RAJEEV GANDHI GOVT. POST GRADUATE COLLEGE,

AMBIKAPUR, SURGUJA (CG), INDIA

Learning Outcomes based Curriculum Framework

FOR

MASTER OF SCIENCE PROGRAMME

IN

PHYSICS

SEMESTER SYSTEM (CBCS)

SESSION 2023-2024

DEPARTMENT OF PHYSICS

VISION

The vision of the Physics Department is to provide in proficiency both in depth understanding of principles and concept of Physics, theoretical and experimental Physics. The Department aims to enhance the students' knowledge in basic and applied physics. To inculcate aptitude for a research career in academia or industry by introducing advanced ideas and techniques that are applicable while emphasizing the underlying concepts of Physics.

MISSION

- To impart quality education in Physics such that they aim to become Scientists in reputed Research Organisations. To make the students effectively disseminate their knowledge in Physics to coming generations..
- Develop the capacity and know -how to apply principles/laws of Physics to solve the problems. The ability to do and interpret the data obtained in experiments. To become a center of excellence and extend research facilities.
- Apply the Physics knowledge for sustainable development useful for society. Assume responsibility and always practice ethical principles. To function effectively as individual as well as in a team.

PROGRAMME OUTCOMES (POs)

PO1	Knowledge	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study
PO2	Research Aptitude	Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusion from the analysis
PO3	Communication	Ability to communicate effectively on general and scientific topics with the scientific community and with society at large
PO4	Problem Solving	Capability of applying knowledge to solve scientific and other problems
PO5	Individual and Team Work	Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings.
PO6	Investigation of Problems	Ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
PO7	Modern Tool usage	Ability to use and learn techniques, skills and modern tools for scientific practices
PO8	Science and Society	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities

		relevant to the professional scientific practices
PO9	Life-Long Learning	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life
PO10	Project Management	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects

PROGRAMME SPECIFIC OUTCOMES (PSOs)

After successful completion of M. Sc. Physics program, the students will

PSO1	Acquire an in-depth understanding and knowledge of the core areas of Physics encompassing mathematical physics, classical mechanics, quantum mechanics, electrodynamics, and statistical mechanics for explicating physical phenomena covering wide length and time scales.
PSO2	Be capable of applying the core physical laws to unravel a multitude of physical properties, processes, and effects involving radiation, nuclei, atoms, molecules, and bulk forms of matter.
PSO3	Develop hands-on skills for carrying out elementary as well as advanced experiments in different sub-fields of Physics viz. condensed matter physics, nuclear physics, particle physics, materials science, computational physics & electronics, along with enhancing their understanding of physical concepts and theories.
PSO4	Attain abilities of critical thinking, problem mapping & solving using fundamental principles of Physics, systematic analysis & interpretation of results, and unambiguous oral & writing/presentation skills.
PSO5	Have robust foundation in basic and practical aspects of Physics enabling them to venture into research in front-line areas of physical sciences, and career as Physics teachers and scientists.

Graduate Attributes

1. In depth understanding of the fundamental concepts of physics.
2. Ability to undertake problems in multidisciplinary domains of Science & Technology viz. Space Science, Medical Physics, Plasma Science, Quantum Technologies, Advanced Materials Science, Computational Techniques, etc.
3. Ability to apply the acquired knowledge of Physics to Engineering Problems.
4. Understanding of basic tools of computational physics and their application in various domains of physics and engineering.
5. Ability to perform the experiments and analyze the experimental data based on acquired knowledge in the domains of electronics, atomic and nuclear physics, condensed matter physics, optics and Lasers, and other advanced topics.
6. Skills to demonstrate basic principles of physics by use of simple experimental as well as high end experimental techniques.
7. Ability to develop advanced functional materials and carry out their characterization.
8. Ability to design, fabricate and characterize device structures such as sensors, solar cells, optical components, etc. for various applications.
9. Ability to make effective oral and written technical communication.
10. Appreciation and adherence to norms of professional ethics.

The Programme learning outcomes relating to M.Sc. Programme in Physics:

Upon the successful completion, graduates of the MSc program are expected to be able to:

1. Demonstrate high-level knowledge in advanced classical mechanics, quantum mechanics, electrodynamics and statistical mechanics and apply it to complex problems in physics and in other areas.
2. Use appropriate advanced mathematical and computational tools to solve problems in physics.
3. Demonstrate the ability to successfully complete a research or design a project. This includes demonstrating skills such as assembling and conducting experiments, explaining the physical basis of the operation of an apparatus and interpretation of results of measurement or using appropriate theoretical and computing tools to model and analyze data.
4. Work independently and within a team
5. Demonstrate writing and oral communication skills.
6. Demonstrate integrity, professionalism and honesty in their work.
7. Knowledge and deep understanding of principles of basic and applied physics
8. Subject knowledge to pursue higher studies in the advanced physics areas, such as, High Energy Physics, Astrophysics, Quantum Information Processing, Nanotechnology, Plasma Technology, Nonlinear Optics, Fibre Optics, etc.
9. Knowledge of fabrication and characterization of devices, such as, solar cells, gas sensor, energy storage, magnetic data storage, etc.
10. Skills in certain experimental techniques for characterization of materials f or their structural, morphological, surface topology, electrical, magnetic, dielectric and optical properties.
11. Knowledge and skills to use various vacuum based techniques for development of thin film based materials, structures, and plasma devices and systems.
12. Technical knowledge and skills to understand and appreciate interdisciplinary research topics.
13. Skills in computational physics for wide range of applications ranging from the visualization of physical theories and process, design of functional materials, simulation and modelling of optical processes, etc.
14. Written and Oral technical communication skills.

PROGRAM OUTCOMES (PO) IN RELATION TO GRADUATE ATTRIBUTES PROGRAMME OUTCOMES

At the completion of the M.Sc. Physics program, the students of our Department will be able to:

PO 1	**Distinctive Academic curriculum**:	Mathematical Physics, Classical Mechanics, Advanced Electromagnetic Theory, Electronics, Atomic and Molecular Physics, Quantum Mechanics, Solid State Physics, Nuclear Physics, Numerical Methods and Computer Programming, and project-based learning have acquired knowledge and skill in problem solving.
PO 2	**Qualified and Competent Faculty Members:**	Become professionally trained.
PO 3	**Transfer of Knowledge through Scholarly Activities:**	Demonstrate highest standards of academic excellence.
PO 4	**Interdisciplinary Project-based Learning:**	Excel in the research related to Physics and Materials characterization.
PO 5	**State-of-the-Art Laboratories:**	Become professionally competent in the area of electronics, and microcontrollers.
PO 6	**Exceptional Computational Facilities:**	Develop a knowledge in C programming and critical computing skills.

PO 7	**Internship Program:**	Industry interaction, secure good references and recommendations.
PO 8	**Mentorship**:	Build a strong resume, help guide career goals, Abroad opportunities.
PO 9	**Soft Skill:**	Interpersonal and communication skills as well as a commitment to life-long learning.
PO 10	**Electives**, Extra	Acquire specific and in-depth knowledge to present and
	Disciplinary Paper:	publish research findings.

The M. Sc. programme is a two-year course divided into four-semesters. The syllabus and schemes of examination are detailed herewith.

The M.Sc. course shall consist of 20 theory courses. The M.Sc. Physics Programme would make the students competent in a natural science, viz., Physics, and help them understand its role in modern day technology. Overall, the course would enable the students to understand the fundamental concepts and experimental methods of physics which would help them to innovate/apply/generate new devices/applications/insights/knowledge. Knowledge gained through the open electives would be an asset in branching out in fields other than physics.

In I/II/III/IV semester there shall be five theory courses each of 70 marks and 30 marks for internal assessment test. In internal assessment, there will be 10 marks for written test, 10 marks for assignment and 10 marks for a seminar in each paper.

Thus there shall be T/I=100 marks for each paper, minimum passing / qualifying marks shall be 36% in each theory/internal assessment. Candidate will be required to pass separately in each theory and internal assessment.

ACADEMIC PROGRAMMES & SCHEMES
M.Sc. (Physics)

FIRST SEMESTER (CBCS System)

Paper	Course Type	Course (Paper/Subjects)	External Written Test		Cont. Int. Valuation				
			Max. Marks	Ql. Marks	W. test	Seminar	Assignment	Total	Grand Total
I.	CCC	Mathematical Physics	70	25	10	10	10	30	100
II.	CCC	Lab course A	-	-	-	-	-	-	100
III	CCC	Lab Course B	-	-	-	-	-	-	100
IV	CCC	Classical Mechanics	70	25	10	10	10	30	100
V	CCC	Quantum Mechanics- I	70	25	10	10	10	30	100
VI	PRJ/FST /EST	Social Outreach & Internship/Entrepreneurship	-	-	-	-	-	-	100
VII	ECC/CB	Constitutionalism &Indian Political System	70	25	10	10	10	30	100
	ECC/CB	Electronic Devices and Applications	70	25	10	10	10	30	100
	ECC/CB	Condensed Matter Physics - I	70	25	10	10	10	30	100
	ECC/CB	High Energy Physics-I	70	25	10	10	10	30	100
TOTAL									700

SECOND SEMESTER (CBCS System)

Paper	Course Type	Course (Paper/Subjects)	External Written Test		Cont. Int. Valuation				
			Max. Marks	Ql. Marks	W. test	Seminar	Assignment	Total	Grand Total
I.	CCC	Electronics	70	25	10	10	10	30	100
II.	CCC	Lab Course A	-	-	-	-	-	-	100
III	CCC	Lab Course B	-	-	-	-	-	-	100
IV	CCC	Atomic and Molecular Physics	70	25	10	10	10	30	100
V	CCC	Quantum Mechanics II	70	25	10	10	10	30	100
VI	OSC	Research methodology & computer Application: basics	70	25	10	10	10	30	100
VII	ECC/CB	Environmental and Forest Laws	70	25	10	10	10	30	100
	ECC/CB	Electronic Instrumentation	70	25	10	10	10	30	100
	ECC/CB	Condensed Matter - II	70	25	10	10	10	30	100
	ECC/CB	High Energy Physics - II	70	25	10	10	10	30	100
TOTAL									700

THIRD SEMESTER

Paper	Course Type	Course (Paper/Subjects)	External Written Test		Cont. Int. Valuation				
			Max. Marks	Ql. Marks	W. test	Seminar	Assignment	Total	Grand Total
I.	CCC	Solid State Physics	70	25	10	10	10	30	100
II.	CCC	Lab Course A	-	-	-	-	-	-	100
III	CCC	Lab Course B	-	-	-	-	-	-	100
IV	CCC	Nuclear and Particle Physics	70	25	10	10	10	30	100
V	CCC	Classical Electro Dynamics	70	25	10	10	10	30	100
VI	OSC	Intellectual Property Rights	70	25	10	10	10	30	100
VII	ECC/CB	Tribal Studies	70	25	10	10	10	30	100
	ECC/CB	Microwave Electronics	70	25	10	10	10	30	100
	ECC/CB	Nano Science	70	25	10	10	10	30	100
	ECC/CB	High Energy Physics - III	70	25	10	10	10	30	100
TOTAL									700

FOURTH SEMESTER

Paper	Course Type	Course (Paper/Subjects)	External Written Test		Cont. Int. Valuation				
			Max. Marks	Ql. Marks	W. test	Seminar	Assignment	Total	Grand Total
I.	CCC	Materials Science and Laser Physics	70	25	10	10	10	30	100
II.	CCC	Lab Course A	-	-	-	-	-	-	100
III.	CCC	Lab Course B	-	-	-	-	-	-	100
IV	SSC/PRJ	Dissertation	-	-	-	-	-	-	100
V	CCC	Spectroscopy	70	25	10	10	10	30	100
VI	CCC	Statistical Physics	70	25	10	10	10	30	100
VII	ECC/CB	Energy Physics	70	25	10	10	10	30	100
	ECC/CB	Satellite Communication and Remote Sensing	70	25	10	10	10	30	100
	ECC/CB	Crystal Growth & Thin film Physics	70	25	10	10	10	30	100
	ECC/CB	Renormalization and Supersymmetry	70	25	10	10	10	30	100
TOTAL									700

M. Sc. in PHYSICS: **FACULTY OF SCIENCE**

FIRST SEMESTER (ODD SEMESTER)

Eligibility Criteria (Qualifying Exams)	Admission Criteria	Course Code	Course Type	Course (Paper/Subjects)	Credits	Contact Hours Per WeeK			EoSE Duration (Hrs.)	
						L	T	P	Thy	P
Bachelor Degree in the concerned subject/ discipline	1) Merit List 2) Entrance Test (written or/and oral) if decided by the University 3) Observance of Reservation Policy.	MSP 101	CCC	**Mathematical Physics**	6	4	3	00	3	0
		MSP 111/112	CCC	**Lab Course A/ Lab Course B**	6	00	00	6	00	6
		MSP 102	CCC	**Classical Mechanics**	6	4	3	00	3	0
		MSP 103	CCC	**Quantum Mechanics I**	6	4	3	00	3	0
		MSP S01	PRJ/FST/EST	Social Outreach and Internship/Entrepreneurship	6	00	00	9	00	4
		MSP A01	ECC/CB	Constitutionalism &Indian Political System	6	4	3	00	3	00
		MSP A02	ECC/CB	Electronic Devices and Applications						
		MSP A03	ECC/CB	Condensed Matter Physics - I						
		MSP A04	ECC/CB	High Energy Physics - I						
		MINIMUM CREDITS IN INDIVIDUAL SUBJECT IS 6 AND IN COMPLETE SEMESTER IT WOULD BE 30			TOTAL= 36					

M.Sc. Semester-I

Paper-I: MSP-101: Mathematical Physics

Course Outcomes

After completing the course the students will able to : -

CO -01- Familiarized with different special functions like Associated Legendre Polynomials, Laguerre's Polynomials, etc. and their solutions in solving different physical problems.

