Ph.D ENTRANCE EXAMINATION 2008
DEPARTMENT OF PHYSICS
UNIVERSITY OF CALICUT

Section A

Answer all questions. Each question carry one mark

1.For a lossy transmission line short circuited at the receiving end, the input impedance in given by (ζo is the characteristic impedance `$\gamma$' is the propagation constant and `l' is the length of the line)

a. $\zeta o \coth \gamma l$
b. $\zeta o \cot \gamma l$
c. $\zeta o \tanh \gamma l$
d. $\zeta o \tan \gamma l$

2. Given $\vec{E} = Eo \sin(wt - \beta\varsigma)\ \hat{a}y$ in free space then $\vec{B}$ is given as

a. $\frac{-Eo\beta}{w} \sin(wt - \beta\varsigma)\hat{a}\varsigma$

b. $\frac{-Eo\beta}{w} \cos(wt - \beta\varsigma)\hat{a}x$

c. $\frac{-Eo\beta}{w} \sin(wt - \beta\varsigma)\hat{a}y$

d. None of the above

3.When electromagnetic waves are reflected at angle from a wall, their wave length along the wall is

a. The same as in free space
b. The same as the wave length perpendicular to the wall
c. Shortened because of the Doppler effect
d. Greater than in the actual direction of propagation

4. The intrinsic impedance of a lossy dielectric medium in given by

a. $\frac{jw\mu}{\sigma}$ b. $\frac{jw\in}{\sigma}$

c. $\sqrt{\frac{jw\mu}{\sigma + jw\in}}$ d. $\frac{\mu}{\sigma}$

5.Consider the reflection and refraction of a plane wave at a dielectric interface. Which of the following is true?

a. The frequency of the wave doesn't change
b. The energy of the wave doesn't change
c. The polarization doesn't change
d. The momentum of the wave doesn't change

6. The intensity distribution in microwave spectra gives information about
   A. Temperature of the system B. Pressure of the system
   C. Both D. None of the above
7. The IR spectra of a molecule shows some PQR contour and some complex spectra the molecule will be.
   A. Linear diatomic B. Linear polyatomic
   C. symmetric top D. Asymmetric top
8. Two frequencies n_1 and n_2 are IR active and Raman inactive, then which of the following statements are correct?
   A. $n_1 + n_2$ may be Raman active B. Both $2n_1$ and $2n_2$ may be Raman active
   C. Both A and B are correct D. None of the above are correct.
9. When a diatomic molecule reaches the continuum limit and subsequently dissociate in the electronic spectra, then which of the following statement is correct?
   A. Both atoms are excited and energetic
   B. One atom is excited both are energetic
   C. One is excited and the same is energetic
   D. One is excited and the other is energetic
10. Born oppenheimer approximation holds for
   A. IR spectroscopy B. Electronic Spectroscopy
   C. Both electronic and IR spectroscopies D. None of the above

11. Crystal structure of Nacl
   a. Hexagonal b. Monoclinic c. FCC d. BCC
12. The miller indices of the plane parallel to z and y axes are
   a. (010) b. (100) c. (001) d. (111)
13. The unit of hall coefficient is
   a. $Vm^3A^{+1}wb^{-1}$ b. $Vm^3A^{-1}wb^{-1}$ c. Vm^2Awb^{-1} d. $Vm^2A^{-2}wb^3$
14. Curie – weirs law is
   a. $x = \frac{C}{T}$ b. $x_m = \frac{T-\theta}{C}$ c. $x_m = \frac{C}{T-\theta}$ d. $x_m = \frac{C}{\theta}$
15. The Einstein relationship between D and M for electron is
   a. $\frac{D_n}{M_n} = \frac{e}{kBT}$ b. $\frac{D_n}{M_n} = \frac{2kBT}{e}$ c. $\frac{D_n}{M_n} = \frac{kBT}{e}$ d. $\frac{D_n}{M_n} = kBT - e$

16. An excited state of a nucleus (2-) decays to its ground state (3+) by emitting a gamma ray. The transition is
   a. Purely E1 b. Purely M1
   c. Mixed, with E1 being predominant d. Mixed, with M1 being predominant
17. The width of a nuclear excited state is
   a. Inversely proportional to its half life b. Directly proportional to its half life.
   c. Independent of its half life d. Inversely proportional to its mass

18. In the nuclear shell model, the spin of ground state of an odd A nucleus

a. is decided by the last unpaired nucleus
b. is always zero
c. is always integral
d. is decided by the core.

