Question Bank

B.Sc Part II

Paper I – Thermodynamics and Statistical Physics

1. What is a partition function?
2. State second law of thermodynamics given by Kelvin and Clausious?
3. Explain effect of pressure on melting point of substance?
4. What is degree of freedom of a gas? How much degree of freedom for a diatomic gas?
5. How much specific heat of a vibrating diatomic molecule?
6. What is thermodynamic Probability? Write the relation between entropy and thermodynamic probability?
7. Explain why efficiency of a Carnot engine cannot be 100%?
8. Explain Carnot theorem?
9. What do you mean by phase space and phase point?
10. Differentiate between Fermi Dirac and Bose Einstein statistics?
11. State first law of thermodynamics?
12. Determine the velocity component for which probability is half of its maximum probability?
13. A Carnot engine operates between 227^0C and 27^0C. Calculate the adiabatic expansion ratio of the ideal gas ($\gamma=1.50$) used on it?
14. Determine the temperature of inversion of helium gas (given: $a=0.003$ N-m^4/mol^2, $b=0.0237*10^{-3}$ m^3/mol, R=8.31 J/mol-K)
15. Explain the transport phenomena in gases?
16. Describe Carnot Cycle and deduce the expression for the network done in Carnot Cycle and deduce efficiency of Carnot engine?
17. Using Maxwell thermodynamics relation, derive Clausious-Clapeyron equation. Use it to explain the effect of pressure on melting point and boiling point of solids and liquids?
18. What are liquids He I and He II? Discuss the important properties of liquids He II?
19. State the law of Maxwell law of velocity distribution and describe the method of verifying this law?
20. Obtain an expression for specific heat of a vibrating diatomic molecule and discuss its variation with temperature?
21. Derive the thermodynamic temperature scale using Carnot engine principle and explain that how it is related with ideal gas temperature scale?
22. Explain Internal energy (U), Helmholtz free energy (F), Enthalpy (H) and Gibb's free energy (G) thermodynamical potentials. Hence deduce Maxwell's four thermodynamic relations.
23. What is Joule-Thomson effect? Describe the Porous Plug experiment and prove that in the throttling process of Joule-Thomson experiment, the Enthalpy of a gas remains constant. Also, explain the conditions for heating and cooling effect.
24. Establish Barometric equation on the basis of Maxwell-Boltzmann Statistics?

25. Describe Planck law of radiation from Bose-Einstein distribution law and Obtain Wien's displacement law from it?

Paper II- Mathematical physics

1. Define coordinate surface, coordinate curve and coordinate axis in curvilinear coordinate system.
2. Prove that the velocity of a particle is a contravariant tensor.
3. Define four velocity, four momentum and four force.
4. Explain the light like vector.
5. Write the statement of four momentum conservation law.
6. What do you understand by the kinematics of decay products of unstable particles?
7. Define laboratory frame of reference and centre of mass frame of reference.
8. Write first three Legendre polynomial and represent them graphically.
9. Write the generating function for Legendre Polynomial.
10. Write Hermite differential equation.
11. Write Laplace equation in cylindrical coordinate system.
12. What do you understand by TE and TM mode in cylindrical resonance cavity?
13. Explain the difference between polar and axial vectors.

14. Obtain an expression for divergence of a vector point function in orthogonal curvilinear coordinates. Use the result for determination of an expression of $\nabla.A$ in spherical coordinates?
15. (a) Differentiate between contravariant, covariant and mixed tensors?
    (b) Prove that if $A_r{}^{pq}$ and $B^s{}_t$ are two tensors then $C^{pqr}{}_{rt} = A^{pq}{}_r B^s{}_t$ is a tensor?
16. (a) Define four momentum and prove that
    a. $$\sum P_\mu{}^2 = m_0 c^2$$
    b. $E^2 = P^2 C^2 + m_0{}^2 c^4$

    (b) Explain in detail about light cone, light like, space like and time like vectors and also define world line and macro-causality?
17. Write Legendre equation and obtain a general solution for it and give graphical representation of these Legendre polynomials?
18. Define diffusion phenomenon and find out mathematical expression for heat conduction in a thin rectangular plate?
19. In Cartesian coordinate system, prove that $J(x,y,z/u_1,u_2,u_3) = h_1 h_2 h_3$ and calculate its values in cylindrical and spherical coordinate system?
20. (a) State and explain contraction of a tensor giving one example?
    (b) Prove that $\int \delta(x-a) \, \delta(x-b) \, dx = \delta(a-b)$
21. (a) For four velocity (U_μ), Prove that
    $$\sum U_\mu{}^2 = -C^2$$
    (b) Define four force and derive Murkowski equation of motion?
22. (a) Find Power series solution of Hermite differential equation?
    (b) Establish the relation
    $$Xj_n{}'(x) = nj_n(x) - xj_{n+1}(x)$$
23. Find the general solution of the Laplace equation in Cartesian coordinates system by using separation of variable technique?

24. What is Jacobian transformation?

25. Define the gradient of scalar field.

Paper III- Electronics

1. State Thevenin's theorem.

2. State maximum power transfer theorem.

3. Derive an expression for the drift current density in conductors.

4. What is Hall Effect?

5. Define ripple factor and prove that for a full wave rectifier ripple factor is 0.48 .

6. What do you understand by feedback in an amplifier?

7. Derive the Barkhausen condition for self-excitation of oscillations in a transistor oscillator.

8. What is meant by XOR Gate? Draw its logic diagram and write its Boolean expression.

9. Define the h-parameters of a transistor in C-E configuration and explain their meaning.

10. What do you understand by the operating point Q and its stability.

11. Derive the relation between α and β in transistors.

12. Draw the circuit diagram of a full wave rectifier.

13. What is depletion layer. How does the width of depletion layer depends on the applied external potential difference.

14. Explain the concepts of energy bands in solids.

15. State superposition theorem for circuit analysis and prove it.

16. (a) State and prove Thevenin's theorem for circuit analysis.

    (b) What do you understand by junction capacitance of a PN junction diode? Discuss their dependence on the bias voltage

17. (a) Draw a circuit of full wave rectifier with shunt capacitor filter. Explain its working and derive an expression for ripple factor.

    (b)Derive an expression of current gain, input impedance, voltage gain and output impedance of a transistor amplifier using h-parameter.

18. (a) What is a field effect transistor? Draw its static characteristic curve and discuss its static characteristic curve and discuss its different regions. State it's any two advantages as compared to bi-polar junction transistor.

(b) Draw the circuit of a Hartley oscillator and explain its operation. Deduce frequency of oscillation for this circuit and determine condition for sustained oscillations.

19. Define different bias stability factors. Determine the temperature stability factors for fixed bias and self or emitter bias in transistor amplifier circuit.

20. Explain the principle of feedback. Prove that negative feedback improves the stability of an amplifier and reduces its distortion and noise.

21. (a) State and verify Kirchhoff's laws.

(b) State Norton's theorem for circuit analysis and prove it.

22. (a) Draw a circuit diagram of full wave rectifier with series inductor filter. Explain its working and derive an expression for ripple factor.
(b) What is a field effect transistor? Draw its static characteristics curves and discuss its different regions and mention the position of pinch voltage.

23. Explain the working of a Zener diode .How is it used for voltage stabilization.

24. What do you understand by the operating point Q and its stability? Define different stability factors. What is meant by thermal runway? How can an amplifier circuit be prevented from thermal runway?
25. Draw the basic circuit diagram of a Colpitts oscillator and explain its working. Determine the condition for maintained oscillations.