Ref. No: Ex/FP/H10/GR-A/36/2019

BACHELOR OF SCIENCE FINAL EXAMINATION, 2019

(3^{rd} Year, 1^{st} Semester)

Physics (Honours)

Paper HO-10

Time : Two hours

Full Marks: 50

Use a separate Answer-Script for each group. 25 marks for each group.

Group A

Answer any two questions

1(a) What is Fermi-Dirac distribution function? Plot it for different temperatures and hence define the Fermi energy of a metal.

(b) What are the probabilities of occupancy at room temperature (300 K) of an electron state lying 0.1 eV above the Fermi level and 0.1 eV below the Fermi level. Find these values if the temperature is 1000 K. Sketch the Fermi function in the neighborhood of the Fermi level at the above two temperature.

(c) Define Density of state function.

Prove that the density of state function of a three dimensional solid can be expressed as

$$D(E) = \frac{1}{4\pi^2}\left(\frac{2m}{\hbar^2}\right)^{\frac{3}{2}} E^{\frac{1}{2}}$$

where the symbols have their usual meaning. Plot graphically the variation of the above function and state its significance.

$(2+4+6\frac{1}{2})$

2. (a) What is the meaning of rotational symmetry of a crystal? Prove that in a crystal the only allowed symmetries are 1,2,3,4 and 6 fold symmetries. What is the physical reason of absence of 5 fold symmetry in a crystal?

(b) Define a single crystalline and a polycrystalline material.

What is critical nucleus during crystal growth? Derive an expression to find its diameter? Why seeding is important in a crystal growth?

(c) Discuss the importance of the following parameters during Czochralski technique of crystal growth

(i) Choice of crucibles
(ii) Rotation of the seed crystal
(iii) Heating and cooling rate

(d) Describe with a neat diagram float –zone method of growing single crystal.

$(3 + 3 + 3 + 3\frac{1}{2})$

3. (a) With respect to the function of an oil-sealed rotary pump explain the following

(i) Why does the rotor should move eccentrically?
(ii) Why does the pump cannot produce a vacuum less than 10^{-3} Torr?
(iii) What are the required characteristics of the oil for better performance of the pump?

(b) With respect to the function of a diffusion pump explain the following

(i) What are the functions of the oil jet produced in the pump?
(ii) Why does the diffusion pump alone cannot produce the vacuum?
(iii) What should be the characteristics of the diffusion pump fluid?

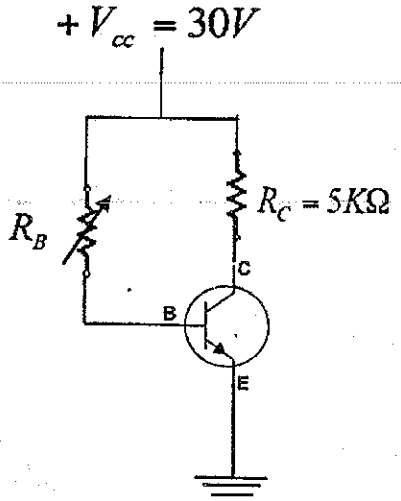
(c) In a neat diagram show with labeling; Roughing valve, backing valve and baffle valve and mention their functions.

(d) Discuss the basic principles of working of a Pirani Guage and Penning Guage with diagrams for vacuum measurement. In what range of vacuum the Gauges will work?

$(3 + 3 + 2 + 4\frac{1}{2})$

GROUP B

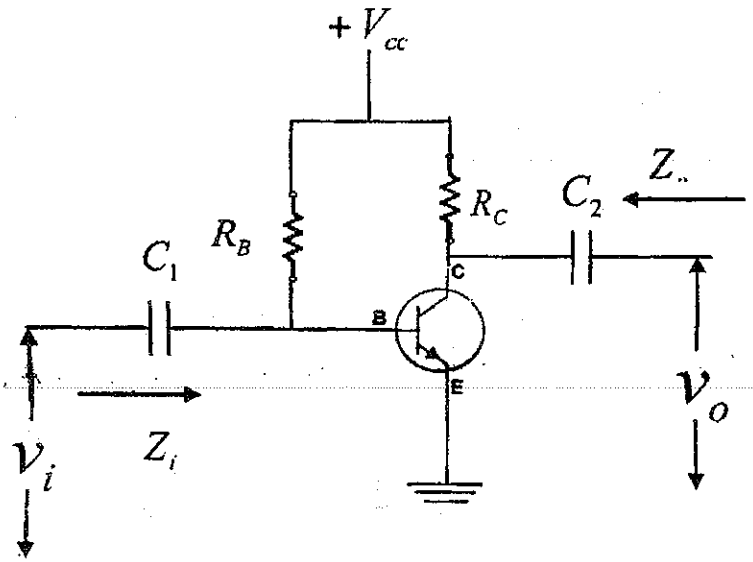
Answer *any* ***three*** questions. One mark is for general proficiency

No. of Qs.	Questions	Marks
1. (a)	What is fundamental difference between an avalanche breakdown and a Zener breakdown occurring in a p-n junction ?	**2**
(b)	**Explain how the dc output voltage across a full wave rectifier changes in presence of a capacitor filter.**	**2**
(c)	Draw a neat circuit diagram of a full wave rectifier and also calculate its efficiency of rectification.	**4**
2.(a)	Assuming a Si transistor, what will be the saturation collector current, $I_{C(sat)}$ and cut-off collector-emitter voltage, $V_{CE(cut-off)}$ in the following circuit 	**3**

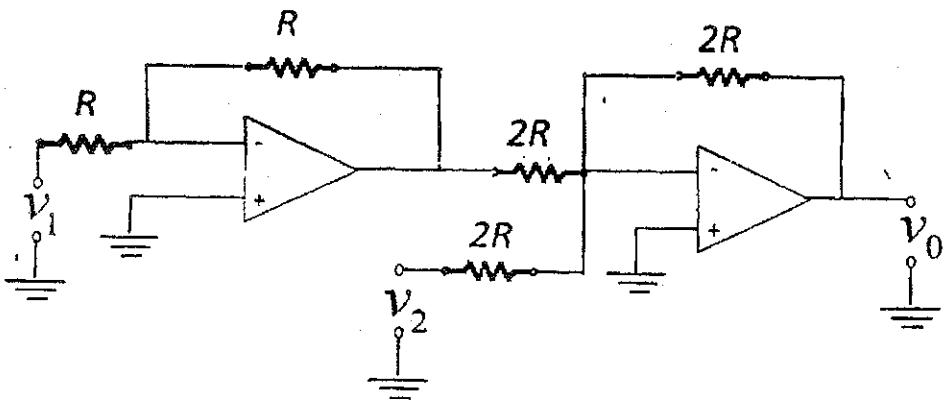
(b) For active region of operation in CE mode, plot how the Q-point shifts for fixed input currents and collector resistance, R_C but varying supply voltage V_{cc}. 3

(c) Explain how the voltage divider bias to a CE amplifier can provide stability to the Q-point? 2

3. (a) Draw the small signal ac equivalent circuit of the following CE mode of an npn transistor and obtain an expression for the voltage gain. 4



(b) Determine the output voltage V_0 for the following OP-Amp circuit. 4



4. (a) Implement the Boolean function $F = AB + A'C$ using **only** NAND gates. 3

(b) Write the truth table for the Boolean function $F = A'BC + AB'C + ABC'$. 3

(c) Explain with examples why NAND gate is called a universal gate. 2