FATIMA COLLEGE (AUTONOMOUS), MADURAI-18

DEPARTMENT OF PHYSICS

For those who joined in June 2019 onwards

PROGRAMME CODE : PAPH

COURSE CODE	COURSE TITLE	HRS / WK	CREDIT	CIA Mks	ESE Mks	TOT. MKs
SEMESTER – I						
19PG1P1	Introduction to Mathematical Physics	6	4	40	60	100
19PG1P2	Applied Electronics	6	4	40	60	100
19PG1P3	Classical Mechanics	6	4	40	60	100
19PG1P4	Practicals-I Non Electronics	4	2	40	60	100
19PG1P5	Practicals-II Electronics	4	2	40	60	100
19P1EDC	Modern Photography	3	3	40	60	100
SEMESTER – II						
19PG2P6	Advanced Mathematical Physics	6	4	40	60	100
19PG2P7	Quantum Mechanics	6	4	40	60	100
19PG2P8	Electromagnetic Theory	6	4	40	60	100
19PG2P9	Practicals-III Non Electronics	4	2	40	60	100
19PG2P10	Practicals-IV Electronics	4	2	40	60	100
19P2EDC	Modern Photography	3	3	40	60	100
SEMESTER – III						
19PG3P11	Condensed Matter Physics	6	5	50	50	100
19PG3P12	Statistical Mechanics	6	5	40	60	100

COURSE CODE	COURSE TITLE	HRS / WK	CREDIT	CIA Mks	ESE Mks	TOT. MKs
19PG3P13	Nuclear and Particle Physics	6	5	40	60	100
19PG3PE1A/ 19PG3PE1B	Communication system/ Numerical methods and Programming in C++	4	4	40	60	100
19PGSLP1	Adv.Learning Course Instrumentation & Experimental Methods	-	3	40	60	100
19PG3P14	Practicals - V	4	2	40	60	100
19PG4P15	Practicals – V1	4	2	40	60	100
SEMESTER – IV						
19PG4P16	Advanced Condensed Matter Physics	6	5	40	60	100
19PG4P17	Molecular Spectroscopy	6	5	40	60	100
19PG4P18	Advanced Quantum Mechanics	6	5	40	60	100
19PG4PE2A/ 19PG4PE2B	Material Science / Astro Physics	4	4	40	60	100
19PG4P19	Practicals –VII	4	2	40	60	100
19PG4P20	Practicals –VIII	4	2	40	60	100
19PG4P19	Project*& Viva Voce	-	3	50	50	100

OLD

II MSC PHYSICS- SEMESTER III

SOLID STATE PHYSICS I – PG3P11

(For those who joined in June in 2019)

5 hrs/week **5 Credits**

Objective: The purpose of this course is to provide a sound foundation in condensed matter physics.

UNIT I **15 hrs**

CRYSTAL STRUCTURE : Periodic arrays of atoms- lattice translational vectors- Basis and crystal structure- Primitive lattice cell.

Fundamental types of lattices **:** Two dimensional and three dimensional lattice types. Index system for crystal planes **–** Simple crystal structures**:** Sodium chloride structure-Cesium chloride structure- Hexagonal close packed structure- Diamond structure-cubic zinc sulphide structure. Direct imaging of atomic structure- Non-ideal crystal structures**.**

RECIPROCAL LATTICE:

Diffraction of waves by crystals**:** Bragg's law.Scattered wave amplitude**:** Fourier Analysis- Reciprocal lattice vectors –Diffraction condition – Laue Equations. Brillouin zones: Reciprocal lattice to sc, bcc and fcc. Fourier analysis of the basis **:** Structure factor of the bcc and fcc lattice- Atomic Form factor.

UNIT II **13 hrs**

CRYSTAL BINDING

Crystals of inert gases **:** Van der Waals-London Interaction – Repulsive Interaction – equilibrium Lattice Constants – Cohesive energy.Ionic crystals**:** Elctrostatic or Madelung Energy – evaluation of Madelung constant. Covalent crystals - Metals- Hydrogen bonds**-** Atomic radii **–** Ionic Crystal radii.

UNIT III **15 hrs**

PHONONS-CRYSTAL VIBRATIONS

Vibrations of crystals with monatomic basis**:** First Brillouin zone- group velocity- long wavelength limit.Two atoms per primitive basis - Quantization of elastic waves. phonons-thermal properties-Phonon heat capacity**:** Planck Distribution- Normal mode enumeration-Density of states in 1D and 3D-Debye Model for density of states- Debye T^3 law- Einstein model of the density of states.

UNIT IV **16 hrs**

FREE ELECTRON FERMI GAS

Energy levels in one dimension - Effect of temperature on the Fermi – Dirac distribution- Free electron gas in 3D.Heat capacity of the electron gas**:** Experimental heat capacity of metals.Electrical conductivity and ohm's law**:** Experimental electrical resistivity of metals (Umklapp scattering not included).Motion in magnetic fields: Hall effect. Thermal conductivity of metals: Wiedemann- Franz law.

energy bands :Nearly free electron model **- (**only descriptive – exclude origin and magnitude of energy gap) Bloch functions - Kronig - Penney model .

UNIT V **16 hrs**

SEMICONDUCTOR CRYSTALS:

Band gap-Equations of motion (exclude physical derivation) -Holes- Effective Mass.-Intrinsic carrier concentration **:**Intrinsic mobility.Fermi surfaces and metals Reduced zone scheme, periodic zone scheme (explanation only) - Construction of Fermi surfaces(orbits not included).

Experimental methods in Fermi surface studies**:** Quantization of orbits in a magnetic field – De Haas-van Alphen effect.

BOOKS FOR STUDY:

Introduction to Solid State Physics - VIII Edition -Charles Kittel

Unit 1: Ch -1, 2

Unit 2: Ch -3(page 48 to page 72 only)

Unit 3: Ch- 4 (page 91 to page 99 only) 5 (page 107 to page 118 only)

Unit 4: Ch- 6(exclude page 151), 7 (page 163 to page 169 only, exclude 165,166)

Unit 5: Ch- 8(exclude pages 193, 199,200 to 205, 209 to 217).

Ch - 9 (page 223 to 228 only and pages 242 to 249only)

BOOKS FOR REFERENCE

1. Elementary Solid State Physics: Principles and applications-M.A.Omar, Addison Wesley- First Indian Reprint, 2000.
2. Elements of Solid State Physics – J.P.Srivastava Prentice Hall of India Private Ltd.
   II Edition.

3. Solid State Physics- S.O.Pillai Revised and enlarged edition- Wiley Eastern Ltd.

New Age International Ltd.

NEW

5%

II M.Sc.

SEMESTER –III

***For those who joined in 2019 onwards* (*Bookman Old Style 1*)**

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG3P11	CONDENSED MATTER PHYSICS	PG Core	6Hrs.	5

COURSE DESCRIPTION

The objective of this course is to understand the structure and properties of solid state materials

COURSE OBJECTIVES

The course enables the student :

- To understand the structure of different types of crystals
- To study the types of binding of crystals
- To gain knowledge about lattice vibrations and properties like specific heat , thermal conductivity
- To discuss metallic and semiconductor crystals and their properties

UNITS

UNIT I **15 hrs**

CRYSTAL STRUCTURE : Periodic arrays of atoms- lattice translational vectors- Basis and crystal structure- Primitive lattice cell. Fundamental types of lattices : Two dimensional and three dimensional lattice types. Index system for crystal planes – Simple crystal structures: Sodium chloride structure-Caesium chloride structure- Hexagonal close packed structure- Diamond structure-cubic zinc sulphide structure. Direct imaging of atomic structure- Non-ideal crystal structures. (self-study)

RECIPROCAL LATTICE:

Diffraction of waves by crystals: Bragg's law. Scattered wave amplitude: Fourier

Analysis- Reciprocal lattice vectors –Diffraction condition – Laue Equations(self-study). Brillouin zones: Reciprocal lattice to sc, bcc and fcc. Fourier analysis of the basis : Structure factor of the bcc and fcc lattice- Atomic Form factor.

