Model Question Paper-I with effect from 2022-23 (CBCS Scheme)

USN | | | | | | | | | | |

First/Second Semester B.E. Degree Examination

Applied Physics for Computer Science Stream

TIME: 03 Hours **Max. Marks: 100**

Note: 01. Answer any **FIVE** full questions, choosing at least **ONE** question from each **MODULE.**
02. Draw neat sketches where ever necessary.
03. **Constants :** Speed of Light 'c' = 3×10^8 ms^{-1}, Boltzmann Constant 'k' = 1.38×10^{-23} JK^{-1}, Planck's Constant 'h' = 6.625×10^{-34} Js, Acceleration due to gravity 'g'= 9.8 ms^{-2}, Permittivity of free space 'ε_0'=8.854×10^{-12} F m^{-1}.

		Module -1	***Bloom's Taxonomy Level**	**Marks**
Q.01	a	Define LASER and Discuss the interaction of radiation with matter.	L2	7
	b	Define Acceptance angle and Numerical Aperture and hence derive an expression for NA in terms of RIs core, cladding and surrounding.	L2	8
	c	A LASER source has a power output of 10^{-3} W. Calculate the number of photons emitted per second given the wavelength of LASER 692.8 nanometer.	L3	5
		OR		
Q.02	a	Illustrate the construction and working of Semiconductor LASER with a neat sketch and energy level diagram also mention its applications.	L2	9
	b	Discuss the types of optical fibers based on Modes of Propagation and RI profile.	L2	6
	c	Obtain the attenuation co-efficient of the given fiber of length 1500 m given the input and output power 100 mW and 70 mW.	L3	5
		Module-2		
Q.03	a	Setup SchrÖdinger time independent wave equation in one dimension.	L2	8
	b	State and Explain Heisenberg's Uncertainty principle and Principle of Complementarity.	L2	7
	c	An electron is kinetic energy 500 keV is in vacuum. Calculate the group velocity and de Broglie wavelength assuming the mass of the moving electron is equal to the rest mass of electron.	L3	5
		OR		
Q.04	a	Discuss the motion of a quantum particle in a one-dimensional infinite potential well of width 'a' and also obtain the eigen functions and energy eigen states.	L2	10
	b	Explain the physical significance of the Wave Function.	L2	5
	c	The speed of electron is measured to with in an uncertainty of 2×10^4 ms^{-1} in one dimension. What is the minimum width required by the electron to be confined in an atom?	L3	5
		Module-3		
Q.05	a	Define a bit and qbit and explain the properties of qubit.	L2	6
	b	Discuss the CNOT gate and its operation on four different input states.	L2	6
	c	A Linear Operator 'X' operates such that X $\|0\rangle = \|1\rangle$ and X $\|1\rangle = \|0\rangle$. Find the matrix representation of 'X'.	L3	8
		OR		
Q.06	a	State the Pauli matrices and apply Pauli matrices on the states $\|0\rangle$ and $\|1\rangle$.	L2	8
	b	Elucidate the differences between classical and quantum computing.	L2	6

	c	Describe the working of controlled-Z gate mentioning its matrix representation and truth-table.	L3	6
		Module-4		
Q.07	a	Define Fermi Factor and Discuss the variation of Fermi factor with temperature and energy.	L2	7
	b	Explain DC and AC Josephson effects and mention the applications of superconductivity in quantum computing.	L2	8
	c	Calculate the probability of occupation of an energy level 0.2 eV above fermi level at temperature 27°C.	L3	5
		OR		
Q.08	a	Describe Meissner's Effect and hence classify superconductors into Soft and Hard superconductors using M-H graphs.	L2	9
	b	Enumerate the assumptions of Quantum free Electron Theory of Metals	L2	6
	c	Lead has superconducting transition temperature of 7.26 K. If the initial field at 0K is 50×10^3 Am^{-1} Calculate the critical field at 6k.	L3	5
		Module-5		
Q.09	a	Discuss timing in Linear motion, Uniform motion, slow in and slow out.	L2	8
	b	Distinguish between descriptive and inferential statistics.	L2	6
	c	Illustrate the odd rule and odd rule multipliers with a suitable example.	L3	6
		OR		
Q.10	a	Describe Jumping and parts of jump.	L2	8
	b	Discuss the salient features of Normal distribution using bell curves.	L2	7
	c	The number of particles emitted per second by a random radioactive source has a Poisson's distribution with $\lambda = 4$. Calculate the probability of $P(X = 0)$ and $P(X = 1)$.	L3	5

*Bloom's Taxonomy Level: Indicate as L1, L2, L3, L4, etc. It is also desirable to indicate the COs and POs to be attained by every bit of questions.

