



ਪੰਜਾਬ ਟੈਕਨੀਕਲ ਯੂਨੀਵਰਸਿਟੀ ਜਲੰਧਰ  
PUNJAB TECHNICAL UNIVERSITY JALANDHAR

Max. Marks: 90

Time: 90 Mins.

**Entrance Test for Enrollment in Ph.D. Programme**

**Important Instructions**

- Fill all the information in various columns, in capital letters, with blue/black ball point pen.
- Use of calculators is not allowed.
- All questions are compulsory. No negative marking for wrong answers.
- Each question has only one right answer.
- Questions attempted with two or more options/answers will not be evaluated.

Stream (Engg./Arch./Pharm./Mgmt./App. Sci./Life Sci.)

Applied Sciences

Discipline / Branch

Physics

Name

Father's Name

Roll No.

Date

Signature of Candidate

Signature of Invigilator

Q. 1 Which of the following is false?

- (a) A symmetric matrix is one for which the transpose of the matrix is the same as the original matrix.
- (b) Diagonal elements of an antisymmetric matrix are all zeros.
- (c) An anti symmetric matrix is one for which the transpose of the matrix is the negative of the original matrix.
- (d) The inverse of a matrix and inverse of its transpose are the same.

Q. 2 The Laplace transform of the function  $t^n$ , ( $n = 1, 2, \dots$ ) is

- (a)  $\frac{n!}{s^{n+1}}$
- (b)  $\frac{n!}{s^n}$
- (c)  $\frac{n!}{s^{n-1}}$
- (d)  $\frac{n}{s^{n+1}}$

Q. 3 Which of the following is true?

- (a) Two non zero vectors are orthogonal if and only if their inner product is non zero.
- (b) The vector addition may or may not be commutative.
- (c) The dot product of two vectors will be zero only if both vectors are zero.
- (d) Dot product of vectors is commutative.

Q. 4 The number of different combinations of  $n$  different things,  $k$  at a time, without repetitions, is

- (a)  $\frac{n!}{k!(n-k)!}$
- (b)  $\frac{n!}{k!(n+k)!}$
- (c)  $\frac{n!}{(n-k)!}$
- (d)  $\frac{n!k!}{(n+k)!}$

Q. 5 For a normal random variable  $X$

- (a) about  $\frac{2}{3}$  of its values will lie between  $\mu-\sigma$  and  $\mu+\sigma$
- (b) about half of its values will lie between  $\mu-\sigma$  and  $\mu+\sigma$
- (c) about 90% of its values will lie between  $\mu-\sigma$  and  $\mu+\sigma$
- (d) about 95% of its values will lie between  $\mu-\sigma$  and  $\mu+\sigma$

Q. 6 A function  $f(x,y)$  is harmonic if

- (a)  $\frac{\partial f}{\partial x} + \frac{\partial f}{\partial y} = 0$
- (b)  $\frac{\partial f}{\partial x} - \frac{\partial f}{\partial y} = 0$
- (c)  $\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} = 0$
- (d)  $\frac{\partial^2 f}{\partial x^2} - \frac{\partial^2 f}{\partial y^2} = 0$

Q. 7 If  $G$  is a group of even order, then

- (a)  $a^2=e$  for all  $a \in G$
- (b)  $a^2=e$  for at least one  $a \in G$
- (c)  $a^2=a$  for all  $a \in G$
- (d) none of above

Q. 8 The set  $G = \begin{bmatrix} a & 0 \\ 0 & b \end{bmatrix}$  such that  $a, b \in \mathbb{R}$  under matrix multiplication, forms

- (a) Abelian group
- (b) Non - Abelian group
- (c) Cyclic group
- (d) none of above

Q. 9 A three dimensional length element  $dl = dx\hat{i} + dy\hat{j} + dz\hat{k}$  in Cartesian coordinates  $(x, y, z)$  may be expressed in spherical polar coordinates  $(r, \theta, \phi)$  as