CO -02- To obtain knowledge of Fourier and Laplace Transforms in solving different problems of Mechanics and Electronics etc.

CO -03- Learn about the concept and uses of Tensors and Tensor algebra (Null tensor, addition, subtraction, inner product, outer product).

CO-04- Solve different physical problems which contain complex variables and implementation of complex variable for calculation of integrals, and also able to expand functions in Taylor's and Laurent's series. Knowledge of theorems of residues and contour integration.

CO -05- Obtain the basic knowledge of Group theory and its applications. This theory is also used to describe the crystal symmetry and electronic structure of crystals.

CO-06- Understand the calculus of residue and evaluate some typical definite integral using the Method of contour integration

CO-07- Find explicit expressions of Hermite, Laguerre, Bessel and Legendre polynomials using the corresponding generating functions and derive orthogonality relations and various recurrence relations among these special functions for their applications in solving quantum mechanical ystems.

CO -08- Apply the knowledge of matrices for solving linear algebraic equations and Learn basics of group theory and prepare group multiplication tables for understanding crystallography.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01				✓						
CO-02	✓									
CO-03								✓		
CO-04				✓						
CO-05		✓								
CO-06	✓				✓					
CO-07						✓				
CO-08						✓				

M.Sc. in PHYSICS		FIRST SEMESTER
COURSE CODE: MSP 101	**COURSE TYPE :** CCC	
COURSE TITLE: **MATHEMATICAL PHYSICS**		
CREDIT: 06 **THEORY: 06 PRACTICAL: 00**	**HOURS: 90** **THEORY: 90 PRACTICAL: 00**	
MARKS: 100 **THEORY: 70 CCA : 30**	**PRACTICAL: 00**	

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 15 Hrs.	**Complex Variables & Matrix analysis** Analytic function, Cauchy's Riemann Condition, kinds of singularity, Line integrals and Cauchy's theorem, Cauchy's formula, Taylor and Laurent series, poles, residues, Residue theorem - Application to evaluation of definite integrals, types of matrices, cayley Hamilton theorem, eigen values and eigen functions problems.
UNIT-2 20 Hrs	**Linear Differential equations** First order linear differential equations and Second order linear differential equations - Rodrigue's Formula, Generating Function, Orthogonality, Recurrence formulae of Legendre's functions.
UNIT-3 20 Hrs	**Laplace and Fourier transforms** Laplace transforms, Solution of linear differential equations with constant Coefficients, Fourier integral, Fourier transforms, Fourier sine and cosine transforms, Convolution theorems and its Applications, Fourier Series.
UNIT-4 20Hrs	**Vector and Tensor Analysis** Vector algebra and vector calculus, Definition of scalars, contravariant Vectors and Covariant Vectors - Einstein's summation convention - Definition of tensors - Second rank cartesian tensor, Symmetric and anti-symmetric tensors - tensors of rank higher than two - Covariant derivatives.
UNIT- 5 15Hrs	**Group Theory & probability theory** Definition of groups, subgroups and conjugate classes, Transformation, Matrix representation, Point groups, Reducible and irreducible representations, Probability, types of probabilities, random variables, binomial, poisson and normal distributions.
SUGGESTED READINGS	1. Mathematical Methods for Physicists: George Arfken , Academic Press 2. Applied Mathematics for Engineers and Physicists: L. A. Pipe , McGraw Hill 3. Mathematical Methods - Potter and Goldberg , Prentice Hall of India 4. Elements of Group Theory for Physicists: A.W. Joshi, Wiley Eastern Ltd. 5. Vector Analysis (Schaum Series), McGraw Hill

COURSE CODE: MSP 111			COURSE TYPE : CCC
COURSE TITLE: **Lab Course A**			
CREDIT: 03		HOURS: 90	
THEORY: 00	PRACTICAL: 03	THEORY: 00	PRACTICAL: 100
Marks			
THEORY: 00		PRACTICAL: 100 (EXPERIMENT:60; VIVA-VOCE:20 & SESSIONAL:20)	

LABORATORY WORK MSP 111

LAB COURSE A:

1. To study the characteristics of SCR.
2. To Study the characteristics of TRAIC.
3. To study the characteristics of MOFET.
4. To study the Characteristics of LED.
5. To study the characteristic of an UJT.
6. To study the characteristics of FET.
7. To study the characteristic of a DIAIC.

M.Sc. in PHYSICS			FIRST SEMESTER
COURSE CODE: MSP 112			COURSE TYPE : CCC
COURSE TITLE: Lab Course B			
CREDIT: 03		HOURS: 90	
THEORY: 00	PRACTICAL: 03	THEORY: 00	PRACTICAL: 100
Marks			
THEORY: 00		PRACTICAL: 100 (EXPERIMENT:60; VIVA-VOCE:20 & SESSIONAL:20)	

LABORATORY WORK
MSP 112

LAB COURSE B:

1. To Study the various types of logic gates.
2. To Study the characteristic of NAND gate and its use as a universal gate.
3. To Study of characteristic of NOR gate and its use as a universal gate.
4. To study the Demorgan's theorem.
5. To study the full adder.
6. To study the half adder.
7. To study the BOOLEAN theorem.

M.Sc. Semester-I

Paper-II: MSP-102: Classical Mechanics

Course Outcomes

After completing the course the students will able to : -

CO- 01- To apply Lagrangian and Hamiltonian for solving simple classical dynamics problems.

CO -02- Apply Newton's laws of motion and conservation law of energy, linear and angular momentum to solve advanced problems involving the dynamic motion of classical mechanical system

CO- 03- Solve the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulations of classical mechanics.

CO -04- Explore the application of Hamilton's equations in solving the equation of motion of a particle in a central force field, projectile motion of a body

CO -05- Formulate the equations of rigid body dynamics and demonstrate the examples of non-inertial frames of reference

CO -06- Develop a deep understanding to tackle the problems of small oscillations and special theory of Relativity

CO-07- Newtonian mechanics, Virtual work, DÁlembert's principle, Formulation of Lagrangian mechanics and problem solving with the help of it. Compare the formulation of Hamiltonian and Lagrangian mechanics and solve the problems of classical and relativistic mechanics

CO -08- To understand rigid body dynamics and small oscillations using Lagrangian approach

CO -09- Acquire knowledge of Poisson and Lagrange Brackets and establish relationships between their Properties

CO -10- Demonstrate the concept of motion of a particle under central force and apply advanced methods to deal with central force problems.

CO -11- Use Hamilton-Jacobi theory for finding the solutions of various Classical systems

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01						✓				
CO-02		✓								
CO-03				✓						
CO-04								✓		
CO-05								✓		
CO-06		✓						✓		
CO-07				✓						
CO-08	✓									
CO-09	✓									
CO-10			✓				✓			
CO-11				✓						

M.Sc. in PHYSICS		FIRST SEMESTER
COURSE CODE: MSP **102COURSE TYPE** : **CCC**		
COURSE TITLE: **CLASSICAL MECHANICS**		
CREDIT: 06 **THEORY: 06 PRACTICAL: 00**		**HOURS: 90** **THEORY: 90 PRACTICAL: 00**
MARKS: 100 **THEORY: 70 CCA : 30 PRACTICAL: 00**		

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 15Hours	**Rigid body dynamics** Angular momentum, Rotational kinetic Energy, Moment of inertia of a rigid body principal moment of inertia and principal axes, moment of inertia tensor, Euler's angles, Euler's equations of motion of a rigid body, Torque free motion of a rigid body.
UNIT-2 20Hours	Central force motion, D'Alembert's Principle and Lagrange's Equation, simple applications of Lagrangian formulation. Hamilton Principle, Calculus of Variations, Derivation of Lagrange's equation from Hamilton's principle, Method of Lagrange's multipliers, Conservation theorems and Symmetry Properties, Noether's theorem. Conservation of energy, linear momentum and angular momentum as a consequence of homogeneity of time and space and isotropy of space.
UNIT-3 20 Hours	Generalized momentum, Legendre transformation and Hamilton's Equations of Motion, simple applications of Hamiltonian formulation, cyclic coordinates, Routh's procedure, Hamiltonian Formulation of Relativistic Mechanics, Derivation of Hamilton's canonical Equation from Hamilton's variational principle. The principle of least action.
UNIT-4 20Hrs	Canonical transformation, generating functions and types of generating functions, Lagrange's and Poisson brackets as canonical invariants, equation of motion in Poisson bracket formulation. Infinitesimal contact transformation, Liouvilee's theorem, Hamilton-Jacobi equation and its applications in simple harmonic oscillator and Kepler's problems .
UNIT- 5 15Hrs	Definition of Action and angle variables, Applications of Action and angle variables in simple harmonic oscillator and Kepler's problems, periodic motion, theory of small oscillations in Lagrangian formulation, normal modes and coordinates and its simple applications.

SUGGESTED READINGS	1. H. Goldstein, 2002, Classical Mechanics. 3rd Edition., C. Poole and J.Safko, Pearson Education, Asia, New Delhi. 2. S.N. Biswas, 1998, Classical Mechanics, Books and Allied Ltd., Kolkata. 3. L.D. Landau and E.M. Lifshitz, 1969, Mechanics, Pergomon Press, Oxford. 4. K.R. Symon, 1971, Mechanics, Addison Wesley, London. 5. J.L. Synge and B.A Griffith, 1949, Principles of Classical Mechanics, Mc. Graw-Hill, New York. 6. C.R.Mondal, Classical Mechanics, Prentice - Hall of India, New Delhi. 7. A. Raychoudhary , Classical Mechanics, Oxford University Press

M.Sc. Semester-I

Paper-III: MSP-103: Quantum Mechanics-I

Course Outcomes

After completing the course the students will able to : -

CO -01- Understand and explain the differences between classical and quantum mechanics Learn operator formalism for observables and basic commutation relations.

CO -02- Solve Schrödinger equation for simple potentials like linear Harmonic oscillator and Hydrogen atoms.

CO -03- Understand the space, time and displacement symmetries.

CO -04- Formulate the Heisenberg & Dirac formulation of quantum mechanics-explain various types of imperfections in crystals.

CO -05- Solve the linear harmonic oscillator and hydrogen-like atom problems using Dirac formulation-analyze the mechanisms behind elastic and plastic deformation is solids and compare different strengthening techniques.

CO -06- Demonstrate angular momentum operators associated with spherical and symmetrical systems. -summarize ceramics and its types and relate their applications with properties.

CO -07- Explain scattering theory, formulate and solve scattering equation-classify polymers and composites based on their properties and applications.