MODEL PAPER - 1

MODULE - 1

1 a). definition and interaction of radiation with matter (in PDF)

b). definition of acceptance angle and numerical aperture and derive expression for acceptance angle and numerical aperture (in PDF)

c) Given

$P = 10^{-3}$ W $\quad h = 6.624 \times 10^{-34}$

$\lambda = 692.8$ nm $= 692.8 \times 10^{-9}$ $\quad C = 3 \times 10^{8}$

$t = 1$ sec

$n = ?$

$$P = \frac{nhc}{\lambda t}$$

$$n = \frac{P\lambda t}{hc}$$

$$= \frac{10^{-3} \times 692.8 \times 10^{-9} \times 1}{6.624 \times 10^{-34} \times 3 \times 10^{8}}$$

$$= \frac{6.928 \times 10^{-10}}{1.9872 \times 10^{-25}}$$

$$\boxed{n = 3.4863 \times 10^{15}}$$

2 a) Semiconductor Laser (in PDF)

b) Types of optical fiber → Single mode
→ Multimode → Step index
→ Graded index

(in PDF)

c) Given

$L = 1500$ m $= 1.5$ km $\quad P_{in} = 100$ mW $\quad P_{out} = 70$ mW

$\alpha = ?$

$$\alpha = \frac{-10}{L} \log_{10}\left(\frac{P_{out}}{P_{in}}\right)$$

$$= \frac{-10}{1.5} \log_{10}\left(\frac{70}{100}\right)$$

$$= \frac{-10}{1.5} \log_{10}(0.7)$$

$$= -6.66(-0.1549)$$

$$\boxed{\alpha = 1.0316 \text{ dB/km}}$$

MODULE - 2

3 a) Schrodinger 1-D time independent wave equatio
(in PDF)

b) Heisenberg's Uncertainity principle &
Principle of Complementarity
(in PDF)

3 c) E = Given

$E = 500\ keV = 500 \times 1.6 \times 10^{-19} = 8 \times 10^{-17}\ J$

$\lambda = ?$ $e = 9.1 \times 10^{-31}$

$V_g = ?$ $h = 6.62 \times 10^{-34}$

$$\lambda = \frac{h}{\sqrt{2mE}}$$

$$= \frac{6.62 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 8 \times 10^{-17}}}$$

$$= \frac{6.62 \times 10^{-34}}{\sqrt{1.456 \times 10^{-46}}}$$

$$= \frac{6.62 \times 10^{-34}}{1.206 \times 10^{-23}}$$

$$= 5.489 \times 10^{-11}$$

$\lambda = 0.548\ A^{o}$

How to find group velocity idk!

4a) Particle in 1-D potential well (in PDF)
+ eigen function & eigen state

b) Physical significance of wave function (in PDF)

c) Given

$\Delta V = 2 \times 10^{4}$ m/s

$m = 9.11 \times 10^{-31}$ kg

$h = 6.62 \times 10^{-34}$ J

$\Delta x = ?$

$\Delta p = m \Delta V$

$= 9.11 \times 10^{-31} \times 2 \times 10^{4}$

$= 1.822 \times 10^{-26}$ kg m/s

$$\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$$

$$\Delta x = \frac{h}{4\pi \Delta p}$$

$$= \frac{6.62 \times 10^{-34}}{4 \times 3.14 \times 1.822 \times 10^{-26}}$$

$$= \frac{6.62 \times 10^{-34}}{2.28 \times 10^{-25}}$$

$= 2.903 \times 10^{-9}$ m $\boxed{\Delta x = 2.903 \text{ nm}}$

5 a) Define bit & qubit + properties of qubit (in PDF)

b) CNOT gate and operation (in PDF)

c) We know that

$$|0\rangle = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

$$|1\rangle = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

Let us consider X as

$$X = \begin{bmatrix} x_{11} & x_{12} \\ x_{21} & x_{22} \end{bmatrix}$$

$$X|0\rangle = |1\rangle$$

$$\begin{bmatrix} x_{11} & x_{12} \\ x_{21} & x_{22} \end{bmatrix} \begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} x_{11} + 0 \\ x_{21} + 0 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

on comparing

$x_{11} = 0$ and $x_{21} = 1$

Similarly

$$X|1\rangle = |0\rangle$$

$$\begin{bmatrix} x_{11} & x_{12} \\ x_{21} & x_{22} \end{bmatrix} \begin{bmatrix} 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

(in PDF)

$$\begin{bmatrix} 0 + x_{12} \\ 0 + x_{22} \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

On comparing we get

$x_{12} = 1$ and $x_{22} = 0$

$$\therefore X = \begin{bmatrix} x_{11} & x_{12} \\ x_{21} & x_{22} \end{bmatrix}$$

$$X = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

6 a) Pauli matrices all three (in PDF)

b) Difference b/w classical and quantum computing (in PDF)

c) Controlled 2-gate (in PDF)

MODULE - 4

7a) Fermi factor + variation of fermi factor (in PDF)

b) AC and DC Josephson's effect + application of superconductivit (in PDF)

c) Given

$E = 0.2\,eV = 0.2 \times 1.6 \times 10^{-19}\,J = 3.2 \times 10^{-20}$

$T = 27^\circ C = 300\,K$

$k = 1.38 \times 10^{-23}$

$f(E) = ?$

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

$$= \frac{1}{e^{\left(\frac{3.2 \times 10^{-20}}{1.38 \times 10^{-23} \times 300}\right)} + 1} = \frac{1}{e^{7.7294} + 1} = \frac{1}{2274.237 + 1} = 4.395 \times 10^{-4}$$

