ELECTRICITY AND ELECTRONICS

(Maximum Marks: 100)

(Time allowed: Three hours)

*(Candidates are allowed additional 15 minutes for **only** reading the paper.*
They must NOT start writing during this time.)

Answer **all** *questions from* ***Part I*** *(Compulsory) and* **five** *questions from* ***Part II****.*

All working, including rough work, should be done on the same sheet as,

and adjacent to the rest of the answer.

Mathematical tables and squared paper are provided.

The intended marks for questions or parts of questions are given in brackets [ ].

PART I (40 Marks)

Answer **all** *questions.*

Question 1

With reference to vacuum tube diode: **[4]**

(a) Draw a graph of plate current (I_P) verses plate voltage (V_P) for *any two* given cathode temperatures.

(b) Define the following terms:

(i) Space charge region

(ii) Plate resistance

Question 2

Explain how an n-type semiconductor can be formed. Also, state the majority and minority charge carriers in n-type semiconductors. **[4]**

Question 3

With the help of a neat circuit diagram, explain the working of a semiconductor diode as a half-wave rectifier. **[4]**

Question 4

Draw a neat diagram showing the construction of a crystal microphone and briefly explain its working. **[4]**

Question 5

Fill in the blanks choosing the appropriate word(s) from those given in brackets. **[4]**
Write the correct answer in your answer booklet.

(a) In the forward region of its characteristics, a diode appears as an _____ switch. (On, Off)

(b) Semiconductor materials have _____ bonds. (ionic, covalent)

(c) The collector characteristics of a Common Emitter (CE) mode transistor may be used to find its _____ . (output resistance, voltage gain)

(d) The voltage gain efficiency of a half-wave rectifier is approximately _____. (40%, 80%)

Question 6

(a) Name *one* element for each of the following: **[2]**

(i) Active circuit element

(ii) Passive circuit element

(b) State *any two* applications of a capacitor. **[2]**

Question 7

A D.C. shunt motor connected to a 230V D.C. supply takes a line current of 12A at some load. If the field resistance and armature resistance are 230Ω and 1Ω respectively, calculate the back emf (E_b). **[4]**

Question 8

Briefly explain how a Cathode Ray Oscilloscope can be used to measure an unknown frequency. **[4]**

Question 9

Write short notes on the following: **[4]**

(a) Ceiling rose

(b) Flexes

Question 10

With reference to Common Base (CB) connection, the current amplification factor is 0·9. If the emitter current (ΔI_E) is 1 mA, determine the value of base current (ΔI_B). **[4]**

PART II (60 Marks)

Answer any **five** *questions.*

Question 11

(a) Give *any one* reason to explain why there is a drop in the terminal voltage of a shunt generator when it is loaded. **[2]**

(b) Giving *any two* reasons, explain why a shunt generator fails to build up its voltage. **[2]**

(c) With the help of a schematic diagram, explain the working of a 3phase 4wire system used in the distribution of A.C. power. **[4]**

(d) State *any two* advantages of overhead cables over underground cables. **[2]**

(e) Name *any two* types of mechanical protection used for manufacturing cables. **[2]**

Question 12

(a) Explain how an electron beam is produced, focussed, deflected and detected in a CRT (Cathode Ray Tube). **[6]**

(b) Draw a neat labelled circuit diagram of a power amplifier circuit. **[4]**

(c) State *any two* precautions that must be taken while wiring is done for bathrooms. **[2]**

Question 13

(a) Draw the circuit diagram of a Choke-Input filter. Explain its filtering action. **[4]**

(b) If the size of a wire is expressed as $\frac{3}{29}$, what do the numbers 3 and 29 indicate? **[2]**

(c) Fill in the blanks choosing the appropriate word(s) from those given in brackets. *Write the correct answer in your answer booklet*. **[4]**

(i) Series motor develops a high torque at a _____ speed. (low, high)

(ii) Speed (N) of a motor is _____ proportional to the back emf (E_b). (inversely, directly)

(iii) The slope emf (E) verses field current (I_f) graph will give the value of _____ resistance. (field, armature)

(iv) In a shunt generator, the field coil is connected _____ to the armature coil. (parallel, in series)

(d) With reference to semiconductors, what is meant by the term *doping?* Also, name *any one* dopant. **[2]**

Question 14

(a) Fill in the blanks choosing the appropriate word from those given in brackets. **[4]**
Write the correct answer in your answer booklet.

(i) A device which blocks A.C. and bypasses D.C. is known as _____. (capacitor, inductor)

(ii) Reverse current of a p-n junction consists of _____ charges. (minority, majority)

(iii) Barrier potential _____ with increase in junction temperature. (decreases, increases)

(iv) The maximum voltage that can be applied to a diode without destroying it is called its peak _____ voltage. (forward, inverse)

(b) With reference to shunt motor, explain briefly the functions of *overload release coil* and *no-volt release coil*. **[6]**

(c) State *any two* differences between *wires* and *cables*. **[2]**

Question 15

(a) With the help of a neat diagram, explain the working of a moving coil loud speaker. **[4]**

(b) With reference to the triode valve, obtain the relationship between amplification factor (μ), mutual conductance (g_m) and a.c. plate resistance (r_p). **[4]**

(c) A 24V, 600 mW zener diode is to be used for providing a 24V stabilized supply to a variable load, as shown in ***Figure 1*** below. The input (I/P) voltage is 32V. **[4]**

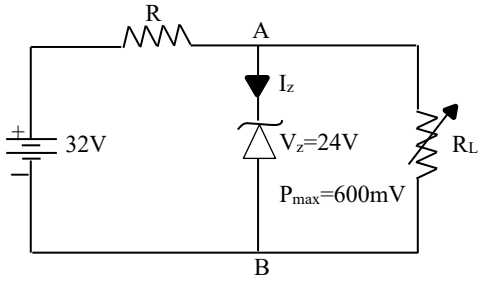

Figure 1

Calculate the following:

(i) Series resistance R required.

(ii) Diode current when R_2 is 1200Ω.

Question 16

(a) With reference to PNP or NPN types of transistor, explain why the three sections are of: **[6]**

(i) Different sizes

(ii) Different doping levels

(b) With reference to practical generator, explain briefly the use of its following parts: **[6]**

(i) Field system

(ii) Armature windings

(iii) Brushes

Question 17

(a) With the help of a neat diagram, explain how a capacitor can help to self-start a single phase A.C. motor. **[6]**

(b) Prove that I_{rms} (root mean squared) value of current is equal to $\frac{I_o}{\sqrt{2}}$, where I_o is the peak value of current for a full wave rectifier. **[4]**

(c) With reference to power supplies, state *any two* functions of bleeder resistance. **[2]**

Question 18

(a) Name *any two* materials used for making a fuse wire and state *two* important properties of this fuse wire. **[4]**

(b) With reference to transistors, obtain the relationship between *current amplification factor in Common-Base (CB) mode* (α) and *current amplification factor in Common-Emitter(CE) mode* (β). **[4]**

(c) State *any two* differences between *transistor* and *triode* tube. **[2]**

(d) Name *any two* methods used to minimise eddy current losses in a transformer. **[2]**