UNIT II 13 hrs

CRYSTAL BINDING

Crystals of inert gases **:** Van der Waals-London Interaction – Repulsive Interaction – equilibrium Lattice Constants – Cohesive energy.Ionic crystals**:** Electrostatic or Madelung Energy – evaluation of Madelung constant. Covalent crystals - Metals-Hydrogen bonds**-** Atomic radii **–** Ionic Crystal radii.

UNIT III 15 hrs

PHONONS-CRYSTAL VIBRATIONS

Vibrations of crystals with monatomic basis**:** First Brillouin zone- group velocity-long wavelength limit.Two atoms per primitive basis - Quantization of elastic waves.

phonons-thermal properties

Phonon heat capacity**:** Planck Distribution- Normal mode enumeration-Density of states in 1D and 3D-Debye Model for density of states- Debye T^3 law- Einstein model of the density of states.

UNIT IV 16 hrs

FREE ELECTRON FERMI GAS

Energy levels in one dimension - Effect of temperature on the Fermi – Dirac distribution- Free electron gas in 3D.Heat capacity of the electron gas**:** Experimental heat capacity of metals.Electrical conductivity and ohm's law**:** Experimental electrical resistivity of metals (Umklapp scattering not included).Motion in magnetic fields: Hall effect. Thermal conductivity of metals: Wiedemann- Franz law.

energy bands :Nearly free electron model **- (**only descriptive – exclude origin and magnitude of energy gap) Bloch functions - Kronig - Penney model .

UNIT V **16 hrs**

SEMICONDUCTOR CRYSTALS:

Band gap- Equations of motion (exclude physical derivation) -Holes- Effective Mass- Intrinsic carrier concentration :Intrinsic mobility.

fermi surfaces and metals .

Reduced zone scheme, periodic zone scheme (explanation only) - Construction of Fermi surfaces(orbits not included).

Experimental methods in Fermi surface studies**:** Quantization of orbits in a magnetic field – De Haas-van Alphen effect.

Change-5%

UNIT –VI DYNAMISM (Evaluation Pattern-CIA only)

Recent developed crystals in semiconductors, metals , ionic crystals –

study of any two crystals for each – their structure, properties and applications.

(From published research papers).

Total Change-5%

BOOKS FOR STUDY:

Charles Kittel - Introduction to Solid State Physics - VIII Edition -

Unit 1: Ch -1, 2

Unit 2: Ch -3(page 48 to page 72 only)

Unit 3: Ch- 4 (page 91 to page 99 only) 5 (page 107 to page 118 only)

Unit 4: Ch- 6(exclude page 151), 7 (page 163 to page 169 only,
(exclude 165,166)

Unit 5: Ch- 8(exclude pages 193, 199,200 to 205, 209 to 217).
Ch - 9 (page 223 to 228 only and pages 242 to 249only)

BOOKS FOR REFERENCE

3. Omar ,M.A. - Elementary Solid State Physics: Principles and applications- Addison Wesley- First Indian Reprint, 2000.

4. Srivastava ,J.P. - Elements of Solid State Physics –Prentice Hall of India Private Ltd. II Edition.

3. Pillai , S.O. -Solid State Physics- Revised and enlarged edition- Wiley Eastern Ltd. New Age International Ltd.

OLD

II M.Sc.,PHYSICS

III SEMESTER
MAJOR CORE
COURSE TITLESTATISTICAL MECHANICS

COURSE CODE - PG3P12

(For those who joined in 2019 onwards)

HOURS/WEEK: 5 **CREDIT:4**

COURSE DESCRIPTION

This course develops concepts in Classical statistical mechanics, Quantum statistics, fluctuations and one dimensional random walk.

COURSE OBJECTIVE/S

The course provides a conceptually based exposure to some advanced topics in the field of equilibrium statistical physics.The course links thermodynamics to the micro description used in classical Statistical Mechanics. The course enables the students to understand the concepts of M-B, B-E and F-D statistics and to apply them to the real systems.

COURSE OUTCOMES (CO)

No.	Course Outcome	Knowledge Level(According to Bloom's Taxonomy)
CO 1	Analyse classical equilibrium thermodynamics to make physical predictions, describe the effects of quantum mechanics on statistical mechanics.	K3
CO 2	Acquire knowledge on Canonical and Grand canonical ensembles.	K1
CO 3	. Understand the concepts of BoseEinestein condensation.	K2
CO 4	Apply statistical mechanics to condensed matter systems such as Fermi gases, white dwarfs and nuclear matter.	K2,K3

CO 5	Compute fluctuations in the systems of canonical, micro canonical and grand canonical ensembles and comprehend random process using Fourier analysis	K1,K2,K3

UNIT I: INTRODUCTION [18 HRS]

Phase Space-Ensemble-Ensemble average-Liouville Theorem-Equation of motion-Equal-apriori-probability-Statistical equilibrium-Micro canonical ensemble-Entropy of an ideal Boltzmann gas using micro canonical ensemble-Gibb's paradox. Quantisation of phase space-basic postulates-classical limit-**Symmetry of wave functions-effect of symmetry on counting**-MB, BE and FD statistics-various distributions using micro canonical ensemble.

UNIT II:CANONICAL AND GRAND CANONICAL ENSEMBLES [18 HRS]

Entropy of a system in contact with a heat reservoir-Ideal gas in canonical ensemble-**Maxwell velocity distribution**-Equipartition of energy. Grand canonical ensemble-Ideal gas in grand canonical ensemble-Canonical partition function Translational partition function-Rotational partition function-Vibrational partition function-Electronic partition function.

UNIT III: BOSE-EINSTEINSTATISTICS [18 HRS]

Bose-Einstein distribution-Bose-Einstein condensation Thermodynamic properties of an ideal BE gas-Liquid Helium-Landau spectrum of Phonons and ProtonsHelium 4 and Helium 3 mixtures-Superfluid phases of Helium 3.

UNIT IV:FERMI-DIRAC STATISTICS [18 HRS]

Fermi-Diracdistribution-degeneracy-Thermionicemission-whitedwarfs-Nuclearmatter-Quantum Hall effect.

UNIT V:FLUCTUATIONS [18 HRS]

Introduction-mean square deviation-Fluctuations in ensembles-Concentration fluctuations in quantum statistics-One dimensional random walk-Brownian motion-Fourier analysis of a random function-Electrical noise-Nyquist theorem.

TEXT BOOKS:

1. Agarwal.B.K. and Melvin Eisner, S***tatistical Mechanics*** ,New Age International Limited, New Delhi (2003) 2nd edition.

REFERENCE BOOKS:

1. Donald A. McQuarrie, S***tatistical Mechanics*** Viva Books Private limited,(2003).
2. Silvio R A Salinas, I***ntroduction to Statistical Physics*** Springer,(2004)
3. Bhattacharjee, S***tatistical Mechanics*** Allied Publishers limited,(1996).
4. Kerson Huang, S***tatistical Mechanics*** Wiley Eastern(1988) third reprint

NEW

5%

SEMESTER –III

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG3P12	STATISTICAL MECHANICS	PG Core	6	4

COURSE DESCRIPTION

This course develops concepts in Classical statistical mechanics, Quantum statistics, fluctuations and one dimensional random walk.

COURSE OBJECTIVES

The course provides a conceptually based exposure to some advanced topics in the field of equilibrium statistical physics.The course links thermodynamics to the micro description used in classical Statistical Mechanics. The course enables the students to understand the concepts of M-B, B-E and F-D statistics and to apply them to the real systems.

UNITS

UNIT –I INTRODUCTION (18 HRS.)

Phase Space-Ensemble-Ensemble average-Liouville Theorem-Equation of motion-Equal-apriori-probability-Statistical equilibrium-Micro canonical ensemble-Entropy of an ideal Boltzmann gas using micro canonical ensemble-Gibb's paradox. Quantisation of phase space-basic postulates-classical limit-Symmetry of wave functions-effect of symmetry on counting-MB, BE and FD statistics-various distributions using micro canonical ensemble.

UNIT –II CANONICAL AND GRAND CANONICAL ENSEMBLES (18 HRS.)