(a)  $dl = dr\hat{e}_r + d\theta\hat{e}_\theta + d\phi\hat{e}_\phi$

(b)  $dl = dr\hat{e}_r + rd\theta\hat{e}_\theta + rd\phi\hat{e}_\phi$

(c)  $dl = dr\hat{e}_r + rd\theta\hat{e}_\theta + r\sin\theta d\phi\hat{e}_\phi$

(d)  $dl = dr\hat{e}_r + d\theta\hat{e}_\theta + r\sin\theta d\phi\hat{e}_\phi$

Q. 10 In an extrinsic semiconductor, the conduction process becomes intrinsic, when

(a) Temperature is low

(b) Temperature is high

(c)  $T \rightarrow 0K$

(d) The conduction process never becomes intrinsic.

Q. 11 Voltage variable capacitances (VVCs) or Varactors are

(a) Reverse biased diodes

(b) Forward biased diodes

(c) Piezoelectric crystals

(d) Vacuum triodes

Q. 12 In a transistor amplifier, the d.c load line locates

(a) values for collector current  $i_C$  and collector-emitter voltage  $V_{CE}$  for series circuit comprised of transistor and load  $R_L$ , at constant  $V_{CC}$

(b) values for emitter current  $i_E$  and emitter-base voltage  $V_{BE}$  for series circuit comprised of transistor and load  $R_L$ , at constant  $V_{CC}$

(c) values for base current  $i_B$  and emitter-base voltage  $V_{BE}$  for series circuit comprised of transistor and load  $R_L$ , at constant  $V_{CE}$

(d) values for base current  $i_B$  and collector current  $i_C$  for series circuit comprised of transistor and load  $R_L$ , at constant  $V_{CE}$

Q. 13 An FET (Field Effect Transistor) differs from BJT (Bipolar Junction Transistor) primarily because of

(a) it is very low input resistance in comparison to BJT

(b) it is low gain in comparison to BJT

(c) it is very high input resistance in comparison to BJT

(d) none of above

Q. 14 The amplifier band width is defined as difference between two frequencies at which the power is

(a)  $\frac{1}{4}$  of midfrequency power

(b) 33% of midfrequency power

(c) Half of midfrequency power

(d) 67% of midfrequency power

Q. 15 The Barkhausen criterion for an amplifier to behave as an oscillator is

(a)  $|a\beta| = 1$

(b)  $|a\beta| > 1$

(c) Phase shift around the loop must be  $(n + 1/2)\pi$

(d) both (a) and (c)

Q. 16 Which of the following is a true cell?

- (a) photoemissive cell
- (b) photoconductive cell
- (c) photovoltaic cell
- (d) both (b) and (c)

Q. 17 For getting an output from XNOR gate, both inputs must be

- (a) high
- (b) low
- (c) at the same logic level
- (d) at the opposite logic level

Q. 18 Only one IC is active at a time to avoid a bus conflict caused by two ICs writing different data to the same bus, is ensured by

- (a) control bus
- (b) control instructions
- (c) address decoder
- (d) CPU

Q. 19 The register in the 8085A that is used to keep track of the memory address of the next op-code to be run in the program is the

- (a) stack pointer
- (b) program counter
- (c) instruction pointer
- (d) accumulator

Q. 20 Constraints that can be expressed as equations of coordinates and time, i.e., by an expression of the form  $f(r_1, r_2, r_3, \dots, t) = 0$ , are said to be

- (a) holonomic
- (b) non holonomic
- (c) scleronomous
- (d) non scleronomous

Q. 21 Scleronomous constraints have:

- (a) explicit time dependence
- (b) no explicit time dependence
- (c) no time dependence at all
- (d) may or may not have a time dependence

Q. 22 Hamilton's principle is an example of a

- (a) consevation law
- (b) continuity equation
- (c) variational principle
- (d) both (b) and (c)