CO -08- Apply the Variational principle and WKB Approximation to solve the real problems-Classify nanomaterials, their fabrication techniques and co relate the effects of confinement to nanoscale on their properties.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓									
CO-02				✓						
CO-03	✓									
CO-04								✓		
CO-05				✓						
CO-06						✓				
CO-07				✓						
CO-08						✓	✓			

M.Sc. in PHYSICS	**FIRST SEMESTER**
COURSE CODE: MSP **103**	**COURSE TYPE : CCC**
COURSE TITLE: QUANTUM MECHANICS I	
CREDIT: 06 **THEORY: 06**	**HOURS: 90** **THEORY: 90**
MARKS: 100 **THEORY: 70 CCA : 30**	

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 2 0Hrs.	Basic formalism Wave functions for a free particle – Intrepretation and condition on the wave function- Postulates of quantum Mechanics and the Schroedinger equation - Ehrenfest's theorem – Operator formalism – Linear operator-Self adjoint operators - Expectation Value - Stationary States –Hermitian Operators for dynamical variables - Eigen value and eigen function.
UNIT-2 15Hrs	Applications Ladder operators and simple harmonic oscillator - Step Potential –Particle in a central potential-– Orbital angular momentum and spherical harmonics - Particle in a periodic potential – Central forces and reduction of two body problem.
UNIT-3 15 Hours	General formalism: Hilbert's space - Dirac notation - Representation theory - Co-ordinate and momentum representations - Time evolution – Schroedinger, Heisenberg and interaction pictures – Symmetries and conservation laws.
UNIT-4 20Hrs	Approximation methods Time-independent perturbation theory for non- degenerate and degenerate levels - Application to ground state of anharmonic oscillator - Variation method - Application to ground state of Helium atom - WKB approximation - WKB quantization rule - Application to simple Harmonic Oscillator.
UNIT- 5 20 Hrs	Angular momentum and identical particles Commutation rules for angular momentum operators -Spin angular momentum-Non relativistic Hamiltonian including spin- Addition of two angular momenta - Clebsch Gordan coefficients - Symmetry and anti symmetry of wave functions - Pauli's spin matrices.

SUGGESTED READINGS	1. P.M. Mathews and K. Venkatesan, 1976, A Text book of Quantum Mechanics, Tata McGraw-Hill, New Delhi. 2. L.I. Schiff, 1968, Quantum Mechanics, 3rd Edition, International Student Edition, McGraw-Hill Kogakusha, Tokyo. 3. V. Devanathan, 2005, Quantum Mechanics, Narosa Publishing House, New Delhi. 4. E. Merzbacher, 1970, Quantum Mechanics 2nd Edition, John Wiley and Sons, New York. 5. V.K. Thankappan, 1985, Quantum Mechanics, 2nd Edition, Wiley Eastern Ltd, New Delhi. 6. P.A.M. Dirac, 1973, The Principles of Quantum Mechanics, Oxford University Press, London. 7. L.D. Landau and E.M. Lifshitz, 1976, Quantum Mechanics, Pergomon Press, Oxford. 8.Ashok Das and A.C. Melissions: Quantum Mechanics - A modern approach (Gordon and Breach Science Publishers).

M.Sc. Semester-I

Paper-V: MSP-A01: CONSTITUTIONALISM & INDIAN POLITICAL SYSTEM

Course Outcomes

After completing the course the students will able to : -

CO -01- Have a comprehensive understanding of the meaning, features and characteristics of the Preamble of the Constitution of India.

CO -02- Describe in details the difference between Constitution and Constitutionalism.

CO -03- Compare and contrast the different forms of government, namely – unitary and federal, parliamentary and presidential with particular reference to Indian Political System.

CO -04- Demonstrate an in-depth knowledge of the concepts of Citizenship, Fundamental Rights, Constitutional amendment procedures and the judicial system in India.

CO -05- Explain in detail the Legislative, Executive and Judicial structure in the Government of India.

CO- 06- Critically analyse the process of devolution and decentralization of powers in relation to centre-state government.

CO -07- Show interest in research studies in relevant topics, like – decentralization of governance, local self-governance.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓									
CO-02										✓
CO-03	✓									
CO-04						✓				
CO-05						✓				
CO-06		✓				✓				
CO-07		✓								

M.Sc. in PHYSICS		FIRST SEMESTER
COURSE CODE: MSPA01COURSE TYPE: ECC/CB		
COURSE TITLE:CONSTITUTIONALISM & INDIAN POLITICAL SYSTEM		
CREDIT: 06 **THEORY: 06**		**HOURS : 90** **THEORY: 90**
MARKS : 100 **THEORY: 70 CCA : 30**		
Scheme of marks: i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words). **iii.** Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words). **iv.** Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).		
UNIT - 1 **12 Hrs**	Unit- I: Meaning: Constitution, Constitutional government & constitutionalism; Difference between Constitution & Constitutionalism; Constitutionalism: Basis, Elements, Features & future. Forms of Government: Democracy & Dictatorship, Unitary & Federal, Parliamentary & Presidential form	
UNIT - 2 **24 Hrs**	Unit-II: Ideals of the Indian Constitution incorporated in the Preamble. Special Features of the Indian Constitution, State and Citizenship, Fundamental Rights, Directive Principles of the State Policy, Fundamental Duties, Judiciary: Supreme Court and High Court, Judicial Review, Judicial Activism and Public Interest Litigation and Provisions relating to Emergency.	
UNIT - 3 10 **H rs**	Unit-III: Union Executive: President, Prime Minister, Council of Ministers, State Executive: Governor, Chief Minister and Council of Ministers. Local Bodies & Panchayati Raj	
UNIT - 4 24 **Hrs**	Unit-IV: Parliament of India, State Legislatures, Legislative Bills: Ordinary, Money and Financial, Procedure to amend the Indian constitution, Union State Relations, Principles of the 'Separation of Power and the 'Principles of Check & Balance'. Political Parties and Pressure Groups. Challenges before Indian Democracy: Terrorism, Regionalism, Communalism, *Linguistics* and National Integration.	
UNIT - 5 20 **Hrs**	Unit-V: Controller & Accountant General of India, Solicitor General, Advocate General, Election Commission, Union and State(s) Public Service Commission, Finance Commission and NHRC	

SUGGESTED READINGS	HOBBES, Thomas, The Leviathan, Chapters XIII & XVII [entry] LOCKE, John, The Second Treatise of Civil Government, Chapter IX [entry] ROUSSEAU, Jean-Jacques, The Social Contract or Principles of Political Right MONTESQUIEU, The spirit of the laws, RAZ, Joseph, "The rule of law and its virtue", in The authority of law, Oxford University Press, 1979 Dicey on British constitution P. Ishwara Bhat Inter-relationship between Fundamental Rights M P Jain Indian Constitutional Law H M Seervai Constitutional Law of India V N Shukla Constitution of India D DBasu Shorter Constitution of India B Sivarao Constitutional Assembly Debates J. V R Krishna Iyer Fundamental Rights and Directive Principles Paras Diwan Human Rights and the Law P K Tripathi Some Insight into Fundamental Rights S P Sathe Fundamental Rights and Amendment to the Constitution P B Gajendragadkar Law, Liberty and Social Justice David Karrys Politics of Law

M.Sc. Semester-I

Paper-V: MSP-A02: Electronic Devices and Applications

Course Outcomes

After completing the course the students will able to : -

CO -01- Understanding the physics of the devices their characteristics and applications, to be able to use them in electronic circuits.

CO -02- Students would develop an insight into the technologies that go into an IC chip that they would be extensively using during and after the course.

CO- 03- In depth understanding would enable the students to appreciate the beauty of the subject and design amplifiers that are technically sound.

CO -04- Students would develop a comprehensive understanding of contemporary integrated circuit amplifier design.

CO -05- Understand the working of latches, flip-flops, designing registers, counters, a/d and d/a converters.

CO -06- Students would be aware of various signal conditioning, processing and generation techniques thus being better equipped to understand their use in larger and complex systems.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓									
CO-02			✓				✓			
CO-03	✓									
CO-04						✓				
CO-05	✓									
CO-06	✓	✓								

M.Sc. in PHYSICS		FIRST SEMESTER
COURSE CODE: MSPA02	**COURSE TYPE** : ECC/CB	
COURSE TITLE: Electronic Devices and Applications		
CREDIT: 06 **THEORY:** 06		**HOURS:** 90 **THEORY:** 90
MARKS: 100 **THEORY:** 70 **CCA :** 30		

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT- 1 20Hrs.	Fabrication of IC and logic families Fabrication of IC - Monolithic integrated circuit fabrication - IC pressure transducers - Monolithic RMS - Voltage measuring device - Monolithic voltage regulators - Integrated circuit multipliers - Intergrated circuit logic - Schottky TTL - ECL - I2L - P and NMOS Logic - CMOS Logic - Tristate logic circuits.
UNIT-2 20Hrs	Opto electronic devices Light sources and Displays - Light emitting diodes - Surface emitting LED - Edge Emitting LED - Seven segment display - LDR - Diode lasers - Photo detectors - Basic parameters - Photo diodes - p-i-n Photo diode - Solar cells - Photo transistors - IR and UV detectors.
UNIT-3 20H rs	Timer and applications 555 Timer - Description - Monostable operation - Frequency divider - Astable operation - Schimitt trigger - Phase Locked Loops - Basic principles - Analog phase detector - Voltage Controlled Oscillator - Voltage to Frequency conversion - PLL IC 565 - Description - Lock-in range - Capture range - Application - Frequency multiplication.
UNIT-4 15Hrs	Op-amp applications Instrumentation amplifier - V to I and I to V converter - Op-amp circuits using diodes - Sample and Hold circuits - Log and Antilog amplifiers - Multiplier and Divider - Electronic analog Computation - Schimitt Trigger - Astable, Monostable Multivibrator - Triangular wave generators - Sine wave generators - Rc Active filters.
UNIT- 5 15Hrs	Pulse and digital Communication Pulse communications - Introduction - Types - Pulse-Amplitude Modulation (PAM) - Pulse Time Modulation - Pulse Width Modulation (PWM) - Pulse Position Modulation (PPM) - Pulse Code Modulation (PCM) - Principles of PCM - Quantizing noise - Generation and Demodulation of PCM - Effects of Noise - Advantages and applications of PCM - Pulse systems - Telegraphy - Frequency-Shift keying - Telemetry - Digital communication - Modem classification - Modes of modem operation - Modem interconnection - Modem interfacing.

SUGGESTED READINGS	1. S.M. Sze, 1985, Semiconductor Devices - Physics and Technology, Wiley, New York. 2. Millman and Halkias, Integrated Electronics, McGraw-Hill, New Delhi. 3. R.A. Gaekwad, 1994, Op-Amps and intergrated circuits EEE. 4. Taub and Shilling, 1983, Digital Integrated Electronics, McGraw-Hill, New Delhi. 5. J. Millman, 1979, Digital and Analog Circuits and Systems, McGraw-Hill, London. 6. George Kenndy, 1987, Electronic communication systems 3rd Edition, McGraw-Hill, London. 7. R.F. Coughlin and F.F, Driscol, 1996, Op-Amp and linear integrated circuits, Prentice Hall of India, New Delhi. 8. M.S.Tyagi, Introduction to Semiconductor Devices, Wiley, New York. 9. P. Bhattacharya, 2002, Semiconductor Optoelectronic Devices, 2nd Edition, Prentice-Hall of India, New Delhi. 10. Deboo/ Burrous, 1985, Integrated circuits and semiconductor Devices - Theory and application, McGraw-Hill, New Delhi. 11. D. Roy Choudhury, 1991, Linear integrated circuits, Wiley Eastern, New Delhi. 12. Ramakant Gaekwad, 1981, Operational amplifiers, Wiley Eastern, New Delhi.

M.Sc. Semester-I

Paper-V: MSP-A03: CONDENSED MATTER PHYSICS – I

Course Outcomes

After completing the course the students will able to : -

CO -01- Have an understanding of basic physical concepts (like band gap, holes, effective mass, etc.) related to semiconductors.

CO-02- Appreciate the concept and importance of Fermi surface of metals and its experimental determination through De Hass-van Alphen effect, along with magneto-transport in a 2D channel.

CO -03- Learn the description of collective excitations of the Fermi Sea (plasmons) and the electrostatic screening of electron-impurity interaction, in terms of the dielectric function of the electron gas.