Entropy of a system in contact with a heat reservoir-Ideal gas in canonical ensemble-Maxwell velocity distribution-Equipartition of energy. Grand canonical ensemble-Ideal gas in grand canonical ensemble-Canonical partition function Translational partition function-Rotational partition function-Vibrational partition function-Electronic partition function.

UNIT –III BOSE-EINSTEIN STATISTICS (18 HRS.)

Bose-Einstein distribution-Bose-Einstein condensation **Thermodynamic properties of an ideal BE gas**-Liquid Helium-Landau spectrum of Phonons and Protons Helium 4 and Helium 3 mixtures-Superfluid phases of Helium

UNIT –IV FERMI-DIRAC STATISTICS (18 HRS.)

Fermi-Dirac distribution-degeneracy-Thermionic emission-white dwarfs-**Nuclear matter**-Quantum Hall effect.

UNIT –V FLUCTUATIONS (18 HRS.)

Introduction-mean square deviation-Fluctuations in ensembles-Concentration fluctuations in quantum statistics-One dimensional random walk-Brownian motion-Fourier analysis of a random function-Electrical noise-Nyquist theorem.

Change - 5%

UNIT –VI DYNAMISM (Evaluation Pattern-CIA only) (4 HRS.)

The Fractional Quantum Hall Effect

Total Change - 5%

REFERENCES:

1. Agarwal.B.K. and Melvin Eisner, S***tatistical Mechanics*** ,New Age International Limited, New Delhi (2003) 2nd edition.
2. Donald A. McQuarrie, S***tatistical Mechanics*** Viva Books Private limited,(2003).
3. Silvio R A Salinas, I***ntroduction to Statistical Physics*** Springer,(2004)
4. Bhattacharjee, S***tatistical Mechanics*** Allied Publishers limited,(1996).
5. Kerson Huang, S***tatistical Mechanics*** Wiley Eastern(1988) third reprint

WEB REFERNCES :

1. https://www.cmi.ac.in/~kpnmurthy/StatisticalMechanics2017/book.pdf
2. https://www.britannica.com/science/degenerate-gas
3. https://www.space.com/23756-white-dwarf-stars.html

OLD

I M.Sc.,PHYSICS

III SEMESTER
MAJOR CORE
COURSE TITLE: NUCLEAR AND PARTICLE PHYSICS

COURSE CODE - PG3P13

(For those who joined in 2019 onwards)

HOURS/WEEK: 5 **CREDIT:4**

COURSE DESCRIPTION

The aim of this course is to provide an overview of the fields of nuclear and particle physics.

COURSE OBJECTIVES

This course provides the knowledge about alpha and beta particles in nuclear physics. And it explains about nuclear fission and fusion reactions and its application in nuclear reactor. Expels knowledge in nuclear force and elementary particles.

UNIT –I ALPHA PARTICLES **(18HRS.)**

Introduction- range of alpha particles-range-velocity-energy-life relations-alpha energy- -mass number- alpha particle spectra- Gamow's Theory of alpha decay, (decay probability, hindrance factors, spontaneous nuclear disintegration).

BETA-DECAY: Introduction- Beta-Spectroscopy. The neutrino hypothesis-energy- half life relationships-Fermi theory of Beta Decay, (Kurie plots, Mass of neutrino, Life time of beta decay, selection rules for allowed and forbidden transitions)-Parity violation- Helicity.

UNIT –II NUCLEAR FISSION **(18 HRS.)**

The discovery of nuclear fission- fission cross sections and thresholds- the fission products-the mass and energy distributions of the fission products-Neutron emission in fission-the energy distribution of the neutrons emitted in fission-the energy release in fission- the theory of the fission process.

NUCLEAR ENERGY SOURCES:Nuclear fission as a source of energy- the chain-reacting system of nuclear reactor- Thermal nuclear reactors- The neutron cycle- the calculation of the multiplication factor for a homogeneous thermal reactor- the heterogeneous thermal reactor- power and breeding- energy production in stars- thermonuclear reactions-controlled thermo nuclear reactions.(self study)

UNIT –III NUCLEAR FORCE & MODELS (18 HRS.)

NUCLEAR FORCES: The Deuteron- Ground State of the Deuteron- Triplet and Singlet states- Meson theory of Nuclear forces.

NUCLEAR MODELS: Introduction- Degenerate Fermi gas model- The Semi-empirical mass formula- the liquid drop model- the shell model- the collective model.

UNIT –IV NUCLEAR REACTIONS (18 HRS.)

Types of nuclear reactions, conservation laws, Nuclear Reaction Kinematics-Solution to Q-equation; Nuclear cross- section, Partial wave analysis of Reaction cross-section, Requirements for a reaction- Reaction mechanism.

UNIT –V ELEMENTARY PARTICLES (18 HRS.)

Introduction- Classification of Elementary particles- Particle Interactions (Gravitational, Electromagnetic, Strong, Weak) Conservation laws- Invariance under charge, parity ,C.P ,time reversal and C.P.T- Electrons and positrons- **protons and antiprotons- neutrons and antineutrons- neutrinos and Antineutrinos – Photons,** Mesons -Hyperons- Elementary particle symmetries, Quark theory.

NEW

5%

SEMESTER –III

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG3P13	NUCLEAR AND PARTICLE PHYSICS	PG Core	6	5

COURSE DESCRIPTION

The aim of this course is to provide an overview of the fields of nuclear and particle physics.

COURSE OBJECTIVES

This course provides the knowledge about alpha and beta particles in nuclear physics. And it explains about nuclear fission and fusion reactions and its application in nuclear reactor. Expels knowledge in nuclear force and elementary particles.

UNITS- 6

UNIT –I ALPHA PARTICLES **(18HRS.)**

Introduction- range of alpha particles-range-velocity-energy-life relations-alpha energy- -mass number- alpha particle spectra- Gamow's Theory of alpha decay, (decay probability, hindrance factors, spontaneous nuclear disintegration).

BETA-DECAY: Introduction- Beta-Spectroscopy. The neutrino hypothesis-energy- half life relationships-Fermi theory of Beta Decay, (Kurie plots, Mass of neutrino, Life time of beta decay, selection rules for allowed and forbidden transitions)-Parity violation- Helicity.

UNIT –II NUCLEAR FISSION **(18 HRS.)**

The discovery of nuclear fission- fission cross sections and thresholds- the fission products-the mass and energy distributions of the fission products- Neutron emission in fission-the energy distribution of the neutrons emitted in fission-the energy release in fission- the theory of the fission process.

NUCLEAR ENERGY SOURCES:Nuclear fission as a source of energy- the chain-reacting system of nuclear reactor- Thermal nuclear reactors- The neutron cycle- the calculation of the multiplication factor for a homogeneous thermal reactor- the heterogeneous thermal reactor- power and breeding- energy production in stars- thermonuclear reactions-controlled thermo nuclear reactions.(self study)

UNIT –III NUCLEAR FORCE & MODELS (18 HRS.)

NUCLEAR FORCES: The Deuteron- Ground State of the Deuteron- Triplet and Singlet states- Meson theory of Nuclear forces.

NUCLEAR MODELS: Introduction- Degenerate Fermi gas model- The Semi-empirical mass formula- the liquid drop model- the shell model- the collective model.

UNIT –IV NUCLEAR REACTIONS (18 HRS.)

Types of nuclear reactions, conservation laws, Nuclear Reaction Kinematics- Solution to Q-equation; Nuclear cross- section, Partial wave analysis of Reaction cross-section, Requirements for a reaction- Reaction mechanism.

UNIT –V ELEMENTARY PARTICLES (18 HRS.)

Introduction- Classification of Elementary particles- Particle Interactions (Gravitational, Electromagnetic, Strong, Weak) Conservation laws- Invariance under charge, parity ,C.P ,time reversal and C.P.T- Electrons and positrons- **protons and antiprotons- neutrons and antineutrons- neutrinos and Antineutrinos – Photons,** Mesons -Hyperons- Elementary particle symmetries, Quark theory.