Q. 23 If the Lagrangian is cyclic in  $q_j$  then,

- (a)  $p_j$  is not conserved
- (b)  $p_j$  is ~~not~~ conserved
- (c)  $q_j$  appears in the Lagrangian
- (d) the Lagrangian is circular

Q. 24 Canonical transformations can often be conveniently found or verified by using

- (a) rotational matrix
- (b) generating function
- (c) degeneration function
- (d) separation tensor

Q. 25 The expression for the conserved angular momentum in a central force problem is,

(a)  $L = mr^2\dot{\theta}$

(b)  $L = \frac{m}{r^2\theta}$

(c)  $L = mr\theta$

(d)  $L = 2mr^2\theta$

Q. 26 The Poisson Bracket of two functions of  $F$  and  $G$  of the coordinates and canonical momenta  $q$  and  $p$  is defined to be

(a)

$$[F, g]_{q, p} = \sum \left[ \frac{\partial F}{\partial q_k} \frac{\partial G}{\partial p_k} - \frac{\partial F}{\partial p_k} \frac{\partial G}{\partial q_k} \right]$$

(b)

$$[F, g]_{q, p} = \sum \left[ \frac{\partial F}{\partial q_k} \frac{\partial G}{\partial p_k} + \frac{\partial F}{\partial p_k} \frac{\partial G}{\partial q_k} \right]$$

(c)

$$[F, g]_{q, p} = \sum \left[ \frac{\partial F}{\partial q_k} \frac{\partial G}{\partial p_k} - \frac{\partial F}{\partial p_k} \frac{\partial G}{\partial q_k} \right]^2$$

(d)

$$[F, g]_{q, p} = \sum \left[ \frac{\partial F}{\partial q_k} \frac{\partial G}{\partial p_k} + \frac{\partial F}{\partial p_k} \frac{\partial G}{\partial q_k} \right]^2$$

Q. 27 Which of the following is efficient in frequency range of (3 - 300) GHz?

(a) Transmission line

(b) Wave guides

(c) Both (a) and (b)

(d) none of these

Q. 28 For lossless waveguides  $w_c$  and  $\sigma$  are

(a)  $\infty, 0$

(b)  $0, \infty$

(c)  $0, 0$

(d)  $\infty, \infty$

Q. 29 Which vector is needed to determine the power flow in wave guides

(a) Poynting vector

(b) Power vector

(c) Phase vector

(d) S - vector

Q. 30 Which of the following Maxwell's equation expresses Ampere's law

(a)  $\nabla \cdot E = \frac{\rho}{\epsilon_0}$

(b)  $\nabla \cdot B = 0$

(c)  $\nabla \times E = -\frac{\partial B}{\partial t}$

(d)  $\nabla \times B = \frac{J}{\epsilon_0 c^2} + \frac{1}{c^2} \frac{\partial E}{\partial t}$

Q. 31 Maxwell's equation  $\oint B \cdot ds = 0$  implies that

(a) Total Magnetic flux crossing any closed surface is zero.

(b) Magnetic flux lines occur in closed loops.

(c) There are no magnetic monopoles.

(d) All of above.

Q. 32 For a sinusoidally varying input voltage of frequency  $\omega$ , the ratio of conduction current density to displacement current density is proportional to

- (a)  $\frac{\omega\epsilon}{\sigma}$   
 (b)  $\frac{\omega\sigma}{\epsilon}$   
 (c)  $\frac{\sigma}{\omega\epsilon}$   
 (d)  $\sqrt{\omega\epsilon\sigma}$

Q. 33 Magnetostriction is a property by which a ferromagnetic substance, when placed in magnetic field shows

- (a) an increase in length in the direction of magnetic field  
 (b) an increase in length in the direction opposite to the magnetic field  
 (c) increase in temperature  
 (d) decrease in temperature

Q. 34 Which of the following statements regarding fields  $E_1$  and  $E_2$  is correct?

$$E_1 = x\hat{i} + y\hat{j} \text{ and } E_2 = xy^2\hat{i} + y^3\hat{j}$$

- (a) Both  $E_1$  and  $E_2$  can represent electrostatic field.  
 (b) Neither  $E_1$  nor  $E_2$  can represent electrostatic field.  
 (c) Only  $E_1$  can represent electrostatic field.  
 (d) Only  $E_2$  can represent electrostatic field.

