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1M2M20097 (Pages : 2) Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Second Semester M.Sc Degree Examination, March/April 2020

MPH2C08 – Computational Physics

(2019 Admission onwards)

Time: 3 hours Max. Weightage : 30

Section A

(Answer all questions. Each carries one weightage)

1. Explain the syntax, structure and operation of the looping constructs in Python.
2. Discuss various ways of creating an n-d array object using Numpy library.
3. Given a set of (x_i,y_i) values, explain how Newton's forward and backward difference tables are constructed.
4. Give the algorithm for implementing simple integration by Monte Carlo method.
5. Explain clearly how the next point on the solution curve is arrived at from the previous point, while solving first order differential equation using RK4 method.
6. Write a short note on Numerov method.
7. Explain how velocity 'v' of a damped simple harmonic oscillator at position 'x' is formulated using Feynmann-Newton method. Assume the oscillator at equilibrium position at $t = 0$.
8. Describe how an approximate value of π is arrived at using Monte Carlo method.

(8 x 1 = 8 weightage)

Section B

(Answer any two questions. Each carries five weightage)

9. What does the Bessel function represent? Formulate Bessel function of the first kind of order n. Using relevant functions from the Matplotlib library, develop a Python program for plotting the function for $n = 2$.
10. Obtain the general form of Newton-Cotes quadrature formula representing the integral of function f(x) within the limits x_0 and x_n. Deduce Simpson's 1/3 rule to represent the integral.
11. a). Explain how Fourier transform help to analyse a system described by a aperiodic function.

    b). Write short notes on DFT and FFT.
12. Write down one dimensional Schrodinger equation. Explain the theory and arrive at the numerical solution to obtain eigen values.

(2 x 5 = 10 weightage)

Section C

(Answer any four questions. Each carries three weightage)

13. Write a Python script to evaluate the series

    $\log(1 + x) = x - x^2/2 + x^3/3 - x^4/4 + \text{-----} \pm x^n/n$, given the values of 'x' and 'n'.

14. What is plot() function used for? Give its syntax and describe any four Line 2D properties as keyword arguments.

15. Give the theory for fitting an exponential curve from a given set of (x_i, y_i) data using least square fit method.

16. Using Euler's method find the approximate value of yfor $x = 0.5$; given that $dy/dx = x^2 - x$ and $y(0) = 0$.

17. Formulate the decay process of a radioactive material and simulate using a suitable Python program.

18. A body is projected horizontally from a height 'h' in the earth's gravitational field. Code a program in Python to find the time required for a vertical displacement oh h/2.

19. Write a Python program to find the adjoint of a square matrix. Use relevant functions from Numpy.

(4 x 3 = 12 weightage)

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FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Second Semester M.Sc Degree Examination, March/April 2020

MPH2C07 – Statistical Mechanics

(2019 Admission onwards)

Time: 3 hours Max. Weightage : 30

Section A
(Answer all questions, each carries weightage 1)

1. What do you mean by macroscopic and microscopic states?
2. Define the term "equal a priori probability".
3. State and explain the Equi-partition theorem.
4. Write an expression for grand partition function and explain the terms.
5. Define the density matrix in quantum statistics.
6. Differentiate between Bose Einstein Condensation and ordinary condensation.
7. What is Stefan Boltzmann law?
8. Give the expression for specific heat of electron gas in a metal.

(8x1=8weightage)

Section B
(Answer ANY TWO questions, each carries weightage 5)

9. Explain Gibb's paradox using the idea of entropy of mixing. How is the paradox resolved? Will there be Gibbs paradox if we use quantum statistics for ideal gas?
10. Obtain thermodynamics of classical ideal gas considering the system as the member of microcanonical ensemble.
11. Explain the thermodynamic behaviour of an ideal Bose gas.
12. Discuss in detail about Pauli's paramagnetism.

(2x5=10 weightage)

Section C

(Answer ANY FOUR questions, each carries weightage 3)

13. Show that in canonical ensemble formulation, internal energy of the system is $\frac{\partial(A\beta)}{\partial\beta}$ where A is the Helmholtz free energy.
14. Average energy of a harmonic oscillator is E=(n+1/2)h ω /2π where n=0,1,2,3....Find the partition function of the oscillator.
15. Determine the energy fluctuation in canonical ensemble.
16. A system has 2 particles, each of which can be in any one of 3 quantum states of energies 0, E and 3E. System is in contact with a heat reservoir at T. Find the partition functions if the particles obey 1)BE statistics and 2) FD statistics.
17. Prove that expectation value of a physical quantity G is $\frac{Tr(\rho G)}{Tr(G)}$.
18. Find C_v of a monoatomic ideal gas using equipartition theorem.
19. Prove that the phase space area equivalent to one Eigen state of a linear harmonic oscillator is h.

