M.Sc. 2nd Semester Examination, 2021
PHYSICS
(Solid State Physics-II & Electronics-II)
Course Code: 203C
Course ID: 22453

Time: 2 Hours **Full Marks: 40**

The figures int he right hand side margin indicate full marks.
Candidates are required to give their answers in their own words as fas as practicable.

Unit-I

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

(a) Explain the electrical conductivity of metals based on free-electron gas model.
(b) Discuss the drawbacks of Sommerfield free-electron theory of metals.
(c) Graphically discuss the variation of the effective mass, velocity and energy of electrons in a one-dimensional periodic potential.
(d) Compare between the Maxwell field ($\vec{\epsilon}$) and Lorenz field ($\overrightarrow{\epsilon_{loc}}$). in dielectrics.
(e) Which physical parameters dictate to form type-II superconductors ?

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

(a) Show that the Pauli spin paramagnetism of a free electron in metal is given by

$$\chi_p = \frac{3}{2}\left(\frac{h_0\mu_B^2}{k_B T_F}\right),$$

where the symbols have their usual meaning.
(b) State and establish the Wiedemann-Franz law.
(c) What is Meissner effect in a superconductor? Explain this with the help of London's theory in terms of penetration depth.
(d) Discuss about the formation of Cooper pair in superconductors.

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

(a) Discuss the Kronig-Penny model of the motion of an electron in a periodic potential. Discuss band formation. 4+2=6
(b) (i) Derive Clausius-Mosotti relation.
(ii) Discuss the origin of electronic polarizability both with classical and quantum mechinical concepts. 2+4=6

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Unit-II

4. Answe *any three* of the followings: **2×3=6**

(a) What are Maxterm and Minterm?
(b) What is multiplexer?
(c) Write the full form of CLA and RCA. What is the advantage of CLA over RCA?
(d) What is reciprocal network?
(e) What are secondary line constants of a HF transmission line?

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

(a) Why MUX is called universal gate? Construct an OR gate using 2:1 MUX.
(b) Briefly explain principle of operation of CLA with proper diagram.

(c) Design an attenuator with *20 dB* attenuation and *200 Ω* characteristic resistor in symmetric π-form.

(d) What is the reflection coefficient and VSWR of a RF transmission line?

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

(a) Using K-Map convert the following standard POS expression into a minimum POS expression, a standard SOP expression, and a minimum SOP expression

$$y = (\overline{A} + \overline{B} + C + D)(A + \overline{B} + C + D)(A + B + C + \overline{D})(A + B + \overline{C} + \overline{D})(\overline{A} + B + C + \overline{D})(A + B + \overline{C} + D)$$

(b) (i) Prove that using same type of reactive elements a passive filter can not be designed.
(ii) What is a constant-k filter? With a circuit diagram explain the operation of a constant-k low-pass filter. 2+(1+3)=6