53 (EC 201) BSEL

2018

BASIC ELECTRONICS

Paper : EC 201

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions out of **seven**.*

1. *(a)* Using energy band diagram, briefly explain why conductivity differs for metals, semiconductors and insulators. 4

(b) What do you understand by 'holes' in semiconductors ? Explain how they give rise to drift current. 4

(c) Discuss the cause of diffusion current and explain how to determine its direction for electrons and holes. 4

(d) Describe the mechanism of Avalanche breakdown in $p-n$ junction diode. 4

(e) Draw the electron energy band diagram of a $p-n$ junction diode in open circuit condition and explain what happens to it when we apply forward and reverse bias to the diode. 4

2. (a) Draw the concentration profile of electrons and holes in open circuit condition and evaluate the expression for built-in voltage. 5

(b) Write the equation for the rate of change of hole concentration in the n-side of a $p-n$ junction diode under forward bias condition and derive the concentration profile of holes in equilibrium condition. 5

(c) From the concentration profile of minority carriers in a forward biased diode, derive the expression for diffusion current components. With the help of a neat diagram, explain how various current components change as a function of position along the length of the $p-n$ junction diode. 5

(d) Explain the law of junction and derive the diode current equation from the expression for diffusion currents due to minority carriers. Plot the V–I characteristics of diode under forward and reverse bias condition. 5

3. (a) Define the parameters : (i) rectification efficiency and (ii) ripple factor. Determine the expression for these in the case of a half-wave rectifier. 5

(b) Show that ripple factor of a half-wave rectifier can be considerably improved by introducing a capacitor of appropriate value across the load resistance. 5

(c) Draw the circuit of a Zener diode based voltage regulator. Explain how it can regulate an unregulated power supply. 5

(d) For the diode circuits shown below, determine the output wave forms. Assume that the diodes have ideal characteristics. 5

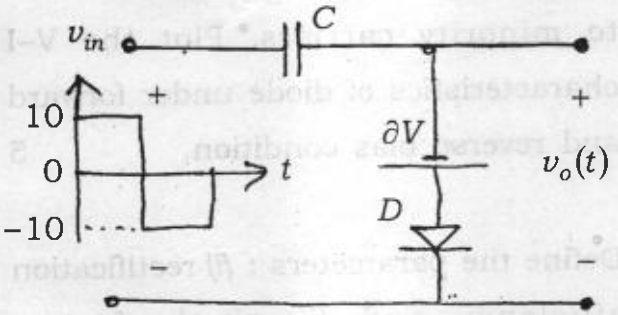

Fig. (1)

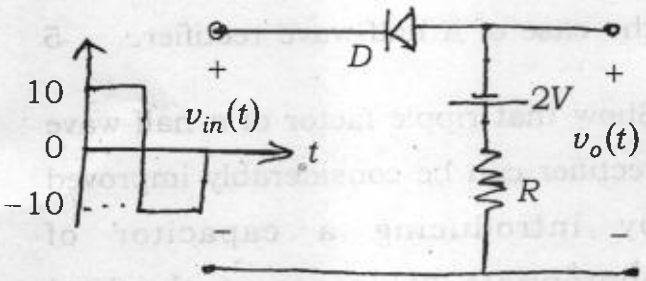

Fig. (2)

4. (a) Draw the input and output characteristics of an *n–p–n* bipolar junction transistor (BJT) and explain the effect of changing the collector-base voltage when it is operating in the active mode. 5

(b) Why do we need biasing circuit to make the BJT function as an amplifier ? Draw the voltage-divider (self-bias) biasing circuit and explain the steps in determining the resistance values. 5

(c) Explain the working of an *n*–channel MOSFET with the help of a neat schematic diagram. Derive the expression for drain current in both Ohmic and Saturation mode of operation. Draw the transfer characteristics and explain how to determine transconductance from it. 4+4+2

5. (a) Explain how a transistor can be used to amplify weak signals. Why the input and output resistance of a voltage amplifier is critical in determining its performance ? 5

(b) Draw the circuit of a non-inverting Operational Amplifier Circuit and derive its expression for voltage gain. Discuss how the circuit could be modified to subtract one signal (say $v_2(t)$) from the other (say $v_1(t)$). 5

(c) Draw the circuit of a Wein Bridge Oscillator and evaluate — 10

(i) the condition for oscillation

(ii) the frequency of oscillation.

6. (a) Change the base of the following numbers : 4

$(19{\cdot}23)_{16} = (\quad)_{10}$

$(11{\cdot}01)_{10} = (\quad)_{2}$

(b) State and prove De Morgan's theorems. 4

(c) Simplify the following expressions : 4

(i) $(A+B)(\overline{A}+B)\,\overline{B}$

(ii) $A[A+AB]$

(d) Implement a full adder circuit using only NOR gates. 4

(e) What is the drawback of S–R flip-flop and explain how it can be overcome in J–K flip-flop ? 4

7. *(a)* With the help of a neat circuit diagram explain how currents in various ranges can be measured using a PMMC meter. 5

(b) Draw the block diagram and explain the principle of operation of CRO. 5

(c) Draw the functional block diagram of Function generator that can produce sine wave, square wave and triangular wave in the audio frequency range. 5

(d) With the help of a neat schematic diagram, explain how liquid-crystal display work. 5