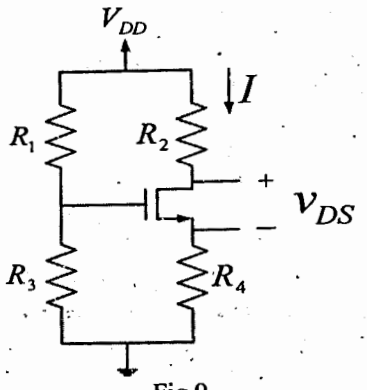

Fig.9

5B. In the circuit shown in Fig. 10, Find I_1 and I_2.

Given: R=3kΩ, V_{DD}=5V, W_1=20 μm, W_2=60 μm, L_1=L_2=1 μm, $\mu_n C_{ox}$ (for both M_1 and M_2) =100 μA/V^2, V_{th} (threshold voltage) =1 V (for both M_1 and M_2).

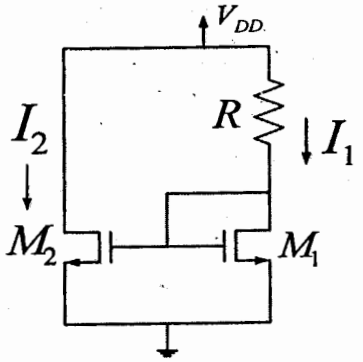

Fig. 10

(8+7)

6A. In a hypothetical structure, made with n type Si and n type Ge, shown in Fig. 11, find ρ (resistivity) of Si and Ge. Hence find out the equivalent resistance.

Given: N_D(Si)=10^{16}/cm^3, N_D(Ge)=10^{15}/ cm^3, μ_n(Si)= 1350 cm^2/V-sec, μ_n(Ge)= 3800 cm^2/V-sec, A (cross-section)=0.1 mm^2, L_1=1mm, L_2=0.5mm.

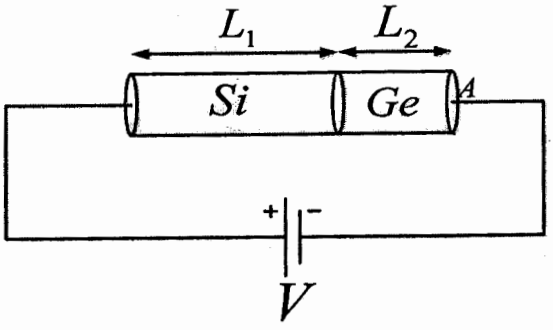

Fig. 11

6B. In a device, suppose i_D= K(v_D^3+2v_D^2+3v_D+4), find out small signal resistance of the device. Where, K-constant, i_D and v_D are total instantaneous values.

(8+7)