Q. 35 Joule-Thomson cooling effect is

- (a) Independent of temperature.  
 (b) temperature dependent  
 (c) dependent on the molecular weight of the gas  
 (d) dependent on the total mass of the gas

Q. 36 The mean square displacement of a particle undergoing Brownian motion at a temperature  $T$  is proportional to

- (a)  $\frac{1}{T}$   
 (b)  $\frac{1}{\sqrt{T}}$   
 (c)  $\sqrt{T}$   
 (d)  $T$

Q. 37 The energy for a diatomic gas having 3 translational and 2 rotational degrees of freedom is

- (a)  $\frac{5}{2}kT$   
 (b)  $5kT$   
 (c)  $\frac{3}{2}kT$   
 (d)  $3kT$

Q. 38 The Gibbs function for a system is given as  $G = H - TS$ , where  $H$  is enthalpy,  $T$  is temperature and  $S$  is the entropy of the system. In the case of a reversible, isothermal, isobaric process

- (a)  $G = \text{constant}$   
 (b)  $G > 0$  and changes with  $T$   
 (c)  $G < 0$  and changes with  $S$   
 (d)  $G$  changes with both  $T$  and  $S$

$$b = 2.897 \times 10^{-3} \text{ mK}$$

Q. 39 If the maximum wavelength  $\lambda_m$  is  $4753 \text{ \AA}$ , then the temperature of the surface of the photosphere of the sun will be

- (a) 6200 K
- (b) 6800 C
- (c) 68000 K
- (d) 68000 C

Q. 40 The Bose - Einstein statistics describe

- (a) all integer spin particles
- (b) all half - integer spin particles
- (c) both interger and half - integer spin particles
- (d) only photons

Q. 41 The Fermi - Dirac distribution function is given as

(a)  $f(E) = \frac{1}{e^{(E-E_F)/kT} + 1}$

(b)  $f(E) = \frac{1}{Ae^{E_F/kT} - 1}$

(c)  $f(E) = \frac{1}{e^{(E-E_F)/kT} - 1}$

(d)  $f(E) = \frac{1}{Ae^{E_F/kT} + 1}$

Q. 42 The diffusion coefficient in solid state diffusion process

- (a) increases linearly with temperature
- (b) increases exponentially with temperature
- (c) does not depend on temperature
- (d) decreases exponentially with temperature

Q. 43 If  $n$  is an exact number and  $Q = x^n$ , then uncertainty in  $Q$  is given as

(a)  $\frac{\delta Q}{|Q|} = \frac{\delta x}{|x|}$

(b)  $\frac{\delta Q}{|Q|} = |n| \frac{\delta x}{|x|}$

(c)  $\frac{\delta Q}{|Q|} = \frac{(\delta x)^n}{|x|^n}$

(d)  $\frac{\delta Q}{|Q|} = \frac{\delta x}{n|x|}$

Q. 44 A box car integrator improves the signal/noise ratio by

- (a) gating the detection
- (b) averaging over multiple pulses
- (c) both (a) and (b)
- (d) none of above

Q. 45 According to the method of least squares, the best fitting curve has the property that

(a)  $\sum_{i=1}^n [y_i - f(x_i)]^2 = \text{aminimum}$

(b)  $\sum_{i=1}^n [y_i - f(x_i)] = \text{aminimum}$

(c)  $\sum_{i=1}^n [y_i - f(x_i)]^{1/2} = \text{aminimum}$

(d)  $\sum_{i=1}^n [y_i - f(x_i)]^{3/2} = \text{aminimum}$

where,  $y$  is dependent and  $x$  is independent variable, while  $f(x)$  describes the fitting curve.