CO -04- Understand different physical quantities (reflectivity coefficient, reflectance, real & imaginary parts of response etc.) related to the optical response of solids, and Raman Effect in crystals.

CO -05- Relate the dielectric polarization with the macroscopic electric field and the local electric field acting on an atom in the dielectric, along with frequency dependence of polarizability.

CO -06- Comprehend ferroelectricity and the Landau theory of phase transition.

CO -07- Calculate magnetic susceptibility for atoms, insulating solids and conduction electrons, and have an understanding of the microscopic origin of ferromagnetism and anti-ferromagnetism.

CO-08- Determine the low-energy excitations (spin waves/magnons) for ferromagnetic and antiferromagnetic systems, understand principle underlying their experimental measurement, and learn about ferromagnetic domains.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓									
CO-02						✓				
CO-03								✓		
CO-04	✓									
CO-05										✓
CO-06	✓									
CO-07				✓						
CO-08			✓							✓

M.Sc. in PHYSICS		FIRST SEMESTER
COURSE CODE: MSP A03		**COURSE TYPE : ECC/CB**
COURSE TITLE: CONDENSED MATTER PHYSICS – I		
CREDIT: 06 **THEORY: 06**	**HOURS : 90** **THEORY: 90**	
MARKS : 100 **THEORY: 70 CCA : 30**		

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT- 1 20Hrs.	Phase transformation and alloys: Equilibrium transformation of first and second order, equilibrium diagrams, phase rule, interpretation of phase diagrams, substitutional solid solutions, Vegard's law, intermediate phases, Hume-Rothery rules, interstitial phases (carbides, nitrides, hydrides, borides). Martensitic transitions.
UNIT-2 20Hrs	High temperature superconductors and GMR/CMR materials: High temperature superconductors, normal state properties (structural phase transition) of cuprates, phase separation and charge distribution into CuO2 planes, striped phase, phase diagram, pseudogap, dependence of Tc on crystal structure, effect of impurities .GMR/CMR materials, Ruddlesden-Popper series of perovskites. Onset of ferromagnetism and metallic conduction. Double exchange.
UNIT-3 20 H rs	Novel organic materials : Special carbon solids, fullerenes and tubules, formation and characterization of fullerenes and tubules. Single wall and multi-wall carbon tubules. Electronic properties of tubules. Carbon nanotubule based electronic devices.
UNIT-4 15 Hrs	Polymers – amorphous polymers, glass transition temperature, effect of molecular architecture on glass transition temperature, free volume theory for glass transition, conducting polymers, optical band gap of polymers, electrical conduction in conducting polymers, mechanical and thermal properties of polymers, polymer blends and composites.
UNIT- 5 15 Hrs	Structural characterization and electron structure determination:Basic theory of X-ray diffraction, indexing of Debye-Scherrer patterns from powder samples, examples from some cubic and non-cubic symmetries. Neutron diffraction – basic interactions, cross section, scattering length and structure factor. Basic principles of X-ray absorption spectroscopy, photo emission and positron annihilation techniques. Qualitative discussion of experimental arrangement and of typical results for both simple as well as transition metals.

SUGGESTED READINGS	1. Andrei Mourachkine: Room temperature superconductivity, Cambridge International Science Publishing. 2. C.N.R. Rao: Colossal magnetoresistance, charge ordering and related properties of managanese oxide, Woprld Scientific, 1998 3. Polymer Physics by Ulf W. Gedde, Chapmann & Hall, 2001. 4. Introduction to Polymer Physics by David. I. Bower. 5. Polymer Science by J.R. Fried.

M.Sc. Semester-I

Paper-V: MSP-A04: HIGH ENERGY PHYSICS I

Course Outcomes

After completing the course the students will able to : -

CO-01-Realize the Fundamental constituents of matter, their origination

CO-02-Understand qualitative and quantitative analysis of Resonance and Dalitz plots.

CO-03-Formulate Quantum mechanical scattering theory leading to understand origination of field particles.

CO-04-Understand three major interactions viz strong, electromagnetic and weak are in existence.

CO-05-Understand Isospin formulation and its fundamentals.

CO-06-Invariance and violation of various conservation laws and symmetries in these interactions.

CO-07-Understand fundamental knowledge of the subject matter leading to the attempt for grand unification.

CO-08-Formulate Parity conservation, violation and Charge conjugation invariance.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01										✓
CO-02	✓		✓							
CO-03				✓						
CO-04	✓									
CO-05										✓
CO-06	✓				✓					
CO-07				✓						
CO-08	✓		✓							

M.Sc. in PHYSICS		FIRST SEMESTER
COURSE CODE: MSPA04		**COURSE TYPE : ECC/CB**
COURSE TITLE: HIGH ENERGY PHYSICS I		
CREDIT: 06 **THEORY: 06**	**HOURS : 90** **THEORY: 90**	
MARKS : 100 **THEORY: 70 CCA : 30**		

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT- 1 20Hrs.	Elementary particles and the fundamental forces. Quarks and leptons. The mediators of the electromagnetic, weak and strong interactions. Interaction of particles with matter; particle acceleration, and detection techniques. Symmetries and conservation laws.
UNIT-2 20Hrs	Bound states. Discoveries and observations in experimental particle physics and relation to theoretical developments.
UNIT-3 20 H rs	Symmetries, group theory, The gourp SU92), Finite Symmetry Group: P and C, SU(2) of Isospin, The group SU(3)
UNIT-4 15 Hrs	Quark and Antiquark states: Mesons, Three quark states: Baryon, color factors, Asymptotic freedom. Charged and neutral weak interactions. Electroweak unification.
UNIT- 5 15 Hrs	Decay rates. Cross sections. Feynman diagrams Introduction to Feynman integrals. The Dirac equation. Feynman rules for quantum electrodynamics (no derivation).

SUGGESTED READINGS	1. Francis Halzen and Allan D. Martin, Quarks and Leptons: An Introductory Course in Modern Particle Physics, John Wiley and Sons 2. B.R. Martin and G. Shaw, Particle Physics, 2nd edition, J. Wiley and Sons (1997). 3. The Review of Particle Physics, Particle Data Group 4. David Griffiths, Introduction to Elementary Particles 5. Byron Roe Particle Physics at the New Millennium 6. Donald Perkin, Introduction to high energy physics.

M. Sc. in PHYSICS **FACULTY OF SCIENCE**

SECOND SEMESTER (EVEN SEMESTER)

Eligibility Criteria (Qualifying Exams)	Course Code	Course Type	Course (Paper/Subjects)	Credits	Contact Hours Per WeeK			EoSE Duration (Hrs.)	
					L	T	P	Thy	P
After appearing in the first semester examination irrespective of any number of back/ arrear papers	MSP 201	CCC	**Electronics**	6	4	3	00	3	0
	MSP 211/212	CCC	**Lab Course A / Lab Course B**	6	00	00	6	0	6
	MSP 202	CCC	**Atomic and Molecular Physics**	6	4	3	00	3	0
	MSP 203	CCC	**Quantum Mechanics II**	6	4	3	00	3	0
	MSP 221	OSC	Research methodology & computer Application: basics	6	4	3	00	3	00
	MSP B01	ECC/CB	Environmental and Forest Laws	6	4	3	00	3	00
	MSP B02	ECC/CB	Electronic Instrumentation						
	MSP B03	ECC/CB	Condensed Matter Physics – II						
	MSP B04	ECC/CB	High Energy Physics – II						
	MINIMUM CREDITS IN INDIVIDUAL SUBJECT IS 6 AND IN COMPLETE SEMESTER IT WOULD BE 30			TOTAL= 36					

M.Sc. Semester-II

Paper-I: MSP-201:Electronics

Course Outcomes

After completing the course the students will able to : -

CO -01- Acquire knowledge of operational amplifier circuits and their applications.

CO -02- Gain knowledge and evaluate the Boolean expressions, combinational logic circuits and Simplifications using Karnaugh maps.

CO -03- Analyze the operation of decoders, encoders, multiplexers, adders and subtractors.

CO 04- Understand the working of latches, flip-flops, designing registers, counters, a/d and d/a converters.

CO 05- Design and Analyze synchronous and asynchronous sequential circuits.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓									
CO-02		✓								
CO-03						✓				
CO-04	✓									
CO-05						✓				

.

M.Sc. in PHYSICS		SECOND SEMESTER
COURSE CODE: MSP 201		**COURSE TYPE :** CCC
COURSE TITLE: ELECTRONICS		
CREDIT: 06 **THEORY:** 06 **PRACTICAL:** 00		**HOURS:** 90 **THEORY:** 90 **PRACTICAL:** 00
MARKS: 100 **THEORY:** 70 **CCA :** 30		**PRACTICAL:** 00

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 20 Hrs.	Operational Amplifiers: Differential amplifier - circuit configurations - dual input, balanced output differential amplifier, AC and DC analysis, inverting and non-inverting inputs, CMRR-constant current bias level translator. Block diagram of typical OP-Amp analysis. Open loop configuration, inverting and non-inverting amplifiers, Op-Amp with negative feedback, effect of feedback on closed loop gain, input resistance, bandwidth and output offset voltage, voltage follower. Practical Op-Amp, input offset voltage-input bias current-input offset current, total output offset voltage, integrator and differentiator.
UNIT-2 15 Hrs	Oscillators: Oscillator and their Principle, the phase-shift oscillator, Wein bridge oscillator, Hartley oscillators,
UNIT-3 15	Wave Shaping Circuits : Multivibrators and their principle, Types of Multivobrators (Monostable, astable and bistable Multivibrators), Comparators, clamping and clipping circuits.
UNIT-4 20Hrs	Digital Electronics: Combinational logic: Standard representations for logic functions, Karnaugh Map Representation of logical functions, Simplification of logical functions using K-Map, Minimization of Logical functions specified in Minterms / Maxterms or truth table, Don't care conditions, Adder (half and full), Subtractor (half and full), Multiplexers and their uses, Demultiplexer and their uses, BCD arithmatics, Seven Segment display device. ROM.
UNIT-5 20Hrs	Sequential Logic: Flip-Flops: one - bit memory, RS, JK, JK master slave, T and D type flip flops, shift resisters - synchronous and asynchronous counters, Decade counter. A/D and D/A conversion- Basic principles and their circuitry, Basic idea of IC 555, Opto-electronic Devices: Photo diode, Phototransistor, Light emitting Diode and their applications
SUGGESTED READINGS	1. "Electronic Devices and Circuit Theory" by Robert Boylested and Louis Nashdsky, PHI, New Delhi - 110001, 1991. 2. "OP-AMP and Linear Integrated Circuits" by Ramakanth, A. Gayakwad, PHI, Second Edition 1991. 3. "Digital Principle and Applications" by A.P. Malvino and Donald P. Leach, Tata McGraw Hill Company, New Delhi, 1993.

M.Sc. in PHYSICS SECOND SEMESTER			
COURSE CODE: MSP 211		**COURSE TYPE :** CCC	
COURSE TITLE: Lab Course A			
CREDIT: 03		**HOURS: 90**	
THEORY: 00	**PRACTICAL: 03**	**THEORY: 00**	**PRACTICAL: 100**
Marks			
THEORY: 00		**PRACTICAL: 100 (EXPERIMENT:60; VIVA-VOCE:20 & SESSIONAL:20)**	

LABORATORY WORK MSP 211

LAB COURSE A:

1. To find the root of an Equation using secant method.
2. To find the modification of Euler equation by using c.
3. To find the real roots of the given function by implement lagragian inverse formula.
4. To find the real roots of any polynomial equation through graeffe's Method.
5. To find the value of definite integral using simpson's Method.
6. To find the real root of the given function using Regula falsi Method.
7. To find the root of an equation using Runga Kutta second order Method.
8. To find the solution of linear simultaneous equation using gauss elimination method.
9. To calculate finite integral or area under a curve using trapezoidal method.
10. To find the real root of the given function using by fixed point interaction Method.

