

MASTER OF SCIENCE (PHYSICS)

PHM-6111

MATHEMATICAL PHYSICS-I

CENTRE FOR DISTANCE
AND ONLINE EDUCATION



मङ्गलायतन
विश्वविद्यालय
॥ विवेकं ज्ञाने प्रीतिरिचयम् ॥

**MANGALAYATAN
UNIVERSITY**
— ALIGARH —

Learn Today to Lead Tomorrow

Anurag Shukla

Director

Centre for Distance and Online Education
Mangalayatan University, Beswan, Aligarh-202146 (U.P.)

Registrar
Mangalayatan University
Beswan, Aligarh

M.Sc. PHYSICS

PROGRAMME DESIGN COMMITTEE

Prof. Dinesh Kumar Sharma,
Institute of Applied Sciences
Mangalayatan University, Aligarh

Prof. Abdul Wadood Siddiqui
School of Pharmacy
Mangalayatan University, Aligarh

Prof. Rajeev Sharma
Dean Academics
Mangalayatan University, Aligarh

Prof. Anurag Shakya
Director, CDOE – Chairman
Mangalayatan University, Aligarh

Prof. Ravi Kant
Institute of Applied Sciences
Mangalayatan University, Aligarh

Prof. Ankur Kumar Agarwal
Institute of Business Management & Commerce
Mangalayatan University, Aligarh

Prof. Y P Singh
Institute of Applied Sciences
Mangalayatan University, Aligarh

Prof. Keshav Deo Verma
Head Department of Physics
Shri Prof. Keshav Deo Verma
Varshney (PG) College, Aligarh

Prof. Bhanu Prakash Singh
(Ex-Chairperson)
Department of Physics,
Aligarh Muslim University, Aligarh

Prof. Khushvant Singh
Head Department of Physics
BSA College, Mathura

Prof. Rakesh Sharma
Institute of Biomedical Education & Research
Mangalayatan University, Aligarh

Prof. CRK Murthy
IGNOU, New Delhi

Prof. Mohd Nafees Ahmed Ansari
Aligarh Muslim University, Aligarh

Prof. Vikas Chadha
Senior Vice President
HireEd, NOIDA

Dr. Rajesh Kumar Upadhyay
Director-CIQA
Mangalayatan University, Aligarh

Dr. Ashok Kumar Upadhyay
Faculty of Arts
Mangalayatan University, Aligarh

Dr. Deepshikha Saxena
Department of Arts
Mangalayatan University, Aligarh

Dr. Santosh Gautam
Department of Journalism & Mass Communication
Mangalayatan University, Aligarh

Dr. Manisha Sharma
Institute of Applied Sciences
Mangalayatan University, Aligarh

Dr. Swati Agarwal
Institute of Applied Sciences
Mangalayatan University, Aligarh

Mr. Love Mittal
Institute of Computer Science
Mangalayatan University, Aligarh

Dr. Soni Singh
Institute of Biomedical Education & Research
Mangalayatan University, Aligarh

COURSE WRITERS

Prof. Y P Singh
Institute of Applied Science
Mangalayatan University, Aligarh
PHM-6112
Classical Mechanics

Dr. Pooja Mishra
Centre for Distance and Online Education
Mangalayatan University, Aligarh
PHM-6113,
Quantum Mechanics-I,
PHM-6114
Classical Electrodynamics

Dr. Mohd. Zubair
Centre for Distance and Online Education
Mangalayatan University, Aligarh
PHM-6111,
Mathematical Physics-I,
PHM-6151
Physics Lab-I

COURSE EDITORS

Prof. Y P Singh
Institute of Applied Science
Mangalayatan University, Aligarh

Prof. Subha Goghakle
Professor of Physics
IGNOU, New Delhi

Prof. Keshav Deo Verma
Head Department of Physics
Shri Prof. Keshav Deo Verma
Varshney (PG) College, Aligarh

Prof. Bhanu Prakash Singh
(Ex-Chairperson)
Department of Physics,
Aligarh Muslim University, Aligarh

Prof. Khushwant Singh
Head Department of Physics
BSA College, Mathura

FORMAT EDITORS

Dr. Poonam Gupta
Centre for Distance and Online Education
Mangalayatan University, Aligarh

Dr. Deepak Dhiman
Centre for Distance and Online Education
Mangalayatan University, Aligarh

Dr. Anup Kumar Manna
Centre for Distance and Online Education
Mangalayatan University, Aligarh

MATERIAL PRODUCTION

1. Dr. Ashok Kumar Upadhyay
2. Dr. Aasheesh Raizada
3. Dr. Deepmala
4. Ms. Rainu Verma
5. Mr. Ripudaman Singh
6. Mr. Rohit Kumar

Block-I: Theory of Functions of a Complex Variable

Unit-1: Fundamentals of Complex Analysis- Analyticity and Cauchy-Reimann Conditions, Cauchy's integral theorem and formula

Unit-2: Advanced Topics in Complex Analysis - Taylor's series and Laurent's series expansion, Zeros and singular points, Multi valued functions, Branch Points and Cuts

Unit-3: Exploring Complex Analysis- Riemann Sheets and surfaces, Residues, Cauchy's Residue theorem, Jordan's Lemma

Unit-4: Complex Integration- Evaluation of definite integrals, Principal Value, Bromwich contour integrals.