- Q. 46 In a De Broglie wave corresponding to a moving body,  
 (a) phase and group velocities are same.  
 (b) phase velocity is same as the velocity with which the body moves.  
 (c) group velocity is same as the velocity with which the body moves.  
 (d) group velocity is more than the phase velocity.

- Q. 47 Using uncertainty principle, the minimum energy that an electron in hydrogen atom (radius =  $5.3 \times 10^{-11} \text{m}$ ) can have is  
 (a) 5.1 eV  
 (b) 10.5 eV  
 (c) 13.6 eV  
 (d) 3.4 eV

- Q. 48 Eigenfunction of the operator  $d^2/dx^2$  is  $\psi = e^{2x}$ . The corresponding eigenvalue is  
 (a) 10  
 (b) 4  
 (c)  $2x$   
 (d)  $4x$

- Q. 49 Zeeman effect is a confirmation of  
 (a) space quantization  
 (b) energy quantization  
 (c) spin-spin coupling  
 (d) spin-orbit coupling

- Q. 50 The parity operator  $\Pi$  is defined as  
 (a)  $\Pi \psi(x) = \overline{\psi(x)}$   
 (b)  $\Pi \psi(x) = \psi(x)^\dagger$   
 (c)  $\Pi \psi(x) = \psi(-x)$   
 (d)  $\Pi \psi(x) = \overline{\psi(-x)}$

- Q. 51 The addition of angular momenta  $j_1=1$  and  $j_2=1$  will result in 9 states, of which the number of linearly independent states with magnetic quantum number  $m=0$  is  
 (a) 9  
 (b) 6  
 (c) 2  
 (d) 3

- Q. 52 Which of the following sets of operators form a commuting set for an electron  
 (a)  $H, J^2$  and  $J_z^2$   
 (b)  $H, J^2$  and  $J_z$   
 (c)  $H, J$  and  $J_z^2$   
 (d)  $H, J$  and  $J_z$

- Q. 53 Systems of identical particles with symmetric wave functions obey  
 (a) Fermi-Dirac statistics  
 (b) Maxwell-Boltzmann statistics  
 (c) Bose-Einstein statistics  
 (d) Any of the above



- Q. 54 In their experiment in 1922, Stern and Gerlach measured
- magnetic dipole moment for silver atom
  - forbidden energy gap in silver atom
  - electric dipole moment for silver atom
  - the hyperfine splitting of silver atom
- Q. 55 The weak interactions are mediated by the
- massive vector bosons
  - massless vector bosons
  - scalar Higgs particle
  - massless gluons
- Q. 56 The antiproton annihilation  $\bar{p} + p \rightarrow n + n$  is forbidden by
- conservation of lepton number
  - conservation of baryon number
  - conservation of strangeness
  - conservation of isospin
- Q. 57 The Gellmann-Nishijima formula is given as
- $Q = I_3 + \frac{B-S}{2}$
  - $Q = I_3 + \frac{B+S}{3}$
  - $Q = I_3 + \frac{B+S}{2}$
  - $Q = I_3 - \frac{B+S}{2}$
- Q. 58 CPT invariance implies that
- particles and antiparticles have equal masses but different lifetimes
  - particles and antiparticles have different masses but equal lifetimes
  - particles and antiparticles have equal masses and lifetimes
  - particles and antiparticles have different masses as well as different lifetimes
- Q. 59 In the Standard Model, neutrino
- has very small mass
  - participates in strong interactions
  - is spin 0 particle
  - exists only in left handed helicity state
- Q. 60 The GIM mechanism explained the
- CP violation in Kaon
  - absence of Flavor changing neutral currents
  - absence of Flavor changing charged currents
  - parity non conservation in weak interactions
- Q. 61 The Standard Model Lagrangian is invariant under the gauge group
- $SU(3) \times SU(2) \times U(1)$
  - $SO(2) \times SU(2) \times SU(1)$
  - $SU(3) \times SO(2) \times SU(2)$
  - $SO(3) \times SO(2) \times SU(2)$