$= 0.0004395$

8 a) Meissner's Effect + Types of superconductors with graph (in PDF)

b) Assumptions of quantum free Electron Theory - (in PDF)

c) Given

$H_c(0) = 50 \times 10^3 \ Am^{-1}$

$T = 7.26 \ K$

$T_c = 6 K$

$H_c = ?$

$$H_c = H_c(0)\left[1 - \left(\frac{T}{T_c}\right)^2\right]$$

$$= 50 \times 10^3 \left[1 - \left(\frac{7.26}{6}\right)^2\right]$$

$$= 50 \times 10^3 \left[1 - (1.21)^2\right]$$

$$= 50 \times 10^3 \left[1 - 1.461\right]$$

$$= 50 \times 10^3 \left[-0.461\right]$$

$$H_c = -23.05 \times 10^3 \ A/m$$

MODULE - 5

9 a) timing in linear motion, uniform motion, slow in & slow out (in PDF)

b)

	Descriptive Statistics	Inferential Statistics
1	It gives information about raw data which describes the data is some manner	It makes inferences about the population using data drawn from the population
2	It helps in organising, analysing and to present data in a meaningful manner	It allows to compare data and make hypothesis and predictions
3	It is used to describe a situation	It is used to explain the chance of occurrence of an event

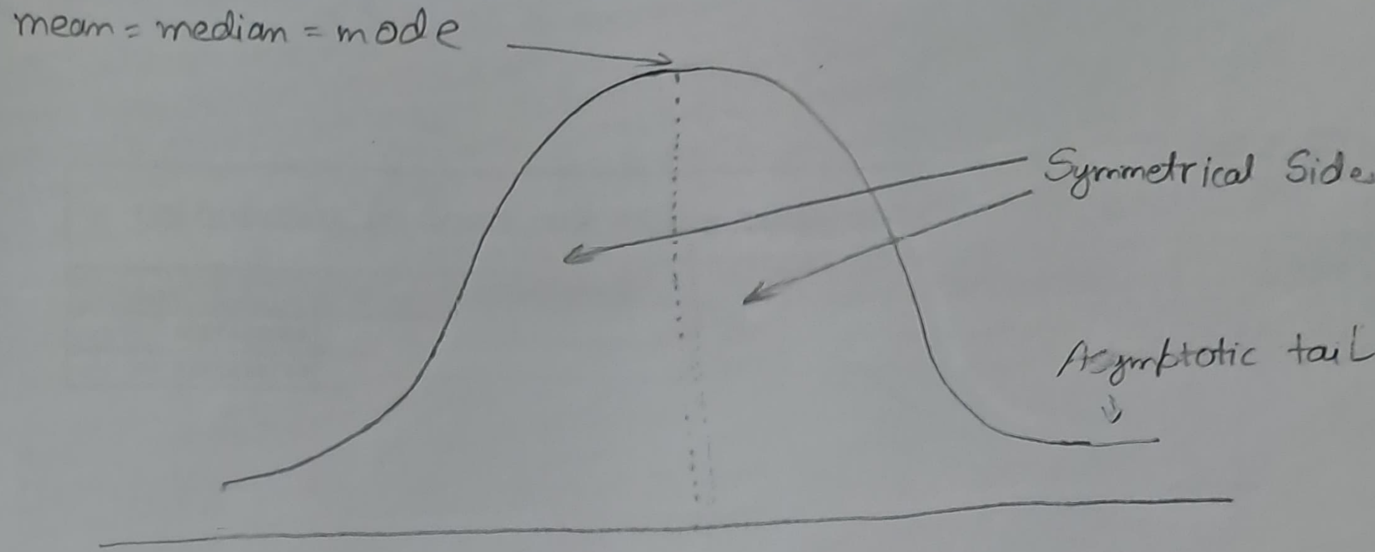
4	It explains already known data and is limited to a sample of population having a small size	It attempts to reach the conclusion about the population
5	It can be achieved with the help of charts, graphs, tables, etc	It can be achieved by probability

c) Odd rule + odd rule multiplier with example (in PDF)

10 a) Jumping and parts of jump (in PDF)

b) The salient features of Normal distribution using bell curves are

- The arithmetic mean (average) is always is the centre of a bell curve or normal curve.
- A bell curve / Gaussian distribution has only one mode, or peak. Mode here means 'peak', a curve with one peak is unimodal; two peaks is bimodal; and so on.
- A bell curve has predictable standard deviations that follow the 68 95 99.7 rule
- A bell curve is symmetric. Exactly half of data points are to the left of the mean and exactly half are to the right of the mean.



c)

Poisson's distribution
idk...!