P.G. Semester-II Examination, 2023

PHYSICS

Course ID : 22453 **Course Code : PHS-203C**

Course Title : Solid State Physics - II and Electronics - II

Time : 2 Hours Full Marks : 40

The figures in the right-hand margin indicate marks.

Candidates are required to give their answers in their own words as far as practicable.

UNIT-I

1. Answer any **three** of the following questions : 2×3=6

   a) Write down the differences between Type-I and Type-II superconductors.

   b) What is the role of electron-phonon interaction in superconductivity?

   c) State and mathematically represent Matthiessen's rule.

   d) What is Meissner effect?

   e) Define piezoelectricity.

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

   a) Obtain the Clausius-Mosotti equation and explain how it relates the dielectric constant to the atomic polarizability.

   b) Show that the 'Effective mass' of an electron in a crystal is inversely proportional to the second order derivative of E-K curve. Discuss the conditions when effective mass becomes positive, negative and infinity.

   c) Define Fermi energy. Explain Fermi distribution function for $T_F = 0K$ and $T_F > 0K$.

   d) Optical index of refraction and dielectric constant for a crystal are 1.5 and 5.6, respectively. Determine the percentage of ionic polarizability.

3. Answer any **one** of the following questions : 6×1=6

   a) i) Derive the density of states in a 3-D free electron gas.

      ii) Prove that average kinetic energy of free electrons at 0K is $3/5^{th}$ of their Fermi energy at 0K.

iii) Fermi energy of Na at absolute zero is 3.2 eV. Find Fermi temperature. 3+2+1

b) Discuss the Kronig-Penney model for the motion of an electron in a periodic potential.

UNIT-II

4. Answer any **three** of the following questions : 2×3=6

a) Simplify the following Boolean expression using Karnaugh map :

$F(A,B,C,D)=\sum m\ (0, 1, 2, 4, 5, 7, 13, 14)$.

b) What are FM signals? Discuss the advantages of FM signals over AM signals.

c) Draw a circuit of MS-JK flip-flop.

d) What do you mean by VSWR and reflection co-efficient of a transmission line? Establish the relation between these two parameters.

e) Give the reasons of using VSB-SC type modulation technique in TV broadcasting.

5. Answer any **two** of the following questions: 4×2=8

a) Design and explain a constant-k lowpass filter using inductors and capacitors. Find the relation between the cut-off frequency (fc) and the values of inductors (L's) and capacitors(C's) used. 2+2

b) Using a frequency modulator, how can you get phase modulated waves? How can you detect DSB-SC type AM signal? 2+2

c) What do you understand by the term ‘distributed parameter’ of an electrical circuit? Derive the "Telegrapher‘s equations" of a high frequency transmission line using distributed line parameters. 2+2

d) "MUX: a universal building block" - Explain.

6. Answer any **one** of the following questions : 6×1=6

a) What are the merits and demerits of asynchronous counter? Design an asynchronous counter that can count 15 states. If the propagation delay of each state is 10 nsec, then what will be the maximum frequency of the clock pulse one can use? 2+3+1

b) The line capacitance of a lossless transmission line is 15 pF/m and the line's insulating material uses a dielectric with relative permittivity of 5. If the line is terminated in a load with impedance $Z_L = 59.12 - j131.38\Omega$, determine:

i) The line inductance per unit length,

ii) The phase velocity,

iii) The line characteristic impedance,

iv) The voltage reflection coefficient at the load.

v) The voltage standing standing wave ratio on the line. 1+1+1+1+2

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