- Q. 62 The quark content of the baryon  $\Sigma^+$  is  
 (a) cts  
 (b) ucb  
 (c) ucs  
 (d) uus
- Q. 63 The local gauge invariance of the electromagnetic interaction leads to  
 (a) masslessness of the photons and the gluons  
 (b) the masslessness of the photons  
 (c) the masslessness of the gluons  
 (d) the massive W and Z bosons
- Q. 64 The ratio of the magnitude of electric field intensity to the magnitude of magnetic field intensity is called  
 (a) attenuation coefficient  
 (b) phase constant  
 (c) intrinsic impedance  
 (d) extrinsic impedance
- Q. 65 The characteristic of a good conductor is  
 (a)  $\frac{\sigma}{\omega\epsilon} \gg 1$   
 (b)  $\frac{\sigma}{\omega\epsilon} \ll 1$   
 (c)  $\frac{\omega}{\sigma\epsilon} \gg 1$   
 (d)  $\frac{\omega}{\sigma\epsilon} \ll 1$
- Q. 66 The work done in displacing a charge of 2C through 0.5m on an equipotential surface is  
 (a) zero  
 (b) 4J  
 (c) 1J  
 (d) 6J
- Q. 67 A hollow waveguide can support  
 (a) only TE modes  
 (b) only TM modes  
 (c) only TEM modes  
 (d) both TE and TM modes
- Q. 68 For a vector field  $\vec{A}$  to be solenoidal  
 (a)  $\vec{\nabla} \times \vec{A} = 0$   
 (b)  $\vec{\nabla} \cdot \vec{A} = 0$   
 (c)  $\vec{\nabla} \times \vec{\nabla} \times \vec{A} = 0$   
 (d) None of above
- Q. 69 When em wave propagates through a dielectric medium, then  
 (a) the electric and magnetic fields oscillate in phase and with same frequency  
 (b) the electric and magnetic fields oscillate in phase, but not with same frequency  
 (c) magnetic field oscillates with a phase lag relative to the electric field  
 (d) electric field oscillates with a phase lag relative to the magnetic field

- Q. 70 The selection rules for allowed electric dipole transitions are
- (a)  $\Delta M_J = 0, \pm 1$  and  $\Delta J = 0, \pm 1$
  - (b)  $\Delta M_J = 0$  and  $\Delta J = 0, \pm 1$
  - (c)  $\Delta M_J = 0, \pm 1$  and  $\Delta J = 0$
  - (d)  $\Delta M_J = 0, \pm 2$  and  $\Delta J = 0, \pm 1$

- Q. 71 The resonant frequencies in the NMR are in
- (a) IR region
  - (b) visible region
  - (c) microwave region
  - (d) radiofrequency region

- Q. 72 In the Raman spectrum of diatomic molecules,
- (a) the frequency of the incident and emitted photons are equal.
  - (b) the frequency of the incident and emitted photons are not equal.
  - (c) strength of the scattering is weak
  - (d) none of above

- Q. 73 The Doppler broadening of spectral lines is
- (a) proportional to square root of the temperature
  - (b) proportional to the frequency
  - (c) inversely proportional to square root of atomic weight
  - (d) proportional to atomic number

- Q. 74 Which of the following statements is false.

- (a) Rate of stimulated emission depends on the energy density of incident radiation.
- (b) Rate of spontaneous emission depends on the energy density of incident radiation.
- (c) Rate of absorption depends on the energy density of incident radiation.
- (d) Rate of stimulated emission is not same as the rate of spontaneous emission.