Change - 5%

UNIT –VI DYNAMISM (Evaluation Pattern-CIA only) (3 HRS.)

Application of nuclear fission and nuclear fusion. Application of nuclear energy in constructive purposes.

REFERENCES

1. D.C. TAYAL “ Nuclear Physics” Umesh Prakashan- Khurja
2. Irving Kaplan, Nuclear Physics, Addison-Wesley Publishing Company.
3. Arthur Beiser, Perspectives of Modern Physics, Mcgraw Hill Book company
4. SATHYA PRAKASH, Nuclear Physics and Particle Physics, Sultan Chand
5. Devanathan.V, Nuclear physics, Narosa publishers.
6. Harald Enge Addison, Introduction to Nuclear Physics, Wesley
   a. Publishing Company.

Total Change - 5%

OLD

II MSC PHYSICS - SEMESTER III

NUMERICAL METHODS AND PROGRAMMING IN C ++ -PG3PE1B

(Revised in 2015)

4 hrs/week **5 credits**

The objective of this course is to enable the students to learn the various numerical methods to solve algebraic & transcendental equations and also numerical differentiation and integration. Also it provides object oriented techniques to write programs in C++ especially for all the numerical methods.

UNIT I: **15 hrs**

Numerical solutions of Algebraic and Transcendental Equation: Method of False position(Regula Falsi method)-Newton-Raphson Method-Solution of Simultaneous Linear Algebraic Equations: Gauss Elimination Method-Interpolation with equal intervals: Gregory-Newton's forward interpolation formula for Equal Intervals- Gregory-Newton's Backward interpolation formula for Equal Intervals-Interpolation with unequal Intervals: Lagrange's Interpolation Formula for unequal Intervals-Method of Least Squares: Fitting a straight line-Fitting a Second Degree Parabola.

UNIT II: **15 hrs**

Numerical Differentiation and Integration: Values of the derivatives of y, based on Newton's Forward Interpolation formula- Values of the derivatives of y, based on Newton's Backward Interpolation formula-Numerical integration: Newton-Cote's Quadrature Formula-Trapezoidal rule- simpson's one- third rule -Simpson's three- eighths rule - Numerical solutions of ordinary differential equations: Euler's method- Runge-Kutta formulas of first and second order.

UNIT III: **15 hrs**

Object Oriented programming: Introduction to OOP- Function Prototypes-Comments-Flexible Declarations-*structure, union* and *enum* Syntax- Typecasting-void Pointers- The :: Operator-References- The const Qualifier- Constructure for Intrinsic Data Types- The bool Data Type -Function Overloading –Default Arguments in Functions -Operator overloading-Inline Functions.

NIT IV: **15 hrs**

Classes in C++:Classes and Constructors- Destructors- A complex Class – Overloaded operators Revisited- *this* Pointer- Overloading Unary Operators- Postfix Notation- Function

Definition Outside the class-new and delete Operators- *malloc*( )/*free*( ) versus new/delete- The Matrix Class-Classes, Objects and Memory- Structures and Classes - Overloaded Assignment Operator, Copy Constructor.

UNIT V: **15 hrs**

Inheritance and Polymorphism: Inheritance-Constructors in multiple inheritance- Private inheritance- Protected inheritance- Functions that are not inherited- Pure virtual functions- Classes within classes- Friend functions.

Books for Study:

1) Numerical Methods with Programs in C and C++ -T. Veerarajan, T. Ramachandran- Tata McGraw-Hill Publishing Company Limited, New Delhi.
   Unit I-Pages: 3.3-3.5,4.1-4.2, 6.1-6.4, 7.6-7.7, 2.5-2.6.

   Unit II-Pages: 8.1-8.3, 8.28-8.32, 10.16-10.18.

2) Let Us C++ - Yasshavant P.Kanetkar-BPB Publications.
   Unit III : Pages: 2 – 80.

   Unit IV: Pages: 87-140,187-192.

   Unit V: Pages : 261-304, 321-345,469-478.

Books for reference:

1) Computer Oriented Numerical Methods- V. Rajaraman-Prentice–Hall of India.
2) Object oriented programming with C++-E. Balaguruasamy- Tata McGraw-Hill

   Publishing Company Limited, New Delhi.

3) Programming with C++ by D. Ravi Chandran – TaTa McGraw- Hill Publishing Company Limited- New Delhi. (II edition)

NEW

5%

II M.Sc.,PHYSICS

SEMESTER –III

(***For those who joined in 2019 onwards***)

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG3PE1B	Numerical Methods & Programming in C++	PG Core	4 Hrs.	4

COURSE DESCRIPTION

This course provides object oriented techniques to write programs in C++ especially for numerical methods

COURSE OBJECTIVES

The objective of this course is to enable the students to learn the various numerical methods to solve algebraic & transcendental equations and also numerical differentiation and integration. Also it provides object oriented techniques to write programs in C++ especially for all the numerical methods.

UNITS

UNIT I: Numerical solutions of Algebraic and Transcendental Equation **[12HRS]**

Method of False position (Regula Falsi method)-Newton-Raphson Method-Solution of Simultaneous Linear Algebraic Equations: Gauss Elimination Method-Interpolation with equal intervals: Gregory-Newton's forward interpolation formula for Equal Intervals- Gregory-Newton's Backward interpolation formula for Equal Intervals-Interpolation with unequal Intervals: **Lagrange's Interpolation Formula for unequal Intervals**

UNIT II: Numerical Differentiation and Integration **[12 HRS]**

Values of the derivatives of y, based on Newton's Forward Interpolation formula- Values of the derivatives of y, based on Newton's Backward

Interpolation formula-Numerical integration: **Newton-Cote's Quadrature Formula- Trapezoidal rule**- Numerical solutions of ordinary differential equations: Euler's method- Runge-Kutta formulas of first and second order.

UNIT III: Object Oriented programming [12 HRS]

Introduction to OOP- Function Prototypes-Comments- Flexible Declarations- *structure, union* and *enum* Syntax- Typecasting-void Pointers- The :: Operator-References- **The const Qualifier**- Constructor for Intrinsic Data Types- The bool Data Type -Function Overloading –Operator overloading

UNIT IV :Classes in C++ [12 HRS]

Classes and Constructors- Destructors- A complex Class – **Overloaded operators Revisited**- *this* Pointer- Overloading Unary Operators- Postfix Notation- **Function Definition Outside the class**-new and delete Operators- *malloc*( )/*free*( ) versus new/delete-The Matrix Class-Classes, Objects and Memory

UNIT V :Inheritance and Polymorphism [12 HRS]

Inheritance-Constructors in multiple inheritance- Private inheritance- Protected inheritance- Functions that are not inherited- Pure virtual functions- Classes within classes- Friend functions.

Change-5%

UNIT –VI DYNAMISM (Evaluation Pattern-CIA only)

Advanced features in friend functions, classes within classes, smart pointers.

Total Change-5%

BOOKS FOR STUDY:

1. **Veerarajan. T, Rmachandran T, Numerical Methods with programs in C and C++, Tata Mc Graw Hill Publishing company Ltd, New Delh**

Unit I- Pages 3.5-3.5, 4.1-4.2, 6.1-6.4,7.6-7.7

Unit II-Pages: 8.1-8.3,8.28-8.32, 10.16-10.18

2. **P. Kanetkar Yashavant, Let us C++, BPB publications, First Edition.**

Unit III Chapters: 1,2,3
Unit IV Chapter : 4
Unit V Chapters: 8,9,11(Relevant sections)

BOOKS FOR REFERENCE

1.Balagurusamy. E, Computer Oriented Numerical Methods, Prentice-Hall of India

2.Ravi Chandran. D, Programming with C++, Tata Mc Graw Hill Publishing company Ltd.