M.Sc. in PHYSICS			SECOND SEMESTER
COURSE CODE: MSP 212			**COURSE TYPE :** CCC
COURSE TITLE: Lab Course B			
CREDIT: 03		**HOURS: 90**	
THEORY: 00	**PRACTICAL: 03**	**THEORY: 00**	**PRACTICAL: 100**
Marks			
THEORY: 00		**PRACTICAL: 100 (EXPERIMENT:60; VIVA-VOCE:20 & SESSIONAL:20)**	

LABORATORY WORK MSP 212

LAB COURSE B:

1. To construct Ex-OR Gate and Ex-NOR Gate.
2. To study NOR gate as a universal gate.
3. To study NAND gate as a universal gate.
4. To construct half adder using Ex-OR gate.
5. To construct full adder using Ex-OR gate.
6. To study the DAC convertor.
7. To study the ADC convertor.
8. To study the clocked R-S flip-flop using NOR /NAND gate.
9. To study the clocked D-type flip-flop using NOR/NAND gate.
10. To study the clocked D-type flip-flop using NOR/NAND gate.

M.Sc. Semester-II

Paper-II: MSP-202: Atomic & Molecular Physics

Course Outcomes

After completing the course the students will able to : -

CO- 01- Deal with problems related to Hydrogen-like atomic spectra.

CO -02-Having knowledge about the rotational, vibrational and Raman spectroscopy of molecules.

CO -03- Developing analytical, laboratory and computing skills through problem solving, laboratory & computer based exercises which involve the applications of atomic and molecular physics.

CO -04- Carry out experimental and theoretical studies on atomic and molecular physics with focus on structure & dynamics of atoms and molecules.

CO- 05-Account for theoretical models, terminology & working methods used in atomic and molecular physics.

CO -06-To successfully apply the theoretical techniques presented in course to practical problems.

CO -07- comprehend the instrumentation techniques that are used in different regions of spectra.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01								✓		
CO-02	✓		✓							
CO-03		✓	✓			✓				
CO-04						✓				
CO-05									✓	
CO-06						✓				
CO-07							✓			

M.Sc. in PHYSICS		SECOND SEMESTER
COURSE CODE: MSP 202		**COURSE TYPE : CCC**
COURSE TITLE: ATOMIC AND MOLECULAR PHYSICS		
CREDIT: 06 **THEORY: 06 PRACTICAL: 00**	**HOURS: 90** **THEORY: 90 PRACTICAL: 00**	
MARKS: 100 **THEORY: 70 CCA : 30 PRACTICAL: 00**		

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 20 Hrs.	Non degenerate first order perturbation method and their simple Applications, relativistic correction to energy levels of an atom, Quantum mechanical treatment of stark effect, atom in a weak uniform external electric field, first and second order Stark effect
UNIT-2 15 Hrs	Degenerate stationary state perturbation theory, linear Stark effect for hydrogen atom levels, inclusion of spin orbit interaction and weak magnetic field, Zeeman effect, effect of strong magnetic field. Magnetic dipole interaction, Lamb shift (only qualitative description).
UNIT-3 20 Hrs	Indistinguishability and exchange symmetry, many particle wave functions and Pauli's exclusion principle, spectroscopic terms for atoms. Variational method and its use in calculation of ground state energy. Heitler London method for hydrogen molecule. WKB method for one dimensional problem, application to bound states (Bohr Sommerfeld quantization) and the barrier penetration.
UNIT-4 20Hrs	Spectroscopy (qualitative): General features of the spectra of one and two electron system – singlet, doublet and triplet characters of emission spectra using examples, general features of alkali spectra. Rotation and vibration band spectrum of a molecule, P,Q and R branches. Raman spectra for rotational and vibrational transitions, General features of electronic spectra, Frank and Condon's principle.
UNIT- 5 15Hrs	Laser cooling and trapping of atoms: The scattering force, chirp cooling, optical molasses technique, Doppler cooling limit, magneto optical trap, Magnetic trap (only qualitative description) for confining low temperature atoms produced by Laser cooling, Bose-Einstein condensation in trapped atomic vapours, the scattering length.
SUGGESTED READINGS	1. G. Banewell – Atomic and Molecular spectroscopy 2. Christopher J. Foot – Atomic Physics, Oxford Master series, 2005 3. G.K. Woodgate, Elementray Atomic Structure, Second Edition Clarendon Press, Oxford. 4. T.A. Littlefield - Atomic and Molecular Physics. 5. Eistaberg and Rasmic- Quantum Physics of Atoms. Molecules Solids and Nuclear Particles. 6. Ashok Das and A.C. Melfessions. Quantum Mechanics ; A Modem Approach (Gordon and Breach Science Publishers). 7. White - Atomic Spectra. 8. Herzberg- Molecular spectra.

M.Sc. Semester-II

Paper-III: MSP-203:Quantum Mechanics-II

Course Outcomes

After completing the course the students will able to : -

CO 01- Understand the kinematics of scattering process.
CO 02- Evaluate the partial wave analysis using Born approximation method.
CO 03- Applytime Independent perturbation theory for non-degenerate case.
CO 04- Gain knowledge on WKB approximation method to study alpha decay. Remember time dependent perturbation theory.
CO 05- Analyze the interaction of an atom with electromagnetic radiation and the relativistic quantum mechanics using Klein Gordon equation, Explore the properties of gamma matrices.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓									
CO-02									✓	
CO-03						✓				
CO-04	✓									
CO-05						✓				

.

M.Sc. in PHYSICS		SECOND SEMESTER
COURSE CODE: MSP 203		**COURSE TYPE : CCC**
COURSE TITLE: **QUANTUM MECHANICS II**		
CREDIT: 06 **THEORY: 06 PRACTICAL: 00**		**HOURS: 90** **THEORY: 90**
MARKS: 100 **THEORY: 70 CCA : 30**		

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 20 Hrs.	Scattering Theory Scattering amplitude - cross sections-Relation between differential cross section and scattering amlitude - Transformation from centre of mass to laboratory frame-Relation between scattering angle in L frame and C-M frame- Partial wave analysis-Born approximation and its validity.
UNIT-2 15 Hrs	Perturbation Theory Time dependent perturbation theory - Harmonic perturbations - Transition probabilities - Fermi's-Golden rule, Adiabatic approximation - Sudden approximation - The density matrix - spin density matrix and magnetic resonance - Semi classical treatment of an atom with electromagnetic radiation.
UNIT-3 20 Hrs	Relativistic Quantum Mechanism Klein-Gordon equation - Failures - Dirac equation - Plane wave solutions - Interpretation of negative energy states - Antiparticles - Spin of electron - Magnetic moment of an electron due to spin - Energy values in a coulomb potential.
UNIT-4 20Hrs	Dirac equation Covariant form of Dirac equation - properties of gamma matrices, Invariance of Dirac equation under Lorentz transformation - T-Transformation for the Dirac equation in presence of electromagnetic field.
UNIT-5 15 Hrs	Particle in potential well Particle in 1D box – Partile in 2D box – Particle in 3D box – Finite potential well – Cubic potential – Multidimension potential - Infinite potential well – Symmetric potential well - Asymmetric potential well – Linear harmonic oscillator (1D,2D,3D).

SUGGESTED READINGS	1. Ashok Das and A.C. Milissiones : Quantum mechanics - A Modern Approach, Garden and Breach Science Publishers. 2. J.J. Sakurai : Advanced Quantum Mechanics (John Wiley) 3. E. Merzbacher, 1970, Quantum Mechanics, 2nd Edition, John Wiley and Sons, New York. 4. J.D. Bjorken and S.D. Drell, 1964, Relativistic Quantum Mechanics, McGraw-Hill, New York. 5. V.K. Thankappan, 1985, Quantum Mechanics, 2nd Edition, Wiley Eastern Ltd, New Delhi. 6. L.D. Landau and E.M. Lifshitz, 1958 Quantum Mechanics, Pergomon Press, London. 7. G. Aruldhas, 2002, Quantum Mechanics, Prentice-Hall of India, New Delhi.

M.Sc. Semester-II

Paper-IV: MSP-221:RESEARCH METHODOLOGY & COMPUTER APPLICATION: BASICS

Course Outcomes

After completing the course students will be able to demonstrate-

CO-01- Knowledge of research process reading evaluating developing and analyzing the ideas/ thought in critical/ analytical manner.

CO-02- literature reviews using print and online database of the subject and allied branches in perspectives of its inter -relation and so on.

CO-03- competent use of MLA and APA format for citation of print and electronic materials available .

CO-04- Potentials to identify explain, compare and prepare the key elements of research proposal and research report.

CO-05- Compare and contrast qualitative and quantitative research paradigms and to explain the use of each in research.

CO-06- The rationale for research ethics and importance of local processes for Institutional Review Board reviews for its rational improvisation.

CO-07- How Educational research contributes to the objectives of doctoral programme and specific career in higher education

CO-08- Competent use of information received in general social welfare and issues relevant and focused in the context of humanity as whole and its positive solutions in larger interest be devised.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓									
CO-02									✓	
CO-03							✓			
CO-04		✓								
CO-05										✓
CO-06		✓						✓		
CO-07		✓								✓
CO-08			✓			✓	✓			

M.Sc. in PHYSICS		SECOND SEMESTER
COURSE CODE: MSP 221		**COURSE TYPE : OSC**
COURSE TITLE: RESEARCH METHODOLOGY & COMPUTER APPLICATION: BASICS		
CREDIT: 06 **THEORY: 06 PRACTICAL: 00**		**HOURS: 90** **THEORY: 90**
MARKS: 100 **THEORY: 70 CCA : 30**		

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 15 Hrs.	**CONCEPT OF RESEARCH :** Meaning and characteristics of research , Steps in research process , Types of research - i) Basic, applied and action researchii) Quantitative and qualitative research , Areas of research in concern discipline **SELECTION OF PROBLEM FOR RESEARCH :** Sources of the selection of the problem ,Criteria of the selection of the problem ,Drafting a research proposal , Meaning and types of variables ,Meaning and types of hypotheses.
UNIT-2 15 Hrs	**TOOLS OF RESEARCH :** Meaning and general information about construction procedure of (i) Questionnaire, (ii) Interview, (iii) Psychological test, (iv) observation (v) Rating scale (vi) Attitute scale and (vii) check list , Advantages and disadvantages of above tools **SAMPLING :** Meaning of population and sample , Importance and characteristics of sample , Sampling techniques - i) Probability sampling : random sampling, stratified random sampling, systematic sampling, cluster sampling ii)Non-probability sampling: incidental sampling, purposive sampling, quata sampling
UNIT-3 15 Hrs	**METHODS OF RESEARCH** Meaning and conducting procedure of following methods of research : Historical method Survey method , Case study , Causal comparative method , Developmental methods, Experimental methods
UNIT-4 15 Hrs	**TREATMENT OF DATA :** Level of measurements of data , Steps in treatment of data: editing, coding, classification, tabulation, analysis and interpretation of results **WRITING RESEARCH REPORT :** Sections of report : Preliminary section , Content section: various chapters , Supplementary section: appendices, references, abstract , Format and style

UNIT-5 **15 Hrs**	**Computer Fundamentals** **Computer System :** Features, Basic Applications of Computer, Generations of computers. **Parts of Computer System :** Block Diagram of Computer System ; Central Processing Unit (CPU) ; Concepts and types of Hardware and Software, Input Devices - Mouse, Keyboard, Scanner, Bar Code Reader, track ball ; Output Devices - Monitor, Printer, Plotter, Speaker ; Computer Memory - primary and secondary memory, magnetic and optical storage devices. **Operating Systems - MS Windows :** Basics of Windows OS ; Components of Windows - icons, taskbar, activating windows, using desktop, title bar, running applications, exploring computer, managing files and folders, copying and moving files and folders ; **Control panel :** display properties, adding and removing software and hardware, setting date and time, screensaver and appearance ; **Windows Accessories :** Calculator, Notepad, WordPad, Paint Brush, Command Prompt, Windows Explorer.
UNIT-6 **15 Hrs**	**Office Software Package** **Word Processing - MS Word :**Creating, Saving, Opening, Editing, Formatting, Page Setup and printing Documents ; Using tables, pictures, and charts in Documents ; Using Mail Merge sending a document to a group of people and creating form, letters and label. **Spreadsheet - MS Excel :**Opening a Blank or New Workbook, entering data/Function/ Formula into worksheet cell, Saving, Editing, Formatting, Page Setup and printing Workbooks. **Presentation Software - MS Power Point :** Creating and enhancing a presentation, modifying a presentation, working with visual elements, adding Animations & Transitions and delivering a presentation

