647510 **BSCmcmCC5010** **Seat No :_____**

B.Sc. Semester - 5 (*CBCS*) Examination

Oct/Nov. – 2019

MATHEMATICAL PHYSICS CLASSICAL MECHANICS AND QUANTUM MECHANIC (CORE)

Time: 2:30 Hours **Marks: 70**

Instructions:

1. All questions are compulsory.
2. Figures to the right indicate marks.

1(a) Answer the following question (any one). **(7)**

(1) Obtain the Fourier series for a Full-wave rectifier function .

(2) Derive the formulas of Fourier coefficients a_0, a_n and b_n, using the orthogonal relations of sine and cosine function .

1(b) Answer the following question (any one). **(4)**

(1) State and prove Parseval's theorem in the form of Fourier coefficients a_0, a_n and b_n.

(2) Write and briefly explain the Dirichlet's conditions .

1(c) Answer the following question (any three). **(3)**

(1) If f(x) is an even function, then which type of series does it represent ? Whether sine or cosine series ?

(2) Write the Fourier sine and cosine integrals, for a function f(x) .

(3) Define Dirac delta function , in one dimension .

(4) Write complex form of Fourier series .

(5) Mention any three physical applications of Fourier series analysis .

2(a) Answer the following question (any one). **(7)**

(1) Deduce the Lagrange's equations of motion for conservative system from D'Alembert's principle .

(2) Derive the Hamilton's principle from D'Alembert's principle . Obtain the Newton's second law of motion from Hamilton's principle .

2(b) Answer the following question (any one). **(4)**

(1) Obtain the equations of motion of a spherical pendulum , using Lagrange's equations of motion .

(2) What are constraints ? Discuss the classification of constraints by four different ways.

2(c) Answer the following question (any three). **(3)**

(1) What are the degrees of freedom ?

(2) Write D'Alembert's principle .

(3) Give the expression of Hamilton's variational principle.

(4) Write Euler-Lagrange differential equations.

(5) Are the dimensions of generalised velocity , necessarily the dimensions of linear or angular velocity ?

3(a) Answer the following question (any one). **(7)**

(1) Obtain Hamilton's canonical equations of motion. Discuss the physical significance of Hamiltonian H .

(2) Explain Lagrange's method of undetermined multipliers.
Solve the problem of simple pendulum using Lagrange's multiplier method.

3(b) Answer the following question (any one). **(4)**

(1) Apply Hamilton's equations of motion to obtain equation of motion of compound pendulum .

(2) Explain : If the Lagrangian of a system is invariant with respect to translation in a certain direction , then the linear momentum of the system in that direction is constant in time .

3(c) Answer the following question. (any three). **(3)**

(1) What is a cyclic co-ordinate ?

(2) Mention the advantages of Lagrange's equations over Newton's equations of motion (any two) .

(3) If a co-ordinate is cyclic , than it would reduce the number of variables by which value , in Hamiltonian formulation ?

(4) Write the Hamitonian (H) of the system .

(5) Under which conditions , the Hamiltonian H is equal to total energy E of the system ?

4(a) Answer the following question (any one). **(7)**

(1) Describe the proof of uncertainty principle .

(2) What is Compton effect ? Deduce the expression for the Compton shift .

4(b) Answer the following question (any one). **(4)**

(1) Define Commutator. Give three illustrations of commutation relations .

(2) Explain normalization of the wave functions .

4(c) Answer the following questions.(any three). **(3)**

(1) Define operator .

(2) Write one-dimensional time dependent Schrodinger equation for a free paricle .

(3) Write the orthogonality condition .

(4) On which factors do the photo-electric current depends ?

(5) Mention the normalization condition .

5(a) Answer the following question (any one). **(7)**

(1) Write the Hermite's differential equation .Obtain the solution of Hermite's differential equation .

(2) Derive the expression of energy for hydrogen like atom .

5(b) Answer the following question (any one). **(4)**

(1) Obtain Schrodinger wave equation for the oscillator .

(2) Explain : (a) The number operator . (b) The density operator .

5(c) Answer the following question (any three). **(3)**

(1) Define : Ket vectors .

(2) Define : Null operator .

(3) Give the symbol of bra vector .

(4) What is the Hamiltonian for a linear harmonic oscillator ?

(5) Mention any one property of a linear operator .

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