Block-II: Fourier Transform

Unit-5: Transforms- Fourier transform, Sine, Cosine and Complex transforms with examples, Definition, Properties and Representations of Dirac Delta Function

Unit-6: Analyzing Fourier Transforms- Properties of Fourier Transforms, Transforms of derivatives

Unit-7: Exploring Fourier Transforms- Parseval's Theorem, Convolution Theorem, Momentum representation, Applications to Partial differential equations,

Unit-8: Discrete Fourier Transform- Discrete Fourier transform, Introduction to Fast Fourier transform

Block-III: Laplace Transforms

Unit-9: Power of Laplace Transform- Laplace transform,

Unit-10: Laplace Transform- Properties and examples of Laplace Transform

Unit-11: Convolution Theorem- Convolution theorem and its applications,

Unit-12: Differential Equations with Laplace Transform Method- Laplace transform method of solving differential equations.

Block-IV: Green's Functions

Unit-13: Introduction to Green's function method, Green's function as a solution to Poisson's equation with a point source

Unit-14: symmetry of Green's function, forms of Green's functions, spherical polar coordinate expansion,

Unit-15: Quantum Mechanical Scattering- Neuman Series as well as Green's Function Solutions, Eigen function expansion,

Unit-16: One dimensional case, integral-differential equation, linear Harmonic oscillator, Green's function and Dirac delta function

CENTRE FOR DISTANCE AND ONLINE EDUCATION



MANGALAYATAN
UNIVERSITY
Learn Today to Lead Tomorrow

Extended NCR, 33rd Milestone, Aligarh-Mathura
Highway, Beswan, Aligarh, UP-202146



www.mangalayatan.in, www.mude.ac.in
cdoe@mangalayatan.edu.in

MASTER OF SCIENCE (PHYSICS)

PHM-6211

STATISTICAL MECHANICS

CENTRE FOR DISTANCE
AND ONLINE EDUCATION



**MANGALAYATAN
UNIVERSITY**
—ALIGARH—

Learn Today to **Lead Tomorrow**

M.Sc. PHYSICS

PROGRAMME DESIGN COMMITTEE

Prof. Dinesh Kumar Sharma,
Institute of Applied Sciences
Mangalayatan University, Aligarh

Prof. Abdul Wadood Siddiqui
School of Pharmacy
Mangalayatan University, Aligarh

Prof. Rajeev Sharma
Dean Academics
Mangalayatan University, Aligarh

Prof. Anurag Shakya
Director, CDOE – Chairman
Mangalayatan University, Aligarh

Prof. Ravi Kant
Institute of Applied Sciences
Mangalayatan University, Aligarh

Prof. Ankur Kumar Agarwal
Institute of Business Management & Commerce
Mangalayatan University, Aligarh

Prof. Y P Singh
Institute of Applied Sciences
Mangalayatan University, Aligarh

Prof. Keshav Deo Verma
Head Department of Physics
Shri Prof. Keshav Deo Verma
Varshney (PG) College, Aligarh

Prof. Bhanu Prakash Singh
(Ex-Chairperson)
Department of Physics,
Aligarh Muslim University, Aligarh

Prof. Khushvant Singh
Head Department of Physics
BSA College, Mathura

Prof. Rakesh Sharma
Institute of Biomedical Education & Research
Mangalayatan University, Aligarh

Prof. CRK Murthy
IGNOU, New Delhi

Prof. Mohd Nafees Ahmed Ansari
Aligarh Muslim University, Aligarh

Prof. Vikas Chadha
Senior Vice President
HireEd, NOIDA

Dr. Rajesh Kumar Upadhyay
Director-CIQA
Mangalayatan University, Aligarh

Dr. Ashok Kumar Upadhyay
Faculty of Arts
Mangalayatan University, Aligarh

Dr. Deepshikha Saxena
Department of Arts
Mangalayatan University, Aligarh

Dr. Santosh Gautam
Department of Journalism & Mass Communication
Mangalayatan University, Aligarh

Dr. Manisha Sharma
Institute of Applied Sciences
Mangalayatan University, Aligarh

Dr. Swati Agarwal
Institute of Applied Sciences
Mangalayatan University, Aligarh

Mr. Love Mittal
Institute of Computer Science
Mangalayatan University, Aligarh

Dr. Soni Singh
Institute of Biomedical Education & Research
Mangalayatan University, Aligarh

COURSE WRITERS

Dr. Pooja Mishra
Centre for Distance and Online Education
Mangalayatan University, Aligarh
PHM-6213
Nuclear and Particle Physics

Statistical Mechanics,
PHM-6212,
Electronics
PHM-6251,
Physics Lab-II

PHM-6214,
Computational Physics and
Programming,
PHM-6252
Computational Physics and
Programming Lab

