UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2017

Program: :	**M.Tech (Nuclear Science and Technology)**	**Semester : I**
Subject (Course):	**Quantum Mechanics & Electrodynamics**	**Max. Marks : 100**
Course Code:	**NSAT 7002**	**Duration : 3 Hrs**
No. of page/s: 2		

SECTION - A

Answer all questions (Each question carries 5 marks)

1) In the following, choose the correct alternative:

a) Heisenberg Uncertainty principle asserts that
   (i) $\Delta p . \Delta x = \hbar$
   (ii) $\Delta p . \Delta x \geq \hbar$
   (iii) $\Delta p . \Delta x \geq h$
   (iv) $\Delta p . \Delta x \leq \hbar$

b) Classical physics could not explain the behavior of a black body radiator at very short wavelengths. What was this problem called?
   (i) Absorption failure
   (ii) Ultraviolet catastrophe/explosion
   (iii) Wavelength decrease
   (iv) Photoelectric effect

c) How does the momentum of a photon change if the wavelength is doubled?
   (i) Doubles
   (ii) Quadruples
   (iii) Halves
   (iv) Becomes one fourth

d) When an electron falls from an orbit where n = 2 to n = 1:
   (i) Atomic energy increases
   (ii) No change in atomic energy
   (iii) A photon is released
   (iv) A photon is absorbed

e) The direction of the gradient of a field is along
   (i) Decreasing potential
   (ii) Same potential
   (iii) Increasing potential
   (iv) Zero potential

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2) Give the physical significance of determination of ***divergence, gradient*** and ***curl*** of functions.

3) Differentiate between ***dipole moment***, and ***polarization***.

4) Give the De-Broglie hypothesis. Give also one practical ***benefit*** obtained from it.

SECTION - B

Answer all questions (Each question carries 10 marks)

5) Explain the terms: a) Electric field intensity, b) Electric flux density, c) Adjoint of an operator, d) Normalization of a wave function, and e) Hermitian operator.

6) Define ***scalar*** and ***vector*** potentials for electromagnetic fields, and explain how their introduction helps in the solution of the ***Maxwell's equations***.

7) Evaluate the following:

   a) The average period that elapses between the excitation of an atom and the time it emits radiations is 10^{-8} secs. Find the uncertainty in the energy emitted. [4]
   b) For Normalized wave function $\psi = ax$, find the following expectation values:
      i) $\langle x \rangle$, and ii. $\langle x^2 \rangle$. [2 x 3]

8) Define, using different mathematical relations and conditions, a ***complex vector space***, and its ***subspace***.

Or

Explain ***inner product, norm and metric*** w.r.to vector space. What type of vector space is considered for Quantum Mechanics?

SECTION - C

Answer both the questions (Each question carries 20 marks)

9) Solve the one-dimensional 'particle in a box' problem. Show that the Eigen value spectrum is discrete. Obtain the normalized wave functions for the solutions obtained. [10+4+6]

10 a) What are Maxwell's equations? Give them for air/vacuum in the integral form. Interpret them in detail.
   [4+4+8]
   b) Describe the motion of a charged particle in an uniform and static magnetic field. [4]

Or

Solve the one-dimensional harmonic oscillator problem, and give the Eigen values of the Hamiltonian. Hence, show that its zero point energy is not zero. Show/plot some sample wave functions for the solutions obtained.
[10+4+2+4]

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