19. In a nuclear reaction, the mass of the reaction products is
a. Always equal to the sum of the masses of the colliding nuclei.
b. Always less than the sum of the masses of the colliding nuclei
c. Always greater than the sum of the masses of the colliding nuclie
d. Different from the sum of colliding nuclear masses of he colliding nuclei

20. In a GM counter
a. The output is directly proportional to the incident radiation energy.
b. The output pulse is independent of the incident energy
c. The operation is in the proportional region
d. The electric field is uniform

21. In an emitter coupled differential amplifier the CMRR depends on
a. Collector Resistances R_C
b. Emitter resistance R_E
c. Input impedance Z_I
d. Output impedance Z_o

22. A miller integrator functions similar to a
a. Low pass filter b. Band reject filter
c. High pass filter d. Narrow band pass filter

23. Which of the following is correct?
a. An enhancement type MOSFET can be operated using both polarities of the gate voltage.
b. A depletion type MOSFET can be operated in both depletion mode and enhancement mode
c. Both types of MOSFETS can be operated using both polarities of gate voltage.
d. Each type of MOSFET can be operated is only one mode.

24. A photodiode and a solar cell
a. Both work in the first quadrant of the diode I-V characteristics
b. Both work in the IVth quadrant of the dived I-V characteristics
c. Both work in the IIIrd quadrant of the dived I-V characteristics
d. Both work in the IInd quadrant of the dived I-V characteristics

25. In an S-R flip flop
a. S=0, R =1 leads to an undetermined state
b. S=1, R = 0 leads to an undetermined state
c. S=R = 1 is completely forbidden
d. S= R =1 is to an allowed state.

26. The function $\frac{e^{1/z}}{z-2}$ has
a. Only one pole at z=2

b. Only one pole at z=0
c. Has two poles at z=0 and z = 2
d. Has a zero at z=2

27. The Neumann function $N_n(x)$
a. Is linear combination of Bessel functions
b. Remains finite every where
c. Has an infinite number of poles
d. Has a singularity at the origin

28. What can you say about $J_{1/2} = (x)$?
a. It is an odd function of x
b. It is not defined for x=0
c. It is given by $\sqrt{\frac{2}{\prod x}} \sin x$
d. Its value is 0 at x =0

29. Contraction of a tensor of rank r over a pair of its indices results in a tensor of rank
a. r-2 b. r+2 c. Zero d. r

30. If $f(t)=t^n$, n = an integer, then the Laplace transform will be
a. $s^{n-1}/n!$ b. $n!/s^{n+1}$ c. $n\,s^{n-1}$ d. s^n

31. Which among the following is true about neutrinos and antineutrinos
a). All neutrinos are left handed and all antineutrinos are right handed
b) All neutrinos are right handed and all antineutrinos are left handed
c) There are both left handed and right handed neutrinos and antineutrinos
d) No handedness is associated with neutrinos and antineutrinos

32, $\Delta(1232)$ has
a) Spin J=1/2 and hence has two states
b) Spin J=3/2 and hence has four states
c) Spin J=5/2 and hence has six states
d) Spin J=7/2 and hence has eight states

33. The energy dependence the cross section of a reaction between two particles, close to resonance energy E_0 is described by
a) Bethe-Bloch formula
b) Brest-Wigner formula
c) Gamous-Teller formula
d) Bethe-Weizacker formula

34. Isospin conservation law is obeyed by
a) All the four interactions
b) The EM, weak and strong only
c) Weak and strong only
d) Strong interaction only

35. A stone is thrown from a point P and follows a parabolic path. The highest point reached is T. The vertical component of the acceleration of the stone is
a) Zero at T
b) Greatest at T
c) Greatest at P
d) Same at P and T

36. A bead resting on a smooth horizontal surface is connected to two identical springs and is made to oscillate to and fro along the line of the springs. When the bead passes through the central position, its energy is

a) Zero
b) Mostly P.E.
c) All P.E.
d) All K.E.

