2025

M.Sc. 3rd Semester Examination

PHYSICS

Paper : PHS - 306A/B

Full Marks : 50 Time : Two Hours

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

PHS - 306A

(Advanced Condensed Matter Physics-I)

1. Answer any ***four*** questions : 2×4=8

(a) Find the Madelung constant for one dimensional infinite line of ions of alternating sign.

(b) Show that self diffusion radioactive Sodium ion in NaCl is following Gaussian distribution.

(c) Explain what is the origin of Polaron in a solid.

(d) Explain what is Mott's metal to Insulator transition.

(e) Mention different views for the origin of spontaneous polarisation in a Ferroelectric solid.

(f) Explain the mechanism of the formation of F-Center in Solid.

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2. Answer any ***four*** questions : 4×4=16

(a) Find the total elastic energy per unit length of Screw Dislocation in a crystal.

(b) Find the origin of Plasmon in a solid and hence find the frequency associated with it.

(c) What is the origin of Frenkel exciton in a solid and hence derive the dispersion relation for Frenkel exciton.

(d) The density of Schottky defects in a certain Sodium Chloride is 5×10^{11} m^{-3} at 300K. If the interionic seperation is 2.82Å, what is the average energy required to create one Schottky defect?

(e) Show that in transition from ferroelectric state to non ferroelectric state for Rochelle salt the polarisation does not show any discontinuity with temperature variation.

(f) Explain the characteristics of Raman effect in a solid.

3. Answer any ***two*** questions : 8×2=16

(a) Derive LST relation for Ionic crystal.

(b) Find the expression of electrical conductivity assuming ionic crystal and hence derive the Einstein relation.

(c) What is de Haas-van Alphen effect and show the variation of magnetic moment with magnetic field. What is Ultra quantum region in this respect.

(d) Assuming Boltzmann transport equation, derive the expression for electrical conductivity of metal in terms of relaxation time.

Internal Assessment : 10 marks

PHS - 306 B

(Applied Electronics -I)

Full Marks : 50 Time : Two Hours

[Analog Electronics]

1. Answer any ***two*** questions : 2×2=4

   (a) Sketch the circuit diagram of a peak detector and describe how it works.

   (b) Draw the circuit diagram of a Voltage Controlled Oscillator (VCO) using Op-Amps and MOSFETs.

   (c) How 4 quadrant analog multiplier can be designed using BJTs? Explain with proper circuit diagram.

   (d) Explain how an Ex-OR gate can be used as a digital phase detector.

2. Answer any ***two*** questions : 4×2=8

   (a) Draw the circuit diagram of an audio bridge power amplifier using audio power amplifier IC LM380 and explain how it can deliver 4 times the output power compared to a single power amplifier IC with the drawing of the necessary output waveforms.

   (b) Explain the design and operation of a Switched Mode Power Supply (SMPS). How is regulates the output voltage?

P.T.O.

(c) Draw the circuit diagram of an anti-logarithmic amplifier using OP-Amps and matched pair of transistors and derive the expression for its output voltage as a function of its input voltage and input reference voltage.

(d) Draw the circuit diagram of a Schmitt trigger using Op-Amp. Explain its operation and derive the expression for its hysteresis voltage.

3. Answer any ***one*** question : 8×1=8

(a) Draw the circuit diagram of a triangular wave generator using modified version of Schmitt trigger. Derive the expression for the frequency of oscillation and peak-to-peak voltage of the output signal. Also draw the corresponding waveforms at different output points. 1+5+2

(b) What do you mean by Butterworth response of active filters? Design a second order low pass Butterworth active filter at cut-off frequency f_H=10 kHz. Derive the expression used in this design and show that this circuit will act as second order low pass Butterworth active filter at a particular condition. State the condition also. 1+1+5+1

[Digital Electronics]

1. Answer any *two* questions : 2×2=4

   (a) What is the reason that ECL gates are very good in 'speed' but very poor in noise immunity?

   (b) Solve the following digital equation by using 4 : 1 Mux IC : $Y = \sum 2,3,4,7$

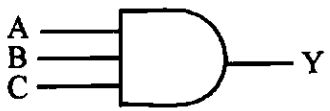
   (c) What is the fundamental circuit difference between a typical SRAM memory cell and a typical DRAM memory cell?

   (d) How does a call from a mobile to land phone is established?

2. Answer any *two* questions : 4×2=8

   (a) Differentiate Packet Switch Network and Message Switch Network in computer communication.

   (b) Design the following circuit with CMOS technology :



   (c) With circuit diagram describe the data transfer procedure of a ratio-less dynamic two phase shift register.

   (d) Define the following terms :

   (i) CDMA (ii) Router (iii) MTSO (iv) WAN

P.T.O.

3. Answer any ***one*** question : 8×1=8

(a) (i) Give the circuit of an open collector 2-input TTL NAND gate.

(ii) What is the advantage of it?

(iii) What is the typical 'figure of merit' of TTL gate?

(iv) What is the concept of I^2L gate? 2+2+2+2

(b) (i) Describe the process of data transfer in three phase CCD memory.

(ii) Store the result of the following equations by FPLA ROM circuit;

$$Y_1 = \sum 3,4,6 \ \& \quad Y_2 = \sum 1,3,7$$

(iii) In a 32 GB RAM if the word length is two bytes then what is the length of the address bus? 3+3+2

Internal Assessment : 10 marks