EX/FP/I/X/37/2017

BACHELOR OF SCIENCE FINAL EXAMINATION, 2017

(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

GROUP A

Answer any two questions

1. Discuss the classical theory of nucleation for crystal growth from solution. Hence find an expression for the critical nucleus. What is the role of seed crystal in crystal growth?

   (b) With neat diagram explain the process of crystal growth by Bridgman technique and Float Zone technique. Mention their advantages and disadvantages.

   $(7\frac{1}{2}+5)$

2. (a) Discuss the relative components of lattice and electronic specific heats of a metal at room temperature and at very low temperature.
   Prove that the electronic component of specific heat can be expressed as

   $C_{el} = \frac{1}{3}\pi^2 N K_B \frac{T}{T_F}$; where the symbols have their usual meanings.

   b) Metallic sodium crystallizes in body-centred cubic form, the length of the cube being 4.25×10^{-8} cm. Find the concentration of conduction electrons. Adopting the free electron Fermi gas model derive an expression for the Fermi energy and show that it depends on the concentration of electrons only.

   $(7+5\frac{1}{2})$

3. (a) Explain the working principle of an oil-sealed rotary vacuum pump with a neat diagram. What limits the final vacuum for such a pump?

   (b) What type of gauge you use to measure the vacuum produced by oil-sealed rotary pump? Describe its working principle. How does it differ with absolute gauge?

(c) If a 100 litre vessel at room temperature (25 C) is evacuated to a pressure of 50 mTorr how many moles of gas are there in the vessel? Calculate the number of molecules in the vessel also.

$(6+3+3\frac{1}{2})$

4. (a) Define density of state function for a solid. Show that for a three dimensional solid it varies with energy according to following relation

$$D(E) \ \alpha \ E^{\frac{1}{2}}$$

Show graphically the above variation and explain its physical significance.

(b) Assuming the above dependence of density of state function calculate the average kinetic energy of an electron in a metal at absolute zero.

$(8+4\frac{1}{2})$

Ref. No.: [redacted]

FINAL B. Sc. EXAMINATION, 2017

(1st Semester)

PHYSICS (HONOURS)

PAPER: H-10

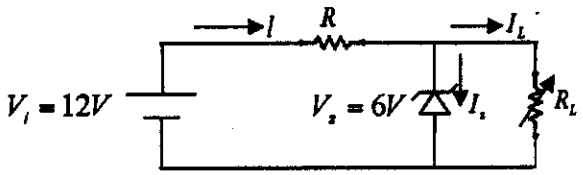
Time: Two hours | Full Marks: 50

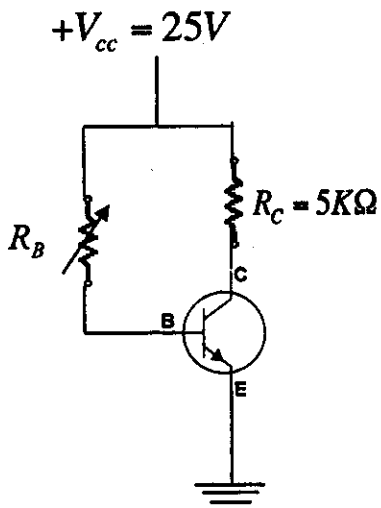
25 marks for each group

Use separate Answer-script for each Group

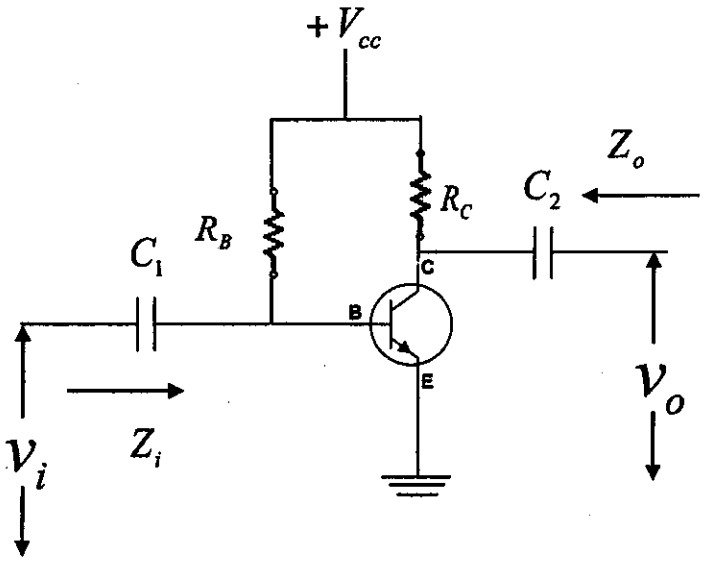
GROUP B

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

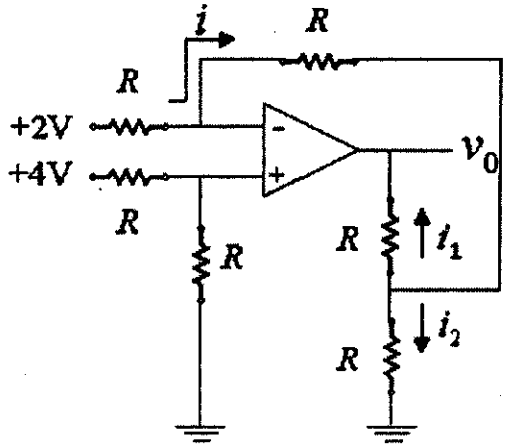
No. of Qs.	Questions	Marks
1. (a)	In the following circuit, the maximum value of load current, $(I_L)_{max.}$=100 mA and the value of minimum Zener current, $(I_z)_{min.}$=10 mA. Calculate the value of R such that the output voltage across R_L, V_0 remains constant at 6V. Also calculate the value of maximum Zener current, $(I_z)_{max}$. 	**3+1**
(b)	Explain what type of breakdown is expected the reverse bias across a heavily doped p-n is increased?	**1**
(c)	Explain how the dc output voltage across a full wave rectifier changes in presence of a capacitor filter? What should be the selection criteria for such a capacitor filter?	**3**
2.(a)	In the following circuit, calculate the saturation collector current, $I_{C(sat)}$ and cut-off collector-emitter voltage, $V_{CE(cut-off)}$? Assume a Si transistor.	**2+2**



(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}.	2
(c)	What state of operation a transistor will be in both E-B and C-B junctions are forward biasd ? Justify your answer.	1+1
3. (a)	Explain why the input and output signals in a CE amplifier are always out of phase by 180°?	2
(b)	Draw the small signal ac equivalent circuit for the following CE mode of a npn transistor and obtain an expression for the voltage gain.	3+3



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



(b) Implement the Boolean function $F = AB + CD$ using **only** NAND gates. 2

(c) Write the truth table for the Boolean function $F = A'BC + AB'C + ABC' + AB'C$ 2