OLD

IV SEMESTER
MAJOR CORE
ADVANCED CONDENSED MATTER PHYSICS – PG4P16

(For those who joined in 2019 onwards)

HOURS/WEEK: 6 **CREDIT:5**

COURSE DESCRIPTION

The objective of this course is to understand in depth the physics of the properties of metals, superconductors, dielectrics and magnetic solids

COURSE OBJECTIVE/S

The course enables the student :

- To understand the transmission and reflection properties of plasmons
- To study the types of lattice defects
- To gain knowledge about the superconducting property of solids
- To understand the polarisation and magnetisation properties of solids

COURSE OUTCOMES (CO)

No.	Course Outcome	Knowledge Level(According to Bloom's Taxonomy)
CO 1	Analyse the dispersion of electromagnetic waves in a non-magnetic solid Discuss the formation of plasmons, polaritons, polarons and excitons and their interactions with the solids	K1 and K2
CO 2	Identify lattice vacancies and defects and explain the color centers in crystals Compare the behaviour of normal conductor and superconductor Explain superconductivity based on various models and theories	K1, K2 andK3

CO 4	Identify dielectric medium and analyze their polarization properties	K1and K2
CO 5	Identify magnetic solids and their properties Apply quantum theory and analyze the magnetisation and susceptibility properties	K1, K2 and K3

UNIT I **15 hrs**

Plasmons, polaritons, polarons and excitons

Dielectric function of the electron gas **:** Dispersion relation for electromagnetic waves- Transverse optical modes in a plasma – transparency of alkali in the ultraviolet- longitudinal plasma oscillations. Plasmons - Electrostatic screening**:** Mott-Metal transition- screening and phonons in metals. Polaritons **:** LST relation. Polarons- Excitons(types of excitons explanation only. No derivation).

UNIT 2 **16 hrs**

Point defects

Lattice vacancies: Schottky defect, Frenkel defect- Diffusion: Metals- Color centers: F Centers, Other centers in alkali halides.

Super conductivity

Experimental survey: Occurrence of super conductivity-Destruction of superconductivity by magnetic fields – Meissner effect – Heat capacity – Energy gap – Microwave and infrared properties – Isotope effect.

Theoretical survey**:**

Thermodynamics of the superconducting transition – London equation – Coherence length – BCS theory of superconductivity – BCS ground state.

UNIT 3 **16 hrs**

Flux quantization in a superconducting ring – Type II superconductors – Vortex state – Estimation of H_{C1} and H_{C2}- Single particle tunneling – Josephson superconductor tunneling – DC Josephson effect – AC Josephson effect – Macroscopic quantum interference – High Temperature superconductors.

UNIT 4 **13 hrs**

Dielectrics and ferroelectrics

Macroscopic electric field**:** Depolarization field. Local electric field at an atom **:** Lorentz field. Dielectric constant and polarizability- electronic polarizability –classical theory of electronic polarizability. Structural phase transitions. Ferroelectric crystals **:** Classification of ferroelectric crystals. Displacive transitions**:** Soft Optical Phonons – Landau theory of the phase transition – second order transition – first transition – antiferroelectricity – ferroelectric domains – piezoelectricity.

UNIT 5 **15 hrs**

Diamagnetism and paramagnetism

Langevin diamagnetism equation. Quantum theory of diamagnetism of mononuclear systems. Paramagnetism- Quantum theory of Para magnetism: Rare earth ions, Hund rules. Paramagnetic susceptibility of conduction electrons

Ferromagnetism and Antiferromagnetism

Ferromagnetic order: Curie point and the exchange integral **–** Magnons **:** Dispersion relation of magnons.

Ferrimagnetic order **:** Curie temperature and susceptibility of ferrimagnets. Antiferromagnetic order **:** susceptibility below Neel temperature. Ferromagnetic domains**:** Anisotropy energy, Transition region between domains

BOOKS FOR STUDY:

1. Introduction to Solid State Physics VIII Edition – Charles Kittel-

 Unit 1: Ch-14 (page 394 to page 416 only and pages 420 to 421 only),

 Ch-15 (pages 435 to 441 only)

 Unit 2: Ch-10(page 259 to page 279 only), Ch-20 .

 Unit 3: Ch-10 (from page 279 to page 293 only)

 Unit 4: Ch- 16

 Unit 5: Ch-11 (page 299 to page 306 only and pages 315 to 317 only) ,

 Ch - 12 (page 323 to page 325 only and pages 330 to 333, 336 to 338 excluding antiferromagnetic magnons, then include pages 340 to 343 only, 346 to 350 only)

BOOKS FOR REFERENCE

5. Elementary Solid State Physics: Principles and applications-M.A.Omar, Addison Wesley- First Indian Reprint, 2000.
6. Elements of Solid State Physics – J.P.Srivastava Prentice Hall of India Private Ltd. II Edition.

NEW

II M.Sc.

SEMESTER –III

5%

For those who joined in 2019 onwards (*Bookman Old Style 1*)

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG4P16	ADVANCED CONDENSED MATTER PHYSICS	PG Core	6Hrs.	5

COURSE DESCRIPTION

The objective of this course is to understand in depth the physics of the properties of metals, superconductors, dielectrics and magnetic solids

COURSE OBJECTIVES

The course enables the student :

- To understand the transmission and reflection properties of plasmons
- To study the types of lattice defects
- To gain knowledge about the superconducting property of solids
- To understand the polarisation and magnetisation properties of solids

UNITS

UNIT I **15 hrs**

Plasmons, polaritons, polarons and excitons

Dielectric function of the electron gas **:** Dispersion relation for electromagnetic waves- Transverse optical modes in a plasma – transparency of alkali in the ultraviolet- longitudinal plasma oscillations. Plasmons - Electrostatic screening**:** Mott-Metal transition- screening and phonons in metals. Polaritons **:** LST relation. Polarons- Excitons(types of excitons explanation only. No derivation).

UNIT 2 **16 hrs**

Point defects - Lattice vacancies: Schottky defect, Frenkel defect- Diffusion: Metals- Color centers: F Centers, Other centers in alkali halides.

Super conductivity

Experimental survey: Occurrence of super conductivity-Destruction of superconductivity by magnetic fields – Meissner effect – Heat capacity – Energy gap – Microwave and infrared properties – Isotope effect.

Theoretical survey: Thermodynamics of the superconducting transition – London equation – Coherence length – BCS theory of superconductivity – BCS ground state.

UNIT 3 **16 hrs**

Flux quantization in a superconducting ring – Type II superconductors – Vortex state – Estimation of H_{C1} and H_{C2}- Single particle tunneling – Josephson superconductor tunneling – DC Josephson effect – AC Josephson effect – Macroscopic quantum interference – High Temperature superconductors.

UNIT 4 **13 hrs**

Dielectrics and ferroelectrics - Macroscopic electric field**:** Depolarization field. Local electric field at an atom **:** Lorentz field. Dielectric constant and polarizability- electronic polarizability –classical theory of electronic polarizability. Structural phase transitions. Ferroelectric crystals **:** Classification of ferroelectric crystals. Displacive transitions**:** Soft Optical Phonons – Landau theory of the phase transition – second order transition – first transition – antiferroelectricity – ferroelectric domains – piezoelectricity.

UNIT 5 **15 hrs**

Diamagnetism and paramagnetism - Langevin diamagnetism equation. Quantum theory of diamagnetism of mononuclear systems. Paramagnetism- Quantum theory of Para magnetism: Rare earth ions, Hund rules. Paramagnetic susceptibility of conduction electrons

Ferromagnetism and Antiferromagnetism- Ferromagnetic order: Curie point and the exchange integral **–** Magnons **:** Dispersion relation of magnons.

Ferrimagnetic order **:** Curie temperature and susceptibility of ferrimagnets. Antiferromagnetic order **:** susceptibility below Neel temperature. Ferromagnetic domains**:** Anisotropy energy, Transition region between domains

UNIT –VI DYNAMISM (Evaluation Pattern-CIA only) | **Change-5%**

Recent developed crystals in superconductors, dielectrics, ferroelectrics, Ferromagnetic, antiferromagnetic, ferrimagnets - study of any two crystals for each – their structure, properties and applications. Explain spintronics and their applications. (From published research papers).

