Mas

INDIAN INSTITUTE OF TECHNOLOGY

Date: __ February 2014, FN/AN, Time: 2 Hrs., Full Marks: 60, No. of Students : 770 (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.
- Insert this question paper inside your answer booklet and submit it along with your answer booklet
- 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 of electron : 1.6×10^{-19} C, Density of Al = 2.7×10^{3} kg.m^{-3}, Resistivity of Al $\rho = 3.44\times10^{-8}$ Ω.m @ 300K, Atomic weight of Al = 26.98, Avogadro's no, $N_{avo} = 6.023\times10^{23}$, Intrinsic concentration of Si $n_i = 1.45\times10^{10}$ cm^{-3} @ 300K, Ideality factor for a Si diode $\eta = 2$**
- For any value related to any device parameter or circuit parameter, which you may find not given with a problem, assume suitable value for such parameter.
- **Answer ALL questions**

1A. Compute the mobility of the free electrons in aluminum (Al) at room temperature for which all three valence electrons are free for conduction. [3]

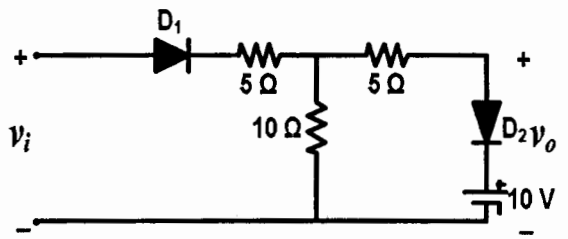
1B. Determine the change in the contact potential in an open-circuited pn junction at room temperature, assuming that N_D and N_A are changed by factors of 2500 and 8000 respectively. [3]

1C. A flat Al strip has a cross sectional area of 2×10^{-4} mm^2 and a length of 5 mm. What is the voltage drop across this strip for a current of 50 mA? [3]

1D. Determine the concentration of free electrons and holes in Si at room temperature which has a donor concentration of $N_D=2\times10^{14}$ atoms/cm^3 and acceptor concentration of $N_A=3\times10^{14}$ atoms/cm^3. [3]

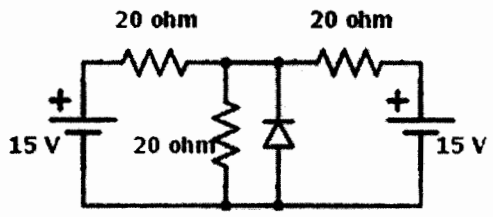
1E. A Si diode is forward biased with 0.2 V at room temperature. Assuming that the saturation current doubles for every 10°C rise in temperature, by what factor will the diode current increase for a 40°C rise above room temperature? [3]

2A. The diodes in the circuit are ideal (V_γ=0 V) as shown in figure below. Sketch the transfer characteristic over the range -20 V $\le v_i \le$ 20 V. [5]

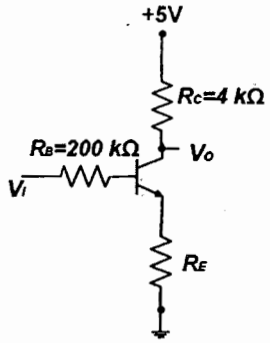


2B. A zener diode has the specifications V_Z =5.2 V and P_{Zmax} = 260 mW. Assume R_Z (Zener Resistance) = 0. (**a**) Find the maximum allowable current I_Z when Zener diode is acting as a regulator. (**b**) If a single-loop circuit consists of an ideal 15 V dc source Vs, a variable resistor R, and the described Zener diode, find the range of R for which the Zener diode remains in constant reverse breakdown with no danger of failure. [6]

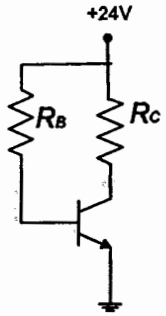
2C. Find the current flowing through the diode in the adjoining figure, given that V_γ=0.5 V, R_f (forward resistance)=5 Ω, R_r(reverse resistance)=500 Ω, V_z=2 V, R_z(zener resistance)=100/3 Ω. [4]



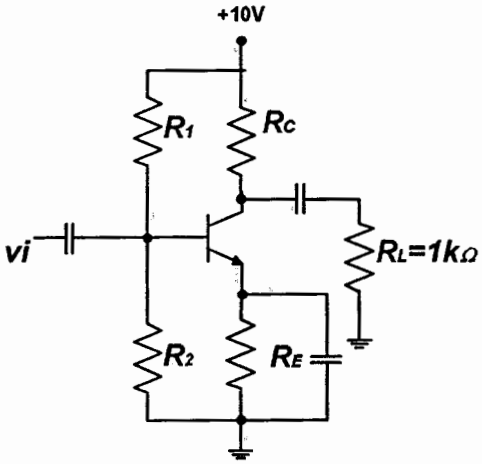
3A. The transistor in figure below has β=120. Plot the voltage transfer characteristics (Vo vs V_I) over the range $0 \le V_I \le 5$ V for (a) R_E=0 and (b) R_E=1 kΩ. **[3.5+3.5]**



3B. For the circuit shown below, the Q point is I_{CQ}=2 mA and V_{CEQ}=12 V when β=60. Determine the values of R_C and R_B. **[2]**



3C. Design a bias stable circuit in the form of figure below with β=120 such that I_{CQ}=0.8 mA and V_{CEQ}=5 V, and the voltage across R_E is 0.7V, assume all capacitors are very large. **[6]**



4A. Two ac signals A and B have the following current amplitude ratios in the dB scale (i) 3 dB, (ii) 20 dB. Find these ratios in the absolute scale.**[2]**

4B. Two ac signals A and B have the following power ratios in the dB scale (i) 6 dB, (ii) -10 dB. Find these ratios in the absolute scale.**[2]**

4C. Draw a positive going negative pulse waveform and a positive impulse waveform. **[2]**

4D. A 5V battery is connected at t=0 sec to an oscilloscope. Consider oscilloscope to be an RC circuit with R=1MΩ and C=1pF. Find the time the oscilloscope will take to show the voltage to rise to 4.5V. Also calculate the rise time of the oscilloscope. **[4]**

4E. It is given that the rise time t_r of a RC circuit is related to the 3 dB cutoff frequency of the RC filter by the formula $f_{3dB}=0.35/t_r$. From this knowledge calculate the approximate peak value of the waveform shown in oscilloscope when a 6.77 KHz, 5V sinusoidal signal is applied to the oscilloscope. Recalculate the same if the applied signal frequency is changed to 3.385 MHz. **[5]**