JADAVPUR UNIVERSITY

B. E. INFORMATION TECHNOLOGY

1st Year, 1st Semester Supplementary Examinations - 2018

BASIC ELECTRONICS Time : 3 hours Full Marks : 100

General instructions (read carefully)

1. Special credit will be given to answers which are brief and to the point.
2. For any value related to any device parameter, which is not given in a question, assume suitable standard value for such parameter.
3. **Answer to every question should start on a new page.**
4. **Do not write answers to various parts of a question at different locations of your answer-script.**
5. The final answer (numerical values with unit) should be underlined or enclosed within a box.
6. Do not write on the front back cover of your answer booklet.

Question No. 1 is compulsory. Answer any 4 (four) from the rest.

Each question carries 20 marks. Question for each sub-part is mentioned at the right margin of a part question or set of part questions.

1. Answer any 10 (ten) of the following questions. Be specific and very brief in answering each question. (10 X 2)

i) Name two intrinsic semiconductor material - one single crystal, another compound.

ii) Why is there no net flow of current due to charge carriers in an open-circuit pn junction, despite the presence of an electric field due to the barrier (or built-in) potential ?

iii) What techniques are used to form a pn junction in a semiconductor diode to bring p and n type material together ?

iv) Why cannot a normal pn junction diode be used as a Zener diode in voltage regulation applications ?

v) What is transition or junction capacitance ? In which bias is it dominant ?

vi) Assuming ideal diode, derive the dc voltage in a half wave rectifier in terms of the peak voltage.

vii) Name two applications of a transistor. In which mode does it operate in each of these applications ?

viii) Compare the output resistance of a BJT in common base and common emitter configuration.

ix) How is the current gain of a BJT in common base and common emitter configuration related to each other ?

x) In a BJT in common base configuration does the input current increase or decrease for a particular value of input voltage, with increase in output voltage ?

xi) If the Q point is shifted from the centre of the Load Line to too close to the saturation region, which swing (positive or negative) of the output signal will be clipped ? Why is it so ?

xii) Proper biasing of the BJT ensures that the Q point once selected, does not shift due to change in values of which two parameters ?

xiii) Why is the potential divider bias circuit the most prevalent / popular biasing circuit among all biasing circuits ?

xiv) Which feedback is used in oscillators ? What is the other name for such a feedback ?

xv) At what frequencies are LC and crystal oscillators used ? What type of waveform(s) is generated at such frequencies ?

xvi) What are the advantage(s) of using an OP-AMP instead of a BJT in building a Hartley oscillator ?

2. i) Derive the formula for finding the hole concentration in an n-type semi-conductor material. (4)

ii) Consider a gallium arsenide sample at T = 300 K with doping concentrations of $N_a = 0$ and $N_d = 10^{16}$ / cm^3. Assume complete ionization. Take values of electron and hole mobilities to be 8500 cm^2 / V-s and 400 cm^2 / V-s respectively. Intrinsic carrier concentration of the semi-conductor at 300 K is 1.8 X 10^6 / cm^3.

Calculate the minority carrier hole concentration and the drift current density, if the applied electric field is E = 10 V / cm. (6)

iii) a) A semi-conductor diode has a forward voltage of 0.25 V at current 10 mA at room temperature (300 K). Find the reverse saturation current.

b) Assuming diode ideality factor $\eta = 1$, calculate the bias voltage needed for diode current of 1 mA and 100 mA, at the same temperature.

What can you deduce about the change in forward current with corresponding change in forward voltage in the given semi-conductor diode from the given data ? [Hint : V_D is 0.25 V at current I_D = 10 mA (given); compare with values of V_D as obtained above for I_D of 1 mA and 100 mA].

c) Estimate the value of the reverse saturation current and forward current at 0.25 V at 30^0 C above room temperature.

What can you deduce about the values of the reverse saturation currents obtained for different temperature values [as obtained in a) and c)] ? (2 + 4 + 4)

3. i) Draw and explain the input characteristic of a BJT in common emitter configuration for different values of collector emitter voltage, V_{CE}. (5)

ii) Draw and explain the output characteristic of a BJT in common emitter configuration for different values of input current. Mention realistic values of input current and output current and voltage values along the axis. Show the different regions of operation and the input - output current relation in each region. (5 + 5)

iii) What are the functions of the coupling capacitors and the emitter bypass capacitor in a BJT used for amplification ? Are these capacitor values chosen to be high or low ? Why ? (3 + 2)

4. i) For a voltage (or potential) divider bias scheme of a BJT in common emitter configuration, derive the values of the output current I_C and voltage V_{CE}. What is the condition for bias stabilization for such a circuit ? What will be the value of I_C under such condition ? (6 + 2 + 2)

ii) For a pnp BJT in common emitter configuration and with voltage divider bias, draw the circuit (showing v_s, v_i, and v_o) and the ac equivalent circuit using <u>either</u> the r_e model <u>or</u> the h-parameter transistor model. Calculate the output impedance, Z_o and the current gain, A_i of such a circuit. (6 + 4)

5. i) What are the different feedback amplifier topologies ? (Mention as "_ amplifier with _ feedback").

Describe in detail any one of the above using block diagram. (4 + 4)

ii) Enumerate four differences in the characteristics between a BJT and a JFET. Which of these characteristics is considered an advantage and which a disadvantage in that particular application? (4)

iii) Draw the drain and transfer characteristics of an n-channel enhancement type MOSFET identifying clearly the ohmic (triode), saturation and cut-off regions. Give representative values of the parameters used to draw the characteristic. (8)

6. i) Enumerate the differences (any six) of the characteristics of an ideal OP-AMP and a practical OP-AMP. (3)

ii) Draw the Subtractor circuit using OP-AMP. Derive the closed loop voltage gain of such a circuit. (5)

iii) Enumerate any three advantages and any one disadvantage of using negative feedback amplifiers. (4)

iv) Draw the circuit of a Phase shift oscillator using OP-AMP and explain its operation. Explain how Barkhausen criteria is complied with ?

What is the frequency, f_o at which such an oscillator will oscillate ? At this frequency what will be the gain of the OP-AMP ? (6 + 2)

7. i) Draw the circuit symbol of an SCR. What is the other name of SCR ? (1 + 1)

ii) In what applications do you find use of SCRs (any four)? (2)

iii) By using two-transistor equivalent circuit, briefly describe the basic operation of an SCR. Draw typical forward and reverse characteristics of an SCR, marking all relevant device parameters and regions of operation. (6 + 4)

iv) How can we control the conduction angle of an SCR, by applying a Gate voltage ? Explain using a circuit with resistive load with a sinusoidal AC input. Draw appropriate voltage and current waveforms. (6)

8. Write short notes on *(any five)* (5 X 4)

i) Mass action Law and Law of electrical neutrality in a semi-conductor.
ii) Load Line and Quiscent (Q) point of a semi-conductor diode.
iii) Zener diode breakdown mechanisms.
iv) "Punch through" in a BJT in common base circuit configuration.
v) Frequency response (voltage gain vs frequency) of a BJT amplifier.
vi) Saturation in a non-ideal OP-AMP.
vii) Methods of turning an SCR OFF.

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