Seat No. : _____

FD-138

February-2025

M.Sc., Sem.-I

PHY-404 : Physics

(Solid State Physics and Analog Electronics)

(New Course)

Time : 2:30 Hours] **[Max. Marks : 70**

1. (A) Explain in detail, how the energy bands are formed in the solid ? **7**

1. (B) Obtain approximate solution for energy near zone boundary. **7**

OR

1. (A) Describe the Harrison's construction of free electron Fermi surfaces for square lattices. **7**

1. (B) Write a short note on : de-Hass van-Alphen effect. **7**

2. (A) Give experimental account of Entropy, Heat capacity, Free energy and Energy gap of a superconductor. **7**

2. (B) Show that under ac Joshepson effect, super current oscillates with angular frequency $\frac{2eV}{\hbar}$. **7**

OR

2. (A) Write a short note on : Meissner effect. **7**

2. (B) Show that the Magnetic flux through the super conducting ring is quantized. **7**

3. (A) What are the different classes of power amplifier ? Discuss their properties. **7**

3. (B) Draw circuit diagram of Class – B push pull amplifier. Explain its working. Show that the maximum theoretical conversion efficiency of class B push pull circuit is 78.5 %. **7**

OR

3. (A) (i) What are the differences between voltage amplifier and power amplifier ? **7**

(ii) What are the advantages and disadvantages of single ended transformer coupled power amplifier ?

3. (B) What is a voltage regulator ? Give block diagram of IC 723 voltage regulator. Describe function of each block. **7**

4. (A) Draw basic circuit of a phase shift oscillator using operational amplifier. Sketch the circuit waveforms, and briefly explain the circuit operation. **7**

Write the oscillating frequency equation. Discuss the amplifier gain requirements.

4. (B) Explain application of operational amplifier as Differential bridge amplifier. **7**

OR

4. (A) Giving neat circuit diagram and wave forms. Describe working of operational amplifier triangular wave generator. **7**

4. (B) Draw the circuit diagram for an integrating circuit. Sketch the output waveform produced by a rectangular wave form input to the inverting circuit. Explain the output waveform. **7**

5. Answer in brief any **seven** questions from the following : **14**

(Each question is of **two** mark).

(i) Define the pseudopotential.

(ii) Explain magnetic breakdown.

(iii) The volume of the first Brillouin zone is _____.

(iv) The susceptibility of a superconductor is _____ and _____.
(positive, negative, small, unity). (Choose correct options).

(v) Draw the magnetizing curves as a function of applied magnetic field for type – II super conductors.

(vi) Write equation for the critical field for the superconductor.

(vii) What is dc load line ?

(viii) Define harmonic distortion.

(ix) Define efficiency of a power amplifier.

(x) What is the difference between actual ground and virtual ground ?

(xi) What is voltage follower circuit ?

(xii) Draw circuit diagram of current to voltage converter using Op-Amp.

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FD-138

February-2025

M.Sc., Sem.-I

PHY-404 : Physics

(Solid State Physics and Plasma Physics)

(Old Course)

Time : 2:30 Hours] **[Max. Marks : 70**

1. (A) Write Bloch theorem and discuss the wave equation of electron in a periodic potential in detail. **7**

1. (B) Discuss the nearly free electron approximation in detail. **7**

OR

1. (A) Write a short note on Empty Lattice Approximation. **7**

1. (B) Discuss origin of the energy gap and magnitude of the energy gap in detail. **7**

2. (A) Write different methods used for the calculation of energy bands and discuss Wigner-Seitz method in detail. **7**

2. (B) Using tight binding approximation, explain energy bands in the simple cubic crystals. **7**

OR

2. (A) Explain construction of Fermi surface in 2-dimension with necessary diagram. **7**

2. (B) Explain briefly Hole orbits and Open orbits and discuss reduced zone scheme in detail. **7**

3. (A) Define : Thomson scattering. Prove that the Thomson scattering cross section of a free charge particle is $\sigma_T = \left(\frac{8\pi}{3}\right)\left(\frac{q^2}{4\pi\varepsilon_0 mC^2}\right)^2$. **7**

3. (B) Discuss in details on dispersion in solids and liquids. **7**

OR

3. (A) Discuss Radiation damping and obtain the expression of Abraham-Lorentz equation. **7**

3. (B) Derive the expression for media containing free electron in the system and show that this media behaves like a opaque or transparent under different conditions. **7**

4. (A) Write the three moment equations and discuss first moment equation in detail. **7**

4. (B) Write short note on Magneto hydrodynamics and explain one fluid model plasma in detail. **7**

OR

4. (A) Obtain Liouville equation for N-identical particles in six-dimension space. Write the Poisson bracket for [D, H] and using [D, H], obtain Liouville equation from the given relation $\frac{\partial D}{\partial t} + [D, H] = 0$. **7**

4. (B) (i) Show that $\vec{a} = \frac{e}{m}[\vec{E} + \vec{u} x \vec{B}] + \frac{e}{m}[\vec{W} x \vec{B}] - \frac{d\vec{u}}{dt} - \vec{W}(\nabla_r \cdot \vec{u})$. **7**

(ii) For isothermal process show that ∇_p (isothermal) = $KT_0 \nabla n_1$.

5. Short Answers : (Any **seven**) **14**

(1) Classify the materials by energy gap.

(2) Define 1st Brilliouin zone.

(3) State the validation of tight binding approximation.

(4) Define : Fermi energy.

(5) State the effective mass in case of metal.

(6) In the Kronig-Penny model, if there exist no potential barrier, then _____.

(7) Plasma can be defined as

(a) Dimension Length << Debye Length << Density of electrons

(b) Dimension Length >> Debye Length << Density of electrons

(c) Dimension Length >> Debye Length >> Density of electrons

(d) Dimension Length << Debye Length >> Density of electrons

(8) Write Rayleigh's scattering expression for resonance condition.

(9) Define : Skin depth.

(10) Why sky looks dark at night ?

(11) What is the value of Cauchy's constant 'A' ?

(12) In case of scattering of radiation by a bound charge, when $\omega << \omega_0$ and $1 \rightarrow 0$ then $<\sigma_{bound}>$ = _____.