SUGGESTED READINGS	*Agrawal, Y. P. (1988).* ***Better sampling : Concepts, Techniques and Evaluation.****New Delhi : sterling Publishers Private Ltd.Best, J. W. (1993).* ***Research in Education*** *(6th ed.)New Delhi : Prentice-Hall of India Pvt. Ltd.* *Broota, K. D. (1992)* ***Experimental design in Behavioral Research*** *(2nd ed.)* *New Delhi : Wiley Eastern Limited.* *Dasgupta, A. K. (1968).* ***Methodology of Economic Research****.Bombay: Asia Publishing House.Edwards, A. L. (1957).* ***Techniques of Attitude Scale construction.****New York : Appleton-Contury* *Gall, M. D., Gall, J. P. and Borg, W. R. (2007).* ***Educational Research : An introduction*** *(8th ed.) Coston : Allyn and Bacon.* *Garrett, H. E. & Woodworth, R. S. (1969).* ***Statistics in Psychology and Education****.Bombay :Vakils, Fecffer& Simons Pvt. Ltd.* *Goode, W. J. &Hatt, Paul K. (1952).* ***Methods in Social Research.****New York : McGraw-Hill.* *Gopal, M. H. (1964).* ***An Introduction to research Procedure in Social Sciences.*** *Bombay : Asia Publishing House.* *Hillway, T. (1964)* ***Introduction to Research (2nd ed.)*** *Noston : Houghton Miffin.* *Hyman, H. H., et al. (1975****). Interviewing in Social Research.*** *Chicago : University of Chicago Press.* *Kerlinger, F. N. (1983)* ***Foundation of Behavioural Research. (2nd Indian Reprint)*** *New York : Holt, Rinehart and Winston.* *Kothari, C. R. (2007)* ***Research Methodology: Methods & Techniques****(3rd ed.)* *New Delhi :WishwaPrakashan.Fundamentals Of Computers, Dr. P. Mohan, Himalaya Publishing House.* *Microsoft First Look Office 2010, K. Murray, Microsoft Press.* *Fundamental Of Research Methodology And Statistics, Y.K. Singh, New Age International (P) Limited, Publishers.Practical Research Methods, Dr Catherine Dawson,* *The Essence Of Research Methodology, Jan Jonker&BartjanPennink, Springer.*

M.Sc. Semester-II

Paper-V: MSP-B01: ENVIRONMENTALAND FOREST LAWS

Course Outcomes

After completing the course the students will able to : -

CO- 01- The primary learning outcome is to sensitize the students towards human activities that adversely affect the environment and the need for regulation of such activities.

CO -02- Students will develop a thorough understanding of practice and procedure followed by various environmental law enforcing agencies/bodies.

CO 03- Students will be able to pursue environmental litigation before the National Green Tribunal and assist the Tribunal as a researcher or in any other capacity.

CO 04- Students will be able to assist industries and projects in obtaining environmental clearance and compliances with other environmental laws.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01								✓		
CO-02						✓				✓
CO-03		✓								✓
CO-04		✓								✓

M.Sc. in PHYSICS		SECOND SEMESTER
COURSE CODE : MSPB01		**COURSE TYPE : ECC/CB**
COURSE TITLE: ENVIRONMENTALAND FOREST LAWS		
CREDIT: 06 **THEORY: 06**		**HOURS : 90** **THEORY: 90**
MARKS : 100 **THEORY: 70 CCA : 30**		

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT - 1 18 Hrs	**EVOLUTION OF FOREST AND WILD LIFE LAWS** a) Importance of Forest and Wildlife b) Evolution of Forest and Wild Life Laws c) Forest Policy during British Regime d) Forest Policies after Independence. e) Methods of Forest and Wildlife Conservation.
UNIT - 2 18 Hrs	**FOREST PROTECTION AND LAW** a) Indian Forest Act, 1927 b) Forest Conservation Act, 1980 & Rules therein c) Rights of Forest Dwellers and Tribal c) The Forest Rights Act, 2006 d) National Forest Policy 1988
UNIT - 3 18 H rs	**WILDLIFE PROTECTION AND LAW** a) Wild Life Protection Act, 1972 b) Wild Life Conservation strategy and Projects c) The National Zoo Policy

UNIT - 4 **18 Hrs**	**CHAPTER – BASIC CONCEPTS** a. Meaning and definition of environment. b. Multidisciplinary nature of environment c. Concept of ecology and ecosystem d. Importance of environment e. Meaning and types of environmental pollution. f Factors responsible for environmental degradation. **CHAPTER– INTRODUCTION TO LEGAL SYSTEM** a. Acts, Rules, Policies, Notification, circulars etc b. Constitutional provisions on Environment Protection c. Judicial review, precedents d. Writ petitions, PIL and Judicial Activism **CHAPTER – LEGISLATIVE FRAMEWORK FOR POLLUTION CONTROL LAWS** a) Air Pollution and Law. b) Water Pollution and Law. c) Noise Pollution and Law.
UNIT - 5 **18 Hrs**	**CHAPTER- LEGISLATIVE FRAMEWORK FOR ENVIRONMENT PROTECTION** a) Environment Protection Act & rules there under b) Hazardous Waste and Law c) Principles of Strict and absolute Liability. d) Public Liability Insurance Act e) Environment Impact Assessment Regulations in India **CHAPTER – ENVIRONMENTAL CONSTITUTIONALISM** a. Fundamental Rights and Environment i) Right to Equality ……..Article 14 ii) Right to Information ……Article 19 iii) Right to Life ……..Article 21 iv) Freedom of Trade vis-à-vis Environment Protection b. The Forty-Second Amendment Act c. Directive Principles of State Policy & Fundamental Duties d. Judicial Activism and PIL

SUGGESTED READINGS	Bharucha, Erach. Text Book of Environmental Studies. Hyderabad : University Press (India) Private limited, 2005. Doabia, T. S. Environmental and Pollution Laws in India. New Delhi: Wadhwa and Company, 2005. Joseph, Benny. Environmental Studies, New Delhi: Tata McGraw-Hill Publishing Company Limited, 2006. Khan. I. A, Text Book of Environmental Laws.Allahabad: Central Law Agency, 2002. Leelakrishnan, P. Environmental Law Case Book. 2nd Edition. New Delhi: LexisNexis Butterworths, 2006. Leelakrishnan, P. Environmental Law in India. 2nd Edition. New Delhi: LexisNexis Butterworths, 2005. Shastri, S.C (ed). Human Rights, Development and Environmental Law, An Anthology. Jaipur: Bharat law Publications, 2006. Environmental Pollution by Asthana and Asthana, S,Chand Publication Environmental Science by Dr. S.R.Myneni, Asia law House Gurdip Singh, Environmental Law in India (2005) Macmillan. Shyam Diwan and Armin Rosencranz, Environmental Law and Policy in India – Cases, Materials and Statutes (2nd ed., 2001) Oxford University Press. **JOURNALS :-** Journal of Indian Law Institute, ILI New Delhi. Journal of Environmental Law, NLSIU, Bangalore. **MAGAZINES :-** Economical and Political Weekly Down to Earth.

M.Sc. Semester-II

Paper-V: MSP-B02: ELECTRONIC INSTRUMENTATION

Course Outcomes

After completing the course the students will able to : -

CO -01- Measure various electrical parameters with accuracy, precision, resolution.
CO -02- Design different types of amplifiers and filters.
CO -03- Select specific instrument for specific measurement function.
CO -04- Understand principle of operation, working of different electronic instruments like digital multi meter, vector voltmeter, and power factor meter.
CO -05- Analyze the functioning, specification, and applications of signal generators and signal analyzing instruments.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓									
CO-02						✓				
CO-03								✓		
CO-04								✓		
CO-05						✓				

M.Sc. in PHYSICS		SECOND SEMESTER
COURSE CODE: MSP B02		**COURSE TYPE** : ECC/CB
COURSE TITLE: **ELECTRONIC INSTRUMENTATION**		
CREDIT: 06 **THEORY: 06**		**HOURS : 90** **THEORY: 90**
MARKS : 100 **THEORY: 70** **CCA : 30**		

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted

ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).

iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).

iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 20Hrs.	Transducers : Classification of Transducers - Principle, construction and working of Thermistor, LVDT, Electrical strain gauges and capacitive transducers. Measurement of non-electrical quantities - Strain, Displacement, temperature, Pressure and Force.
UNIT-2 20 Hrs	Digital Instrumentation : Principle, block diagram and working of Digital frequency counter, digital multimeter, digital pH meter, digital conductivity meter and digital storage oscilloscope.
UNIT-3 20 H rs	Analytical Instrumentation : Principle, block diagram, description, working and applications of UV-VIS spectrometer, IR spectrometer, Flame emission spectrometer and ICP - AES spectrometer - Basic concepts of Gas and Liquid Chromatography.
UNIT4 15 Hrs	Bio-Medical Instrumentation : Physiological transducers to measure blood pressure, body temperature. Sources of Bio-electric potentials - resting potential, action potential, bio-potential electrodes. Principle, block diagram and operation of ECG and EEG - recorders.
UNIT-5 15 Hrs	Computer Peripherals : Printers - Printer mechanism - Classification. Dot matrix, Ink jet and laser printers. Basic concepts of key board and mouse. Mass data storage - floppy disk -Hard Disk - Optical disk (CD).

SUGGESTED READINGS	1. Dr. Rajendra Prasad, Electronic Measurements and Instrumentation, Khanna Publications. 2. S. Ramambhadran, Electronic Measurements and Instrumentation Khanna Publications. 3. S.M. Dhir, Electronics and Instrumentation, Khanna Publishers. Khandpur

M.Sc. Semester-II

Paper-V: MSP-B03:CONDENSED MATTER PHYSICS – II

Course Outcomes

After completing the course the students will able to : -

CO -01- Explicate response of band electrons to an external electric field and their scattering, and calculate currents in bands.

CO -02- Develop a semi-classical description of electrical and thermal transport in metals using the Boltzmann approach, and explain different thermoelectric effects.

CO -03- Distinguish nanostructures from bulk materials and learn principle of different imagining techniques for nanostructures.

CO -04- Calculate the electronic structure of nano-scale 1D, 0D solids in effective mass approximation, and use it to explain the electrical transport in these solids.

CO -05- Treat the electron-electron interactions in Hartree and Hartree-Fock approximations using the variational principle and apply these to calculate electronic properties of simple metals.

CO -06- Learn the concept of screening and calculate the screened potential using the Thomas-Fermi and Lindhard approaches.

CO -07- Transform the Schrodinger equation for a many-particle system (bosons as well as fermions) to the second quantized form, and construct field operators for one- and two-body operators.

CO- 08- Apply the second-quantized method to a degenerate homogenous electron gas for calculating the first-order ground-state energy.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01				✓						
CO-02		✓	✓			✓				
CO-03								✓		
CO-04				✓						
CO-05		✓								
CO-06					✓			✓		
CO-07	✓									
CO-08						✓				

M.Sc. in PHYSICS	**SECOND SEMESTER**
COURSE CODE: MSP B03	**COURSE TYPE : ECC/CB**
COURSE TITLE: CONDENSED MATTER PHYSICS – II	
CREDIT: 06 **THEORY: 06**	**HOURS : 90** **THEORY: 90**
MARKS : 100 **THEORY: 70 CCA : 30**	

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 20Hrs.	Disordered systems: Substitutional, positional and topographical disorder, short and long range order, glass transition, glass forming ability, nucleation and growth processes. Anderson model for random system and electron localization, mobility and hopping conduction. Metal glasses, models for structure of metal glasses. Structure factor for binary metallic glasses and its relationship with radial distribution function. Discussion of electric, magnetic and mechanical properties of glassy systems. Point defects: shallow impurity states in semiconductors. Localized lattice vibrational states in solids. Vacancies, interstitials and colour centres in ionic crystals.
UNIT-2 20 Hrs	Nanomaterials: Free electron theory (qualitative idea), variation of density of states with energy, variation of density of state and band gap with size of crystal. Electron confinement in infinitely deep square well, confinement in two and one dimensional well, idea of quantum well structure , tunneling through potential barrier, quantum dots, quantum wires.
UNIT-3 20 H rs	Different methods of preparation of nanomaterials. Sol-gel and chemical co-precipitation method, effect of temperature on the size of the particles. Bottom up: cluster beam evaporation, ion beam deposition, top down: ball milling. DC and RF sputtering.
UNIT4 15 Hrs	Films and surfaces: Study of surface topography by multiple beam interferometry, conditions for accurate determination of step height and film thicknesses (Fizeau fringes). Electrical conductivity of thin films, difference of behaviour of thin films from bulk material, Boltzman transport equation for a thin film (for diffuse scattering), expression for electrical conductivity for thin film. Enhancement of magnetic anisotropy due to surface pinning.
UNIT-5 15 Hrs	Experimental techniques: Basic ideas of the techniques of field emission, scanning tunnelling and atomic force microscopy, scanning electron microscopy, transmission electron microscopy, X-ray diffraction line broadening, small angle X-ray scattering and small angle neutron scattering.