BOOKS FOR STUDY:

2. Introduction to Solid State Physics VIII Edition – Charles Kittel-
   Unit 1: Ch-14 (page 394 to page 416 only and pages 420 to 421 only),
   Ch-15 (pages 435 to 441 only)
   Unit 2: Ch-10(page 259 to page 279 only), Ch-20 .
   Unit 3: Ch-10 (from page 279 to page 293 only)
   Unit 4: Ch- 16
   Unit 5: Ch-11 (page 299 to page 306 only and pages 315 to 317 only) ,
   Ch - 12 (page 323 to page 325 only and pages 330 to 333, 336 to 338 excluding antiferromagnetic magnons, then include pages 340 to 343 only, 346 to 350 only)

BOOKS FOR REFERENCE

1. Omar, M.A.- Elementary Solid State Physics: Principles and applications- Addison Wesley- First Indian Reprint, 2000.
2. Srivastava, J.P. - Elements of Solid State Physics –Prentice Hall of India Private Ltd.
II Edition.
3. Pillai, S.O. - Solid State Physics- S.O.Pillai Revised and enlarged edition- Wiley Eastern Ltd. New Age International Ltd.

Total Change-5%

OLD

FATIMA COLLEGE (Autonomous), Madurai-18

DEPARTMENT OF PHYSICS- Semester III

ADVANCED QUANTUM MECHANICS – PG4P18

(Modified in the year 2017)

5hrs/week **5 credits**

Objective: This course deals with the approximation methods for stationary states, evolution of time concepts, scattering theory and relativistic quantum mechanics.

After completion of the course, Students will be able to

CO1: Gain the knowledge of time independent perturbation theory and application of charge particle in a electromagnetic field

CO2: Solve quantum mechanical problems using variation method and solve one dimension Schrödinger equation using WKB approximation method

CO3: Explain Quantum mechanical theory of partial wave method

CO4: Insight of dipole approximation, harmonic perturbation, Fermi's Golden rule

CO5: Derive Relativistic wave equations using Klien Gordan and Dirac formulations

UNIT1.APPROXIMATION METHODS FOR STATIONARY STATES: 14 hrs

Perturbation theory for discrete levels: Equations in various order of perturbation theory – The Nondegenerate case.-The first order - The second order – The degenerate case-Removal of degeneracy – The effect of an electric field on the energy levels of an atom (Stark effect): (a) The ground state of the hydrogen atom (b) The first excited level of the hydrogen atom

UNIT 2: **15 hrs**

The variation method: Upper bound on ground state energy application to excited states- Trial function linear in variational parameters – The hydrogen molecules.

The WKB Approximation-The one dimensional Schrödinger equation: a) the asymptotic solution b) solution near a turning point c) matching at a linear turning point d) Asymptotic connection formula-The Bohr – Sommerfeld Quantum condition.

UNIT 3: SCATTERING THEORY **16 hrs**

The scattering cross section : General considerations- Kinematics of the scattering process : Differential and total cross- section- wave mechanical picture of scattering : the scattering amplitude- Green's functions: formal expression for scattering amplitude- the Born approximation -validity of the Born- approximation – the Born series.

Partial wave Analysis – Asymptotic Behavior of Partial waves: Phase shifts: a) Partial waves b) Asymptotic form of radial function c) Phase shifts – the scattering amplitude in terms of phase shifts – the differential and total cross sections: optical theorem. .

UNIT 4: EVOLUTION WITH TIME 16 hrs

Perturbation theory for time evolution problems: Perturbative solution for transition amplitude – Selection rules – First order transitions : Constant perturbation a) Transition probability b)closed spaced levels:constant transition rate- Harmonic perturbations a) amplitude for transition with change of energy b) Transitions induced by incoherent spectrum of perturbing frequencies – Interaction of an atom with electromagnetic radiation – The dipole approximation: selection rules – the Einstein coefficients : Spontaneous Emission.

UNIT 5: RELATIVISTIC WAVE EQUATIONS 14 hrs

Generalization of the Schrodinger Equation: The Klein-Gordon equation:

Plane wave solution; charge and current densities- Interaction with electromagnetic fields; Hydrogen like atom.

The Dirac Equation: Dirac's relativistic Hamiltonian- Position probability density: expectation values- Dirac matrices- Plane wave solutions of the Dirac equation : energy spectrum- The spin of the Dirac particle – Significance of negative energy states; Dirac particle in Electro magnetic fields -Spin magnetic moment- The spin orbit energy.

BOOK FOR STUDY:

A Text book of Quantum Mechanics – P.M. Mathews and K. Venkatesan (Second Edition) – Tata Mc Graw- Hill Publishing Company Limited New Delhi.

Chapters:5,6,9&10

Unit I : 5.1-5.4,

Unit II : 5.6-5.9, 5.11-5.13

Unit III : 6.1-6.6, 6.8-6.11(a)

Unit IV : 9.7, 9.12-9.15

Unit V : 10.1-10.10, 10.15(b),10.16

Books for reference:

1) Relevant sections from Quantum Mechanics by I. A.Schiff
2) Problems in Quantum Mechanics by S. Balasubrahmanian.
3) Quantum Mechanics by G. Aruldas-Prentice Hall
4) Quantum Mechanics by Ajoy Ghatak & S. Lokanathan
5) Advanced Quantum Mechanics by Sathya Prakash-TMGH
6) Quantum Mechanics by V. Devanathan-Narosa

NEW

II M.Sc.

SEMESTER –IV

For those who joined in 2019 onwards

5%

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG4P18	Advanced Quantum Mechanics	PG Core	6	5

COURSE DESCRIPTION

This course deals with the approximation methods for stationary states, evolution of time concepts, scattering theory and relativistic quantum mechanics.

COURSE OBJECTIVES

- Gain knowledge of time independent perturbation theory and application of charge particle in a electromagnetic field
- Solve quantum mechanical problems using variation method and solve one dimension Schrödinger equation using WKB approximation method
- Insight of dipole approximation, harmonic perturbation, Fermi's Golden rule
- Derive Relativistic wave equations using Klien Gordan and Dirac formulations

UNITS

UNIT –I APPROXIMATION METHODS FOR STATIONARY STATES

(14 HRS.)

Perturbation theory for discrete levels: Equations in various order of perturbation theory – The Non degenerate case.-The first order - The second order – The degenerate case- Removal of degeneracy – **The effect of an electric field on the energy levels of an atom (Stark effect):** (a)

The ground state of the hydrogen atom (b) The first excited level of the hydrogen atom

UNIT –II TITLE (15 HRS.)

The variation method: Upper bound on ground state energy application to excited states- Trial function linear in variational parameters – **The hydrogen molecules.**

The WKB Approximation-The one dimensional Schrödinger equation: a) the asymptotic solution b) solution near a turning point c) matching at a linear turning point d) Asymptotic connection formula-**The Bohr – Sommerfield Quantum condition.**

UNIT –III SCATTERINGTHEORY (16 HRS.)

The scattering cross section : General considerations- Kinematics of the scattering process : Differential and total cross- section- wave mechanical picture of scattering : the scattering amplitude- Green's functions: formal expression for scattering amplitude- the Born approximation -validity of the Born- approximation – the Born series.

Partial wave Analysis – Asymptotic Behavior of Partial waves: Phase shifts: a) Partial waves b) Asymptotic form of radial function c) Phase shifts **– the scattering amplitude in terms of phase shifts** – the differential and total cross sections: optical theorem. .

UNIT –IV EVOLUTIONWITHTIME (16 HRS.)

Perturbation theory for time evolution problems: Perturbative solution for transition amplitude – Selection rules – First order transitions : Constant perturbation a) Transition probability b)closed spaced levels: constant transition rate- Harmonic perturbations a) amplitude for transition with change of energy b) Transitions induced by incoherent spectrum of perturbing frequencies – Interaction of an atom with electromagnetic radiation – The dipole approximation: selection rules – **the Einstein coefficient: Spontaneous Emission**

UNIT –V RELATIVISTIC WAVE EQUATIONS (14 HRS.)