Dr. Mohd. Zubair
Centre for Distance and Online Education
Mangalayatan University, Aligarh
PHM-6211,

Dr. Aasheesh Raizada
Centre for Distance and Online
Education
Mangalayatan University, Aligarh

COURSE EDITORS

Prof. Y P Singh
Institute of Applied Science
Mangalayatan University, Aligarh

Prof. Keshav Deo Verma
Head Department of Physics
Shri Prof. Keshav Deo Verma
Varshney (PG) College, Aligarh

Aligarh Muslim University, Aligarh

Prof. Subha Goghakle
Professor of Physics
IGNOU, New Delhi

Prof. Bhanu Prakash Singh
(Ex-Chairperson)
Department of Physics,

Prof. Khushvant Singh
Head Department of Physics
BSA College, Mathura

FORMAT EDITORS

Dr. Poonam Gupta
Centre for Distance and Online Education
Mangalayatan University, Aligarh

Dr. Deepak Dhiman
Centre for Distance and Online Education
Mangalayatan University, Aligarh

Dr. Anup Kumar Manna
Centre for Distance and Online Education
Mangalayatan University, Aligarh

MATERIAL PRODUCTION

- | | | |
|-----------------------------|--------------------|------------------------|
| 1. Dr. Ashok Kumar Upadhyay | 3. Dr. Deepmala | 5. Mr. Ripudaman Singh |
| 2. Dr. Aasheesh Raizada | 4. Ms. Rainu Verma | 6. Mr. Rohit Kumar |

Block I: Classical ensemble theory

Unit 1: Quantum Statistical Mechanics of Identical Particles- Quantum statistical mechanics of identical particles, Condition for statistical equilibrium,

Unit 2: Symmetry, Probability, and Quantum Ensembles- Symmetry of wave function, Postulate of equal a priori probability, Random Walk, Ensemble in quantum statistics,

Unit 3: Grand Canonical Ensemble & Quantum Distributions- Grand Canonical Ensemble, Partition function, Quantum distribution functions (Bose-Einstein and Fermi-Dirac),

Unit 4: Derivation via Grand Partition Function- Derivation of distribution laws using grand partition function.

Block II: Quantum ensemble theory

Unit 5: Phase Space, Liouville's Theorem, and Microcanonical Gas Theory- Phase space and Liouville's theorem, Micro canonical ensemble theory and its application to ideal gas of monatomic particles

Unit 6: Canonical Ensemble: Thermodynamics and Ideal Gas Dynamics- Canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations,

Unit 7: Gibbs Paradox, Sackur-Tetrode Equation, and Quantum Ensembles- Gibbs paradox and its solution, Sackur-Tetrode equation, a system of quantum harmonic oscillators as canonical ensemble, Grand canonical ensemble,

Unit 8: Statistical Quantities and Ideal Gas in Grand Canonical Ensemble- Significance of statistical quantities, classical ideal gas in grand canonical ensemble theory.

Block III: Ideal Bose systems

Unit 9: Ideal Bose Gas and Bose-Einstein Condensation: Fundamentals and Thermodynamics- Basic concepts and thermodynamic behaviour of an ideal Bose gas, Bose-Einstein condensation,

Unit 10: Blackbody Radiation and Ideal Fermi Systems: Thermodynamic Behavior- Blackbody radiation-Planck's formula, Ideal Fermi systems: thermodynamic behavior of an ideal Fermi gas,

Unit 11: Heat Capacity of Free-Electron Gas at Low Temperatures: Insights and Discussion- Discussion of heat capacity of a free-electron gas at low temperatures,

Unit 12: Electron Gas in Metals: Exploring the H-Theorem- Electron gas in metals, H-theorem.

Block IV: Phase transition

Unit 13: Phase Transitions: Ising Model and Critical Fluctuations- Phase transitions, Ising model, Thermodynamic fluctuations, Critical exponents,

Unit 14: Thermodynamic Limit and Random Walk Dynamics- Thermodynamic limit and its importance Random Walk

Unit 15: Brownian Motion, Diffusion, and Fluctuation-Dissipation- Brownian motion, Diffusion equation, Fluctuation-Dissipation theorem.

Unit 16: Universality in Phase Transitions: Ising vs. Heisenberg Models- Concepts of universality of phase transitions, Ising and Heisenberg models

CENTRE FOR DISTANCE AND ONLINE EDUCATION



MANGALAYATAN
UNIVERSITY
Learn Today to Lead Tomorrow

Extended NCR, 33rd Milestone, Aligarh-Mathura
Highway, Beswan, Aligarh, UP-202146



Anamika Shrivastava
Director
Centre for Distance and Online Education
Mangalayatan University, Beswan, Aligarh-202146 (UP)

www.mangalayatan.in, www.mude.ac.in
cdoe@mangalayatan.edu.in

[Signature]
Registrar
Mangalayatan University
Beswan, Aligarh