37. In relation to central force motion choose the incorrect statement :

a) Many comets follow hyperbolic trajectories through the solar system
b) Spacecraft leaving the earth for other points in the solar system may follow a parabolic path
c) Spacecraft and other satellites in earth's orbit follow elliptical or circular paths
d) The path of a particle is a hyperbola in an attractive central force field.

38. If $\{q_i, f(p)\} = \alpha f(p)$ where a is a scalar and {} denotes the Poisson bracket, then f(p) is

a) $e^{\alpha p}$
b) $e^{-\alpha p}$
c) $\alpha e^{\alpha p}$
d) $\alpha e^{-\alpha p}$

39. Angular momentum operator **L** obey

a) $\mathbf{L} \times \mathbf{L} = 0$
b) $\mathbf{L} \times \mathbf{L}$
c) $\varepsilon_{ijk} L_j L_k = kL_i$
d) None of the above

40. If $|\Psi\rangle$ is an eigen vector of an operator A with an eigen value a, then it is also an eigen vector of operator A^{-1} with eigen value

a) a
b) 1/a
c) $1/a^2$
d) $\sqrt{a}$

41. The commutator of [x,p] is

a) h
b) 1/h
c) -ih.
d) ih

42. If J_x and J_y are the components of J, then the raising operator J+ is

a) $J_x + J_y$
b) $J_x - J_y$
c) $J_x + iJ_y$
d) $J_x - iJ_y$

43. The volume in phase space occupied by the canonical ensemble is

a) fugacity
b) grand partition function
c) partition function
d) enthaphy

44. For a system of constant volume and in contact with heat bath at a temperature T, spontaneous changes occur in the direction

a) decreasing helmholtz free energy
b) increasing helmholtz free energy
c) increasing Gibbs free energy
decreasing Enthalphy

45. Classical statistics will hold at

a) high temperature and high density
b) Low temp. and low density
c) high temp and low density
d) Low temp. and high density

46. For an ideal gas containing N molecules its internal energy is

a) NkT/2
b) 3NkT/2
c) 3kT/2N
d) NkT

47. Fermi Temperature of a metal is of the order of

a) 1 K b) 10 K c) 100 K d) 10000 K

48. The packing factor of diamond(cubic) structured crystal is

a) 60% b) 54% c) 90% d) None of these

49. At the state of superconductivity

a) Entropy and thermal conductivity decreases
b) Entropy decreases and thermal conductivity increases
c) Entropy and thermal conductivity increases
d) Entropy increases and thermal conductivity drcreases

50. I . Classical treatment of incident radiation is valid only when large Number of photos contribute to the interaction
II Quantum mechanical effects are generally encountered only when finite number of photons are involved

a) both I and II are true b) I is false and II is true
c) I is true II is false d) Both I and II are false

Section B

Anwer any 10 questions. Each question carry five marks

1. a) Distinguish between TE, TM & TEM waves. Why does a TEM wave not propagate through a single conductor wave guide?
b)Are the four Maxwell's equations independent. Support your answer with necessary agreement

2. Find the values of ent off and guide wavelength in an air filled rectangular wave guide with internal dimensions 7. 62 cm x 2.54 cm for normal H_{10} mode at a frequency of 3000 MHζ.

$\lambda_c = 15.24cm$
$\lambda_g = 13.3cm$

3 Show that NMR resonance frequency is equal to the Lamour precession frequency.

4 Show that Bloch function helps to determine the relaxation time in NMR spectroscopy

5. Discuss Hall coefficient and its importance?
6. Explain what is meant by Voltage variable resistance (VVR) and how an FET can be used in this mode. Give one applciation.
7. Describe how an OPAMP can be used as a unity given buffer circuit Explain its characteristics and use
8. Show that the .Eigen values of a Hermitian matrix are real and the eigen functions are orthogonal.
9. Write down the generating function of Legendre polynomials Derive a recurrence relation there form. Also obtain the value of $P_n(-1)$.
10. Explain neutrino helicity and its role in parity violation in beta decay.
12. What is spin orbit interaction ? Obtaine an expression for the same.
13 Explain the H-R diagram
14 Discuss the principle of least action and its importance.

15.Express $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ in terms of Pauli spin matrices