Generalization of the Schrodinger Equation: The Klein-Gordon equation:

Plane wave solution; charge and current densities- Interaction with electromagnetic fields; Hydrogen like atom. The Dirac Equation: Dirac's relativistic Hamiltonian- Position probability density: expectation values- Dirac matrices- Plane wave solutions of the Dirac equation : energy spectrum- The spin of the Dirac particle – Significance of negative energy states; **Dirac particle in Electromagnetic fields -Spin magnetic moment- The spin orbit energy.**

Change - 5%

UNIT –VI DYNAMISM (Evaluation Pattern-CIA only) (2 HRS.)

Application of quantum mechanics in the current field

REFERENCES

Total Change - 5%

1 . P.M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics, Second Edition– Tata Mc Graw- Hill Publishing Company Limited New Delhi.

Chapters:5,6,9&10

Unit I : 5.1-5.4,

Unit II : 5.6-5.9, 5.11-5.13

Unit III : 6.1-6.6, 6.8-6.11(a)

Unit IV : 9.7, 9.12-9.15

Unit V : 10.1-10.10, 10.15(b),10.16

WEB REFERNCES :(OPTIONAL):

NPTEL online courses – Relevant videos for Quantum mechanics.

OLD

IV SEMESTER
MAJOR ELECTIVE
MATERIAL SCIENCE - PG4PE2A

(For those who joined in 2019 onwards)

HOURS/WEEK: 5 **CREDIT:4**

COURSE DESCRIPTION

Materials science occupies the centre of the innovative research area. This course deals with the various crystal growth techniques, characterization methods, thin films, nano materials and other types of materials such as polymers and ceramics and glass.

COURSE OBJECTIVE/S

The course enables the student

- To study various crystal growth techniques
- To understand the characterizations techniques like TEM, SEM, TGA, XRD.
- To analyse the machanisms of Ceramics, Polymers and composites
- To discuss and explain various preparatory and measurements of thin film.
- To distinguish carbon nanotubes & carbon nanomaterials and their preparatory techniques.

COURSE OUTCOMES (CO)

No.	Course Outcome	Knowledge Level(According to Bloom's Taxonomy)
CO 1	Deduce the expressions of Nucleation phenomena and explain various Crystal growth techniques	K1 and K2
CO 2	understand the concepts of Diffraction analysis, Thermal analysis and Electron microscopy used in crystal characterisation	K1 and K2
CO 3	explain the mechanism of molecular movements in Ceramics, Polymers and Composites	K1 and K2
CO 4	Analyse various methods of preparing thin films and its measurement techniches	K1, K2 and K3

CO 5	: Explore novel methods of preparing carbon nanomaterials and carbon nanotubes.	K1, K2 and K3

UNIT I **(12 hours)**

Crystal growth techniques

Aqueous solution growth-nucleation-classical theory of nucleation,Gibbs Thompson equation-heterogeneous nucleation- crystal growth from melt-Bridgeman technique-Czochralski technique-zone melting technique-chemical vapour technique-liquid phase epitaxy-**vapour phase epitaxy(self study)**.

UNIT II **(12 hours)**

Characterization methods

Diffraction analysis- X-Ray diffraction-electron and neutron diffraction-interpretation of diffraction pattern-cell parameter determination.

Thermal analysis- Thermo gravimetric analysis-**differential thermal analysis-differential scanning calorimetry(self study)**.

Electron microscopy-TEM, SEM –mode of operation-instrumental details-elemental analysis.

UNIT III **(12 hours)**

Ceramics, Polymers and Composites

Ceramics- Classification of ceramics-general properties of ceramics-general

properties and applications of selected engineering ceramics.

Polymers-Types of polymer-polymerization-crystallinity-thermosets-additivesstructure of polymers-mechanism of molecular movement in polymers-**general properties and applications of thermo plastics(self study)**-general properties and applications of thermosetting plastics-elastomers.

UNIT IV **(12 hours)**

Thin Films

Preparation of thin films- Thermal evaporation-**flash evaporation(self study)**- electron gun beam method-cathodic sputtering –chemical vapour deposition- chemical deposition.Thickness measurements-Ellipsometry –interferometry-multiple beam interferometer-Fizeau technique-fringes of equal chromatic order (FECO) method.

UNIT V **(12 hours)**

Nano powders and Nano materials :

What are nano materials? – preparation-plasma arcing-chemical vapour deposition -Sol-gels – electrodeposition – ball milling – using natural nanoparticles-**applications of nanomaterials**.

The Carbon age

New forms of carbon – types of nanotubes- formation of nanotubes

assemblies-purification of carbon nanotubes – the properties of carbon nano tubes - **uses of nanotubes (self study)**

Books for study

Unit I&II (Relevant sections)

1. Crystal growth processes and methods, by P.Santhana Raghavan, P. Ramasamy.

2. Solid state chemistry and its applications, by Antony R.West.

3. Materials science and engineering-A first course by V.Raghavan.

4. Encyclopidia of materials characterization by C.Richard Brundle, Charles A.Evans and Shaun Wilson.

Unit III- Materials science and Engineering – an introduction (V edition) by William.D. Callister, Jr.

Unit IV-Thin Film fundamentals by A.Goswami.(New age International, (P) Ltd.)- Chapter: 1

Unit V- Nanotechnology by Mick Wilson, K.K.G.Smith, M.Simmons, &B.Raguse (Overseas Press)- Chapters: (3.1-3.9)&(4.1-4.7).

II M.Sc.

NEW

SEMESTER –IV

For those who joined in 2019 onwards

5%

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG4PE2A	MATERIAL SCIENCE	PG core	4	4

COURSE DESCRIPTION

Materials science occupies the centre of the innovative research area. This course deals with the various crystal growth techniques, characterization methods, thin films, nano materials and other types of materials such as polymers and ceramics and glass.

COURSE OBJECTIVES

The course enables the student to study various crystal growth techniques and understand the characterizations techniques like TEM, SEM, TGA, XRD. Also to analyse the mechanisms of Ceramics, Polymers and composites and discuss and explain various preparatory and measurements of thin film and distinguish carbon nanotubes & carbon nanomaterials and their preparatory techniques.

UNITS 6

UNIT –I CRYSTAL GROWTH TECHNIQUES (12 HRS.)

Aqueous solution growth-nucleation-heterogeneous nucleation- crystal growth from melt-Bridgeman technique- Czochralski technique-zone melting technique-**liquid phase epitaxy(self study)**.

UNIT –II CERAMICS, POLYMERS AND COMPOSITES (12 HRS)

Ceramics- Classification of ceramics-general properties of ceramics-general properties and applications of selected engineering ceramics.

Polymers-Types of polymer-polymerization-thermosets-additives-structure of polymers-mechanism of molecular movement in polymers-**general properties andapplications of thermo plastics(self study)**

UNIT –III THIN FILMS(12 HRS)

Preparation of thin films- Thermal evaporation-**flash evaporation(self study)**- electron gun beam method-cathodic sputtering –chemical vapour deposition.Thickness measurements-Ellipsometry –interferometry-multiple beam interferometer-Fizeau technique-fringes of equal chromatic order (FECO) method.

UNIT –IV NANO POWDERS AND NANO MATERIALS (12 HRS)

What are nano materials? – preparation-plasma arcing-chemical vapour deposition -Sol-gels – electrodeposition – ball milling – using natural nanoparticles-**applications of nanomaterials**.

The Carbon age

New forms of carbon – types of nanotubes- formation of nanotubes

assemblies-purification of carbon nanotubes – the properties of carbon nano tubes - **uses ofnanotubes (self study)**

UNIT –V CHARACTERIZATION METHODS (12HRS)

Diffraction analysis- X-Ray diffraction-interpretation of diffraction pattern-cell parameter determination.

Thermal analysis- Thermo gravimetric analysis-**differential thermal analysis-differential scanning calorimetry(self study)**.

Electron microscopy-TEM, SEM –mode of operation-instrumental details-elemental analysis.

Change - 5%

UNIT –VI DYNAMISM (Evaluation Pattern-CIA only) (4 HRS.)