- Q. 75 The splitting of spectral lines under the influence of static electric field is known as the

- (a) Kondo effects
- (b) Zeeman Effect
- (c) Stark Effect
- (d) Doppler effect

- Q. 76 In a laser, the role of resonator is to

- (a) provide a feedback of photons for a sustained lasing action.
- (b) provide an active medium
- (c) provide pumping in the lasing medium
- (d) None of the above

- Q. 77 A single fission event can yield  
 (a) over 20 times the energy of the neutron which triggered  
 (b) over 2000 times the energy of the neutron which triggered (c) over 200 thousand times the energy of the neutron which triggered it  
 (d) over 200 million times the energy of the neutron which triggered it
- Q. 78 In liquid drop model, the nucleus is considered to be  
 (a) analogous to a neutral liquid drop with positive charge outside the drop.  
 (b) analogous to a non uniformly charged liquid drop  
 (c) analogous to a uniformly charged liquid drop  
 (d) none of the above
- Q. 79 The Fermi selection rule for the allowed beta decay is  
 (a)  $\Delta j = 0$  and  $\Delta P = 0$   
 (b)  $\Delta j = +1$  and  $\Delta P = +1$   
 (c)  $\Delta j = 0$  and  $\Delta P = +1$   
 (d)  $\Delta j = +1$  and  $\Delta P = 0$
- Q. 80 Maxwell's equation  $\oint B \cdot ds = 0$  implies that  
 (a) total magnetic flux crossing any closed surface is zero  
 (b) magnetic flux lines occur in closed loops  
 (c) there are no magnetic monopoles  
 (d) all of above
- Q. 81 The total number of Bravais lattices in 3 – dimension is  
 (a) 5  
 (b) 9  
 (c) 14  
 (d) 24
- Q. 82 X-ray diffraction technique is used to determine the crystal structure as  
 (a) wavelength of X – ray is comparable to lattice parameter  
 (b) wavelength of X – ray is much shorter than the lattice parameter  
 (c) it is relatively easy to obtain an X – ray beam  
 (d) intensity of X – ray beam can be very high
- Q. 83 The Lorentz-Drude free electron theory is not able to explain  
 (a) the electrical conductivity of metals  
 (b) the thermal conductivity of metals  
 (c) the heat capacity of metals  
 (d) the cyclotron resonance
- Q. 84 The diamagnetic susceptibility of a solid is  
 (a) due to spin-spin interaction  
 (b) due to spin-orbit interaction  
 (c) strongly dependent on temperature  
 (d) independent of the temperature

- Q. 85 Ferrimagnetic substances possess
- (a) magnetic dipole moment in the absence of external magnetic field
  - (b) magnetic dipole moment in the presence of external magnetic field
  - (c) permanent magnetic dipole moment independent of the temperature
  - (d) induced magnetic dipole moment independent of the temperature
- Q. 86 The motion of the electron in a periodic potential in a metallic solid leads to
- (a) the formation of allowed and forbidden energy bands
  - (b) a continuum of electron energies
  - (c) high electrical resistivity of metals
  - (d) low work function of metals
- Q. 87 Dislocations in a crystal are responsible for
- (a) the colour of the crystal
  - (b) mechanical strength of a crystal
  - (c) high conductivity of a crystal
  - (d) elasticity of a crystal
- Q. 88 BCS theory assume the shape of the Fermi surface to be
- (a) ellipsoidal
  - (b) cylindrical
  - (c) spherical
  - (d) hemi-spherical
- Q. 89 In a cooper pair the two electrons are bound to each other by exchange of a
- (a) photon
  - (b) meson
  - (c) phonon
  - (d) vector boson
- Q. 90 The Hall coefficient for a semiconductor increases with
- (a) an increase in the applied current and magnetic field
  - (b) decrease in the applied current and magnetic field
  - (c) decrease in the charge carrier concentration
  - (d) increase in the width of the crystal