SUGGESTED READINGS	1.Tolansky: Multiple beam interferometry 2. Heavens: Thin films 3.Chopra: Physics of thin films 4. Quantum dot heterostructures: D. Bimerg, M. Grundmann and N.N. Ledenstov, John Wiley & Sons, 1998 5. Nano particles and nano structured films – preparation, characterization and applications, Ed. J.H. Fendler, John Wiley & Sons, 1998. 6. Physics of low dimensional semiconductors: John H. Davies, Cambridge Univ. Press, 1997 7. Physics of semiconductor nano structures: K.P. Jain, Narosa, 1997

M.Sc. Semester-II

Paper-V: MSP-B04: HIGH ENERGY PHYSICS - II

Course Outcomes

After completing the course the students will able to : -

CO-01-Realize the Weak interaction, Leptons fundamentals their decay. -

CO-02-Understand the concept of Helicity, Higgs field and existence of Higgs Bosons.

CO-03-Understand of the relativistic kinematics and its importance in calculations at relativistic energies.

CO-04-Construct Analysis of the decay energy in various high energy reactions.

CO-05-Understand the interaction of charge particles with matter and will be able to calculate the dynamics of high energy particles.

CO-06-Learn the quantitative and qualitative analysis of Energy loss and Straggling mechanism.

CO-07-Understand radiations mechanism at relativistic velocities.

CO-08-Grasp details of particle accelerators for the creation of high energy particles will be provided.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓							✓		
CO-02	✓									
CO-03	✓									
CO-04	✓									
CO-05						✓				
CO-06	✓									
CO-07								✓		
CO-08			✓					✓		

M.Sc. in PHYSICS	**SECOND SEMESTER**
COURSE CODE: MSP B04	**COURSE TYPE : ECC/CB**
COURSE TITLE: HIGH ENERGY PHYSICS - II	
CREDIT: 06 **THEORY: 06**	**HOURS : 90** **THEORY: 90**
MARKS : 100 **THEORY: 70 CCA : 30**	

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 20Hrs.	Moller scattering, trace theorems and properties of gamma matrices, helicity representation at high energies., the electron propagator, the photon propagator.
UNIT-2 20 Hrs	Structure of Hadrons: form factors, e-p scattering, inelastic e-p scattering, Bjorken scaling, Partons, gluons, deep inelastic scattering, evolution equations for parton densities.
UNIT-3 20 H rs	QCD: Electron positron annihilation into hadrons, heavy qwuark production, three jet events, QCD corrections, Perturbative QCD, Drell-Yan process
UNIT4 15 Hrs	Weak Interactions: Parity violation, V-A form of weak interaction, Nuclear beta decay, muon decay, pion decay, neutrino electron scattering, neutrino quark scattering, weak neutral currents, the Cabibo angle, weak mixing angles, CP invariance.
UNIT-5 15 Hrs	Gauge Symmetries: U(1) Local gauge invariance and QED, Non-abelian gauge invariance and QCD, massive gauge bosons, spontaneous breakdown of symmetry, the Higgs mechanism.

SUGGESTED READINGS	1. Francis Halzen and Allan D. Martin, Quarks and Leptons: An Introductory Course in Modern Particle Physics, John Wiley and Sons 2. B.R. Martin and G. Shaw, Particle Physics, 2nd edition, J. Wiley and Sons (1997). 3. David Griffiths, Introduction to Elementary Particles 4. Byron Roe Particle Physics at the New Millennium 5. Donald Perkin, Introduction to high energy physics).

M. Sc. in PHYSICS **FACULTY OF SCIENCE**

THIRD SEMESTER (ODD SEMESTER)

Eligibility Criteria (Qualifying Exams)	**Course Code**	**Course Type**	**Course (Paper/Subjects)**	**Credits**	**Contact Hours Per WeeK**			**EoSE Duration (Hrs.)**	
					L	**T**	**P**	**Thy**	**P**
After appearing in the Second semester examination irrespective of any number of back/ arrear papers	MSP 301	CCC	**Solid State Physics**	6	4	3	0	3	0
	MSP 311/312	CCC	**Lab Course A/Lab Course B**	6	00	00	6	00	6
	MSP 302	CCC	**Nuclear and Particle Physics**	6	4	3	0	3	0
	MSP 303	CCC	**Classical Electro Dynamics**	6	4	3	0	3	0
	MSP S02	OSC	Intellectual Property Rights	6	4	3	00	3	00
	MSP C01	ECC/CB	Tribal Studies	6	4	3	00	3	00
	MSP C02	ECC/CB	Microwave Electronics						
	MSP C03	ECC/CB	Nano Science						
	MSP C04	ECC/CB	High Energy Physics - III						
	MINIMUM CREDITS IN INDIVIDUAL SUBJECT IS 6 AND IN COMPLETE SEMESTER IT WOULD BE 30			TOTAL= 36					

M.Sc. Semester-III

Paper-I: MSP-301:Solid State Physics

Course Outcomes

After completing the course the students will able to : -

CO -01- Acquire knowledge about different experimental approaches in the study of Fermi surfaces in different materials.

CO -02- know Semiconductor properties and carrier concentration, effect of temperature on mobility, electrical conductivity and Hall Effect in conductors and semiconductors.

CO -03- Understand piezo, pyro and Ferro electricity, ferroelectric domains and hysteresis.

CO -04- Understand basic theories of magnetic materials like ferromagnetism, ferrimagnetism, antiferromagnetism.

CO -05- elaborate electron in potential wells, degeneracy state, density of states, thermal and electrical conductivity of metals, and thermoelectric power.

CO -06- Acquire basic knowledge on (low temperature) superconductivity in type I and type II super conductors, and also different theoretical approaches to super conductivity (BCS).

CO -07- Understanding of various phenomena related to super conductivity, such as the Meissner effect, flux quantization, Giæver- and Josephson tunnelling.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓									
CO-02	✓		✓							
CO-03	✓									
CO-04	✓									
CO-05								✓		
CO-06	✓				✓					
CO-07								✓		

M.Sc. in PHYSICS		THIRD SEMESTER
COURSE CODE: MSP 301	**COURSE TYPE :** CCC	
COURSE TITLE: SOLID STATE PHYSICS		
CREDIT: 06 **THEORY:** 06 **PRACTICAL:** 00		**HOURS:** 90 **THEORY:** 90 **PRACTICAL:** 00
MARKS: 100 **THEORY:** 70 **CCA :** 30		**PRACTICAL:** 00

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 20 Hrs.	Crystal Physics Types of lattices - Miller indices - simple crystal structures - Crystal diffraction - Bragg's law - Reciprocal lattice (sc, bcc, fcc) - Lau equations - Atomic form factor - Types of crystal binding - Cohesive energy of ionic crystals - Inert gas crystals - Vander Waal, Metal crystals - Hydrogen bonded crystals.
UNIT-2 15 Hrs	Lattice dynamics Monoatomic lattices - Lattice with two atoms per primitive cell - First Brillouin zone - Group and phase velocities - Quantization of lattice vibrations - Phonon momentum - Inelastic scattering by phonons - Debye's theory of lattice heat capacity - Einstein's model and Debye's model of specific heat.
UNIT-3 20 Hrs	Theory of metals and semiconductors Free electrons gas in three dimensions - Electronic heat capacity - Wiedmann-Franz law - Hall effect - Band theory of metals and semiconductors - Bloch theorem - Kronig-Penny model - Semiconductors - Intrinsic carrier concentration - Mobility - Impurity conductivity - de Haas Van Alphen effect.
UNIT-4 15Hrs	Magnetism Elementary ideas of dia, para and ferro magnetism - quantum theory of paramagnetism - Rare earth ion - Hund's rule-Adiabatic demagnetization - Quantum theory of ferromagnetism - Curie point, ferromagnetic domains - Bloch Wall - Spin waves - Quantization - Magnons - thermal excitation of magnons - Curie temperature and susceptibility of ferrimagnets - Theory of antiferromagnetism - Neel temperature.
UNIT- 5 20Hrs	Super conductivity Effect of magnetic fields - Meissner effect - Entropy and heat capacity - Energy gap - Microwave and infrared properties - Type I and II superconductors - theoretical explanation London equation - Coherence length - BCS Theory - superconducting Tunneling - Josephson tunneling - DC and AC Josephson effects.

SUGGESTED READINGS	1. N.W. Aschroft and N.D. Mermin, Solid State Physics, Rhinehart and Winton, New York. 2. J.S. Blakemore, 1974, Solid State Physics, 2nd Edition, W.B. Saunder, Philadelphia. 3. A.J. Dekker, Solid State Physics, Macmillan India, New Delhi. 4. H.M. Rosenburg, 1993, The Solid State, 3rd Edition, Oxford University Press, Oxford. 5. S.O. Pillai, 1994, Problems and Solutions in Solid State Physics, New Age International, New Delhi. 6. S.L. Altmann, Band Theory of Metals, Pergamon, Oxford. 7. M.A. Wahab, 1999, Solid State Physics, Structure and Properties of Materials, Narosa, New Delhi. 8. J.M. Ziman, 1971, Principles of the Theory of Solids, Cambridge University Press, London.

M.Sc. in PHYSICS			THIRD SEMESTER
COURSE CODE: MSP 311			COURSE TYPE : CCC
COURSE TITLE: Lab Course A			
CREDIT: 03		HOURS: 90	
THEORY: 00	PRACTICAL: 03	THEORY: 00	PRACTICAL: 100
Marks			
THEORY: 00		PRACTICAL: 100 (EXPERIMENT:60; VIVA-VOCE:20 & SESSIONAL:20)	

LABORATORY WORK
MSP 311

LAB COURSE A:

1. To find the root of an Equation using Newton–Raphson method.
2. To find the root of an equation using Bisection Method.
3. To find the real roots of an equation using Simpson 1/3rd Method.
4. To find the real roots of an equation using Simpson 3/8th Method.
5. To find the root of an equation using second Method.
6. To find the root of an equation using Regala falsi Method
7. To find the root of an equation using Runga Kutta fourth order Method.
8. To find the root of an equation using Jacobi method.
9. To find the root of an equation by Lu- Decomposition method.
10. To find the root of an equation by Newton forward difference Method.

M.Sc. in PHYSICS			THIRD SEMESTER
COURSE CODE: MSP 312			COURSE TYPE : CCC
COURSE TITLE: Lab Course B			
CREDIT: 03		HOURS: 45	
THEORY: 00	PRACTICAL: 02	THEORY: 00	PRACTICAL: 100
Marks			
THEORY: 00		PRACTICAL: 100 (EXPERIMENT:60; VIVA-VOCE:20 & SESSIONAL:20)	

LABORATORY WORK
MSP 312

LAB COURSE B:

1. To construct and study T-Type Flip Flop using NAND/NOR gate.
2. To Construct and Study RS Flip Flop using NAND/NOR gate.
3. To construct and study D-Type Flip Flop using NAND/NOR gate.
4. To construct and study of 4 bitDigital to Analog Converter (DAC) using R-2R ladder method.
5. To study various Flip-Flops using Digital IC trainer.
6. Construction of full substractor using Ex-OR gate.
7. Construction of half substractor using Ex-OR gate.

M.Sc. Semester-III

Paper-II: MSP-302: NUCLEAR AND PARTICLE PHYSICS

Course Outcomes

After completing the course the students will able to : -

CO -01- Understand Nuclear Force And Nuclear Models.

CO -02- Analyze the semi empirical mass formula and its applications using liquid drop model and shell model.

CO -03- Understand the concept of Nuclear Decay Processes.

CO -04- Interpret the Classification of nuclear reactions.

