# UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

**END SEMESTER EXAMINATION**
**DECEMBER 2021**

**Course:** **QUANTUM MECHANICS I** **Semester: I**
**Course Code: PHYS 7003**
**Programme: MSc PHYSICS** **Max. Marks: 100**
**Instructions:** Read the section headings carefully for Sections A, B and C **Total pages : 02**

## SECTION A

**(Scan and upload)** **(5Qx 4M = 20 Marks)**

| | | |
|---|---|---|
| Q1 | With respect to the classic Black Body radiation problem, match the laws and their descriptions:<br><br>i. Rayleigh-Jeans — a. Complete<br>ii. Wien's displacement — b. Fourth power<br>iii. Planck — c. low frequencies<br>iv. Stefan-Boltzmann — d. $\lambda_{max}$ T constant | CO1 |
| Q2 | Photons of energy 5.0 x $10^{-19}$ J are determined to be the cause of transitions observed in a spectrum. The frequency and wavelength of such photons are ……. and ……... respectively. ( Given h = 6.626 x $10^{-34}$ Js). | CO1 |
| Q3 | What is Compton effect? | CO1 |
| Q4 | What are Eigen functions and Eigen values? | CO2 |
| Q5 | Light of wavelength 3500 Å is incident on two metals A and B. What would be the maximum kinetic energies of the emitted electrons if the work functions are 5 eV and 2 eV respectively? | CO1 |

## SECTION B

**(Scan and upload)** **(4Q x 10M = 40 Marks)**

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|---|---|---|
| Q6 | Considering the concepts of potential well and potential barrier, and applying appropriate quantum mechanical equations explain the exotic phenomenon of Quantum Tunneling. Is Quantum tunneling real and practically achievable? [8+2] | CO3 |
| Q7 | The values for observables/measurable in Quantum Physics are obtained quite differently from as obtained in Classical Physics. Elaborate on this difference in theoretical calculations using the concept of wave equation, wave function, expectation value and operators.<br><br>OR | CO2 |

| | | |
|---|---|---|
| | Write a short note on angular momentum in Quantum Physics. | |
| Q8 | The 'Stern-Gerlach' experiment has a special significance in Quantum Physics. Recollect the experiment and describe in your own words the experiment and its significance in detail. [5+5] | CO1 |
| Q9 | Apply the concepts of Quantum Physics and solve the 'problem' of Simple Harmonic Oscillator (SHO). How, to you, do the quantum and classical solutions compare? [8+2] | CO3 |
| **Section C**<br>**(Scan and upload)** **(2Q x 20M = 40 Marks)** | | |
| Q10 | State the Schrodinger's Time Independent Equation (TISE). Consider a particle in a 1 dimensional box. Apply the appropriate Schrodinger's equation and physical conditions, and arrive at the expression for the wave function and the energy levels of this particle in box. [3+17]<br><br>OR<br><br>Write down the Schrodinger equation for hydrogen atom, and using appropriate physical conditions solve it. List the quantum numbers involved and interpret the solutions in your own language. [3+10+7] | CO3 |
| Q11 | Explain the concept and construct of a Vector Space. Giving the required conditions build the Hilbert Space. [10+10] | CO2 |