Sensors, solar cell, opto electronic devices

REFERENCES:

Total Change - 5%

Unit I&V (Relevant sections)

1. Crystal growth processes and methods, by P.Santhana Raghavan, P. Ramasamy.

2. Antony R.West,Solid state chemistry and its applications

3. V.Raghavan, Materials science and engineering-A first course.

4. C.Richard Brundle, Charles A.Evans and Shaun Wilson

Encyclopidia of materials characterization

Unit II- William.D. Callister, Jr. Materials science and Engineering – an introduction (V edition)

Unit III- A.Goswami, Thin Film fundamentals by (New age International (P) Ltd.)

Unit IV- Mick Wilson, K.K.G.Smith, M.Simmons, & B.Raguse, Nanotechnology by (Overseas Press)

WEB REFERNCES :

https://www.elsevier.com/physical-sciences-and-engineering/materials-science

https://www.sciencedirect.com/referencework/9780128035818/materials-science-and-materials-engineering

http://www.istl.org/02-spring/internet.html

http://igorivanov.tripod.com/physics/materials.html

OLD

IV SEMESTER
MAJOR/ALLIED/ELECTIVE/SKILL BASED CORE
ASTROPHYSICS – PG4PE2B
(For those who joined in 2019 onwards)

HOURS/WEEK: 5 **CREDIT:4**

COURSE DESCRIPTION

This course intends to give an insight into versatile concepts of astronomy namely origin and evolution of universe, observation techniques, stellar evolution, fate of stars and various mechanisms of stellar energy generation.

COURSE OBJECTIVE/S

This course gives an overview of the universe and imparts knowledge on the sense of size and time for astronomical observation techniques. It gives a complete description of the fate of stars comprising of its birth, evolutionary stages and its ultimate fate. Also the origin , evolution and future course of the universe is detailed out.

COURSE OUTCOMES (CO)

This course enables the students to

No.	Course Outcome	Knowledge Level(According to Bloom's Taxonomy)
CO 1	outline variety of objects in the Universe with a sense of scale for size and time and different types of observing techniques, instruments used in Astronomy.	K1/K2/K3
CO 2	quire knowledge about the stellar evolution and mechanism of stellar energy generation	K1/K2/K3
CO 3	gain an idea of fate of massive stars exploding as dazzling supernovae and medium mass stars	K1/K2/K3

	condensing as neutron stars	
CO 4	explain the surface features and regions of the nearest star Sun and the impacts of the solar activities on earth.	K1/K2/K3
CO 5	obtain knowledge about the origin and evolution of the Universe and comprehend its future course..	K1/K2/K3

UNIT I: [15 HRS]

The universe – an overview-a sense of scale-a sense of time-value of astronomy. (self study).

Light and Telescopes-The spectrum-the spectral lines-what a telescope is-refracting telescopes-reflecting telescopes-spectrscopy-recording the data-electronic imaging devices-observing at short wavelengths-ultraviolet and X-ray astronomy-X-ray telescopes-observing at long wavelength-infrared astronomy-radio astronomy

UNIT II: [15 HRS]

Contents

Stellar evolution-stars in formation-stellar energy generation-atoms-stellar energy cycles-the stellar prime of life-(the neutrino experiment)-dying star-red giant-planetary nebula-white dwarfs-white dwarfs and the theory of relativity-**novae-(evolution of binary stars).(selfstudy)**

UNIT III: [15 HRS]

Contents

Red super giants-supernovae-(cosmic rays)-neutron stars-discovery of pulsars-what are pulsars-(gravitational waves.)-the formation of stellar black hole-the photon sphere-the event horizon-rotating black hole – **detecting a black hole-non-stellar black holes (self study)**

UNIT IV: [15 HRS]

Contents

The sun-basic features of the sun-the photosphere-the chromosphere-the corona-space observations of the chromosphere and the corona-sunspots and other solar activity-solar-terrestrial relations-**solar wind-solar constant. (self study)**

UNIT V: [15 HRS]

Comets-meteoroids-astroids-chiron. Structure of Milky way galaxy-nebluae-center of our galaxy-**high-energy sources in our galaxy. (self study)** Quasars-discovery-red shift in Quasars-importance of Quasars. Big Bang theory-General relativity theory and cosmology-steady state theory.

TEXT BOOKS:

CONTEMPORARY ASTRONOMY-JAY M. PASCHOFF

UNIT I : Chapter1-1.1-1.3, 2.1-2.5,2.10-2.13.

UNIT II : Chapter8-8.1-8.7, 9.1-9.3,9.4,9.5,9.6.9.8

UNIT III : Chapter10-10.1,10.2,(10.3),10.4,10.5,10.7,(10.12),11.1-11.6

UNIT IV : Chapter7 – 7.1-7.10

UNIT V : Chapter 20-20.1-20.4, 22.1-22.3, 27.2-27.4, 26.1- 26.3.

REFERENCE BOOKS:

1. An introduction to astrophysics by Baidhyanath Basu
2. An introduction to Modern Astrophysics by Bradley W. Caroll and Dale A.Ostlie

NEW

II M.Sc.,PHYSICS

SEMESTER –IV

(*For those who joined in 2019 onwards*) **5%**

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG4PE2B	ASTROPHYSICS	PG Core	4 Hrs.	4

COURSE DESCRIPTION

This course intends to give an insight into versatile concepts of astronomy namely origin and evolution of universe, observation techniques, stellar evolution, fate of stars and various mechanisms of stellar energy generation.

COURSE OBJECTIVES

This course gives an overview of the universe and imparts knowledge on the sense of size and time for astronomical observation techniques. It gives a complete description of the fate of stars comprising of its birth, evolutionary stages and its ultimate fate. Also the origin , evolution and future course of the universe is detailed out.

UNITS

UNIT I: LIGHT AND TELESCOPE [12 HRS]

Light and Telescopes-The spectrum-the spectral lines-what a telescope is-refracting telescopes-reflecting telescopes-spectrscopy-recording the data-electronic imaging devices-observing at short wavelengths-ultraviolet and X-ray astronomy-X-ray telescopes-observing at long wavelength-infrared astronomy-radio astronomy

UNIT II: STELLAR EVOLUTION [12 HRS]

Stellar evolution-stars in formation-stellar energy generation-atoms-stellar energy cycles-the stellar prime of life-(the neutrino experiment)-dying star-red giant-planetary nebula-white dwarfs-white dwarfs and the theory of relativity-**novae-(evolution of binary stars).(selfstudy)**

UNIT III: PULSERS **[12 HRS]**

Red super giants-supernovae -(cosmic rays)-neutron stars-discovery of pulsars-what are pulsars-(gravitational waves.)-The formation of stellar black hole-the photon sphere-the event horizon-rotating black hole – **detecting a black hole-non-stellar black holes (self study)**

UNIT IV: SUN **[12 HRS]**

The sun-basic features of the sun-the photosphere-the chromosphere-the corona-space observations of the chromosphere and the corona-sunspots and other solar activity-solar-terrestrial relations-**solar wind-solar constant. (self study)**

UNIT V: GALAXY **[12 HRS]**

Comets-meteoroids-astroids-chiron. Structure of Milky way galaxy-nebluae-center of our galaxy-**high-energy sources in our galaxy. (self study)** Quasars-discovery-red shift in Quasars-importance of Quasars. Big Bang theory-General relativity theory and cosmology-steady state the

Change - 5%

UNIT – 6 DYNAMISM **[1**

Impact of black holes on earth atmosphere

Total Change - 5%

TEXT BOOKS:

CONTEMPORARY ASTRONOMY-JAY M. PASCHOFF

UNIT I : Chapter1-1.1-1.3, 2.1-2.5,2.10-2.13.
UNIT II : Chapter8-8.1-8.7, 9.1-9.3,9.4,9.5,9.6.9.8
UNIT III : Chapter10-10.1,10.2,(10.3),10.4,10.5,10.7,(10.12),11.1-11.6
UNIT IV : Chapter7 – 7.1-7.10
UNIT V : Chapter 20-20.1-20.4, 22.1-22.3, 27.2-27.4, 26.1- 26.3.

REFERENCE BOOKS:

3. An introduction to astrophysics by Baidhyanath Basu
4. An introduction to Modern Astrophysics by Bradley W. Caroll and Dale A.Ostlie.

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