(4x3=12weightage)

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Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Second Semester M.Sc Degree Examination, March/April 2020

MPH2C06 – Mathematical Physics - II

(2019 Admission onwards)

Time: 3 hours Max. Weightage : 30

Section A
(Answer all questions, each carries weightage 1)

1. Develop the Taylor series expansion of $\ln(1+z)$.
2. Obtain the conditions for a function of a complex variable to be analytic.
3. If every element of a group is its own inverse, then show that the group is abelian.
4. Show that $(ab)^{-1} = b^{-1}a^{-1}$,where a and b are elements of a group G.
5. Find the Euler equation, if the function in the action integral $f(y, y_x, x) = f_1(x, y) + f_2(x, y)y_x$,where $y_x = \frac{dy}{dx}$.
6. Distinguish between Voterra's equations of I and II kind.
7. Obrain the minimum value of $3x^2 + 8y^2 + 3z^2 + 4xy + 4yz$ on the surface of the spheroid $x^2 + 4y^2 + z^2 = 1$.
8. Show that the Green function is symmetric about its variables.

(8 X 1 = 8 weightage)

Section B
Answer ANY TWO questions, each carries weightage 5)

9. Obtain the formula for Lorentz expansion of a function of complex variable.
10. What are factor groups. Explain with an example.
11. Obtain the Green's function corresponding to the differential equation $y''(x) + y(x) = 0$ with the boundary conditions $y(0) = 1$ and $y'(1) = 0$
12. Solve $\phi(x) = x + \frac{1}{2}\int_{-1}^{+1}(t + x)\,\phi(t)dt$ by the separable kernel method.

(2 x 5 = 10 weightage)

Section C

Answer ANY FOUR questions, each carries weightage 3)

13. Obtain the Cauchy's Integral formula.
14. Evaluate $\int_C z^n dz$ where C is a circle of radius r in the complex plane.
15. Show that the identity element of a group is unique.
16. A flexible cable, of fixed length, is suspended from two fixed points on a horizontal ceiling. Find the curve that will minimize the total gravitational potential of the cable.
17. Find the approximate solution y(x) which satisfies the differential equation $y'' + \left(\frac{\pi}{2}\right)^2 = 0$ with the boundary conditions $y(0) = 1, y(1) = 0.$, taking $y = 1 - x^3$ as trial function.
18. Show that $\int_a^x \int_a^u f(t)dtdu = \int_a^x (x - t) f(t)dt.$
19. Obtain the eigen function expansion of Green's function.

(4 x 3 = 12 weightage

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FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Second Semester MSc Degree Examination, March/April 2020

MPH2C05 – Quantum Mechanics – I

(2019 Admission onwards)

Time: 3 hours Max. Weightage : 30

Section A

Answer all questions, each carry weightage 1

1. What are the advantages of Dirac ket-bra notation.
2. Write a short note on general uncertainty product.
3. Discuss the *Ehrenfest theorem.*
4. Compare between the Quantum mechanical results of free particles and bounded particles.
5. Give the algebra obeyed by Pauli spin matrices.
6. What are spherical harmonics.
7. Explain the *principle of indistinguishability of identical particles.*
8. Establish the correlation between Pauli exclusion principle and Slater determinant.

(Total weightage $8 \times 1 = 8$)

Section B

Answer any two *questions, each carry weightage 5*

9. Describe the sequential Stern-Gerlach experiment and compare it with polarisation of light. What are the consequences of these experiments.
10. Find the energy eigen kets and energy eigen values for simple harmonic oscillator using the Dirac's abstract operator method.
11. Discuss the general theory of angular momentum and find the eigen values of J^2 and J_z. Determine the matrix elements of angular momentum operators.

12. Solve the Schrodinger equation for central potentials and find the energy eigen values of Hydrogen atom.

(Total weightage $2 \times 5 = 10$)

Section C

Answer any four *questions, each carry weightage 3*

13. State and prove Cauchy-Schwarz inequality.

14. Diagonalise the following matrix and find the normalized eigen vectors and the corresponding eigen values.

$$\frac{1}{\sqrt{2}}\begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$$

15. The Hamiltonian for a 1-D particle is given by $H = \frac{p^2}{2m} + V(x)$. Calculate $[[H, x], x]$ and show that

$$\sum_{a'} |\langle a''|x|a'\rangle|^2 (E_{a'} - E_{a''}) = \frac{\hbar^2}{2m}$$

where $|a'\rangle$ and $|a''\rangle$ are the energy eigenkets with eigen values $E_{a'}$ and $E_{a''}$ respectively.

16. For a 1-D simple harmonic oscillator, show that

$$\langle 0|e^{ikx}|0\rangle = e^{-\frac{k^2}{2}\left[\langle 0|x^2|0\rangle\right]}$$

where x is the position *operator*.

17. Using Pauli spin matrices, find the eigenvalues for the Hamiltonian,

$$H = -\frac{2\mu}{\hbar}\vec{S} \cdot \vec{B}$$

for a spin 1/2 particle in the presence of a magnetic field $\vec{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$

18. Show that $[\vec{L}, \vec{p}^{\,2}] = [\vec{L}, \vec{x}^{\,2}] = [\vec{L}, H] = [\vec{L}^2, H] = 0$ for central potentials.

19. Evaluate the clebsch-gordon coefficients for 2 spin half particles.

(Total weightage $4 \times 3 = 12$)