CO -05- Understand the Classification of elementary Particles and their Quantum Numbers

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓									
CO-02			✓			✓				
CO-03	✓									
CO-04						✓		✓		
CO-05	✓									

M.Sc. in PHYSICS	**THIRD SEMESTER**
COURSE CODE: MSP 302 COURSE TYPE : CCC	
COURSE TITLE: NUCLEAR AND PARTICLE PHYSICS	
CREDIT: 06 **THEORY: 06 PRACTICAL: 00**	**HOURS: 90** **THEORY: 90 PRACTICAL: 00**
MARKS: 100 **THEORY: 70 CCA : 30 PRACTICAL: 00**	

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 20 Hrs.	Nuclear Structure And Models Magnetic dipole moment - Liquid drop model - Semi-empirical mass formula of Weizsacker - Nuclear stability - Mass parabolas - Bohr-Wheeler theory of fission, Experimental evidence for shell effects, - Shell model - Spin-orbit coupling - Magic numbers - Angular momenta and parities of nuclear ground state, Collective Model.
UNIT-2 15 Hrs	Nuclear Interactions Nuclear forces, Exchange force, - Tensor forces - Meson theory of nuclear forces - Yukawa potential - Nucleon-nucleon scattering - Low energy n-p scattering - Effective range theory, Isospin formalism.
UNIT-3 20 Hrs	Nuclear reactions Types of reactions and conservation laws - Energetics of nuclear reactions, Q-equation and threshold energies, Direct and compound nuclear reactions, compound nucleus - Scattering matrix - Reciprocity theorem - Breit-Wigner one level formula.
UNIT-4 20Hrs	Nuclear decay Beta decay - Fermi's theory - Fermi-Kurie Plot - Fermi and Gamow - Teller selection rules - Allowed and forbidden decays - Decay rates, Comparative half lives - Theory of Neutrino - Helicity of neutrino, Theory of electron capture, Gamma decay – Selection rule for gamma decay- Multipole transitions in nuclei - Nuclear isomerism.
UNIT- 5 15 Hrs	Particle Physics Concept of Elementary particles, Classification of Elementary Particles, Quantum number of Elementary particles, Types of interactions between elementary particles - Hadrons and Leptons - Symmetry and conservation laws, strange particles, Elementary ideas of CP and CPT invariance - Classification of Hadrons, Quark model, Qunatum number for quarks, composition of particles in quark model, - Gell-mann-Okubo mass formula for octet and decaplet.

SUGGESTED READINGS	1. Y.R. Waghmare, 1981, Introductory Nuclear Physics, Oxford-IBH, New Delhi. 2. Ghoshal, Atomic and Nuclear Physics, Volume 2. 3. J.M. Longo, 1971, Elementary Particles, McGraw-Hill, New York. 4. R.D. Evans, 1955, Atomic Nucleus, McGraw-Hill, New York. 5. B.L. Cohen, 1971, Concepts of Nuclear Physics, TMH, New Delhi. 6. M.K. Pal, 1982, Theory of Nuclear Structure, Affl. East-West, Chennai. 7. W.E. Burcham and M. Jobes, 1995, Nuclear and Particle Physics, Addison-Wesley, Tokyo.

M.Sc. Semester-III

Paper-III: MSP-303: Classical Electrodynamics

Course Outcomes

After completing the course the students will able to : -

CO -01- Acquire knowledge on general wave equation using Maxwell's equations and able to derive Laplace equations for electrostatic potential in Cartesian, spherical and cylindrical coordinates.

CO -02- Analyze scalar and vector magnetic potentials and the propagation of EM waves in different media.

CO -03- Understand the propagation of EM waves in bounded and unbounded media & Boundary conditions for E, D, B and H.

CO -04- Understand poynting theorem and its physical significance.

CO -05- Apply vector calculus to static electric-magnetic fields in different situations.

CO -06- Formulate potential problems within electrostatics, magnetostatics and stationary current distributions in linear, isotropic media.

CO -07- Interpret the deeper meaning of the Maxwellian field equations and account for their symmetry and transformation properties.

CO -08- Define and derive expressions for the energy both for the electrostatic and magneto statics fields, interpret Poyntings theorem derived from Maxwell's equations.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓									
CO-02			✓			✓				
CO-03	✓									
CO-04	✓									
CO-05						✓				
CO-06								✓		
CO-07			✓							
CO-08						✓			✓	

.

M.Sc. in PHYSICS		THIRD SEMESTER
COURSE CODE:	**MSP 303 COURSE TYPE : CCC**	
COURSE TITLE:	**CLASSICAL ELECTRODYNAMICS**	
CREDIT: 06 **THEORY: 06**		**HOURS: 90** **THEORY: 90**
MARKS: 100 **THEORY: 70 CCA : 30**		

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 15 Hrs.	Electrostatics: Electric field, Gauss Law, Differential form of Gaussian law. Another equation of electrostatics and the scalar potential, Boundary conditions on E and D, surface distribution of charges and dipoles, Poisson and Laplace equations, Green's Theorem, Formal Solutions of electrostatic, Boundary value problem with Green's function, Electrostatic potential energy.
UNIT-2 20 Hrs	Boundary Value Problems in Electrostatics: Methods of Images, Point charge in the presence of a grounded conducting sphere, point charge in the presence of a charged insulated conducting sphere, General solution for the potential, conducting sphere wit hemispheres at a different potential.
UNIT-3 20 Hrs	Magnetostatics: Introduction and definition, Biot and Savart Law, the differential equations of magnetostatics and Ampere's law, magnetic induction for a current loop, Magnetic fields of a localized current distribution, Magnetic moment, Force and torque on and energy of a localized current distribution in an external induction, Boundary conditions on B and H, Uniformly magnetized sphere, magnetized sphere in an external fields, permanent magnets.
UNIT-4 20Hrs	Time varying fields, Maxwell's equations, Poynting's Theorem, conservation laws: Energy in a magnetic field, vector and scalar potentials, Gauge transformations, Lorentz gauge, Coulomb gauge, Green function for the wave equation.
UNIT-5 15 Hrs	Lorentz transformations of space and time in four vector form, Equation of continuity in covariant form, Lorentz condition in covariant form, Lorentz transformations of electric and magnetic fields, Lorentz force in covariant form, Maxwell's equations in covariant four vector form, Electromagnetic field tensor, transformation of four potentials and four currents, Invariance of the electromagnetic fields.

SUGGESTED READINGS	1. J.D. Jackson: Classical Electrodynamics 2. Panofsky & Phillip: Classical electrodynamics and magnetism 3. Griffith: Introduction to Electrodynamics 4. Landau & Lifshitz: Classical Theory of Electrodynamics 5. Landau & Lifshitz: Electrodynamics of continuous media

M.Sc. Semester-III

Paper-IV: MSP-S02: INTELLECTUAL PROPERTY RIGHTS

Course Outcomes

After the completion of the course, students will be able to understand:

CO-01:- The concept and development of all forms of I.P.R.

CO-02:- Distinguish and explain various forms of I.P.R

CO-03:- Identify criteria's to fit one's own intellectual work in particular forms of I.P.R

CO-04:- Apply statutory provisions to protect particular forms of I.P.R

CO-05:- Apply the concept and forms of I.P.R in research field

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01								✓		
CO-02								✓		
CO-03						✓				
CO-04			✓							
CO-05		✓	✓			✓				

M.Sc. in PHYSICS		THIRD SEMESTER	
COURSE CODE: MSPS02		**COURSE TYPE : OSC**	
COURSE TITLE: INTELLECTUAL PROPERTY RIGHTS			
CREDIT: 06		**HOURS : 90**	
THEORY: 06	**Practical: 00**	**THEORY: 90**	**Practical: 00**
MARKS : 100 **THEORY: 70 CCA : 30**			

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT - 1 12 Hrs	**Introduction, Nature, Basic Concepts and International Conventions :** Nature and meaning of Intellectual Property, Justification for protection of Intellectual Property Rights, Types of Intellectual Property, Leading International instrument concerning protection of Intellectual Property: The Berne Convention (1886), Rome convention (1961) Trade Related intellectual property agreement, 1995 (TRIPS)
UNIT - 2 24 Hrs	**Law of Copyright** Definition, Subject matter of copyright, Ownership of Copyright, Term of Copyright, Rights of Owner, Assignments and Licenses, Infringement of Copyright , Remedies against infringement of copyright
UNIT - 3 10 H rs	**Law of Patents** Meaning , Criteria for obtaining patents- *Novelty, Utility, Non-obviousness,* Non-patentable inventions, Procedure for Registration, Term of patent, Rights of Patentee, Compulsory licensing and Government use of patent, Infringement of patent, Remedies in case of Infringement
UNIT - 4 24 Hrs	**Law of Trademark** Meaning of mark & Trademark, Categories of Trademark- Conventional and Non-conventional Marks , Concept of distinctiveness, Doctrine of honest concurrent use, Procedure of registration of trademarks and Term of Protection, Absolute and relative grounds for refusal of registration, Assignment and Licensing, Infringement and Passing off.
UNIT - 5 20 Hrs	**Design and other forms of Geographical Indication (GI)** 1. Geographical Indication- Meaning of GI, Difference between GI and Trademark & Concept of Authorized user 2. Designs- Meaning of Design Protection, Concept of original design, Term of Protection

SUGGESTED READINGS	1. V.KAhuja, *Law Relating to Intellectual Property Rights*, Lexis Nexis, Haryana, India. 2. G.B.Reddy, *Intellectual Property Rights and Law,* Gogia Law Agency, Hyderabad. 3. S.R.Myneni, *Intellectual Property Law*, Eastern Law House, Calcutta 4. P. Narayanan *Intellectual Property Rights and Law (1999),* Eastern Law House, Calcutta, India 5. VikasVashistha, *Law and Practice of Intellectual Property*, (1999) Bharat Law House, New Delhi. 6.GyanvatiDhakad, BaudhikSampadaVidhiyan (Intellectual Property Laws- Hindi),Central Law Publication.

M.Sc. Semester-III

Paper-V: MSP-C01: Tribal Studies

Course Outcomes

After completing the course the students will able to : -

CO -01-Describe the need and importance of Tribal Studies, since tribes constitute a significant portion of Indian Population.

CO -02-Identify major tribes of India, with their racial, lingual, and geographical classification.

CO -03-Enumerate various issues posing threat to the tribal existence, identity, development.

CO -04-Critically describe various Laws, Policies, programmes and Constitutional provisions corresponding to tribal development in India.

CO -05-Evaluate various welfare agencies and the programmes related to Scheduled Tribes in the fields of education, employment and social justice.

CO -06-Create a deliberate interest in getting involved with the activities initiated for the improvement of the lives of tribals.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01								✓		
CO-02			✓			✓				
CO-03						✓				
CO-04						✓				
CO-05			✓							✓
CO-06		✓			✓					

M.Sc. in PHYSICS	THIRD SEMESTER
COURSE CODE: MSPC01	**COURSE TYPE : ECC/CB**
COURSE TITLE:TRIBAL STUDIES	
CREDIT: 06 **THEORY: 06**	**HOURS : 90** **THEORY: 90**
MARKS : 100 **THEORY: 70 CCA : 30**	

Scheme of marks:

v. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
vi. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
vii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
viii. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT - 1 12 Hrs	**Tribal Studies :** Meaning, Nature, Scope, Need & importance of tribalstudies. Meaning, Definition & characteristics of Tribe, Caste & Race.
UNIT - 2 24 Hrs	**Scheduled Tribe in India :** Population Composition of tribal, classification of Indian Tribe – Racial, Lingual, Geographical, Cultural. **Some Major Tribes in India :** Santhal, Khasi, Munda, Bhils. **Some Major Tribes in Central India :** Gond, Baiga, Bharia, Korkus.
UNIT - 3 10 H rs	**Iliteracy :**Poverty, Indebness, Unemployment, migration & ExploitationEnvironmental & Degradation. **Problem of Health and sanitation :** Prostitution, Culture Decay due to assimilation. Replacement & Rehabilitation of Tribal population.
UNIT - 4 24 Hrs	**Welfare-Concept, Characteristics:** Tribal Welfare in post independenceperiod. Constitutional provision & safe guard after independence, Legislation & Reservation Policy.
UNIT - 5 20 Hrs	**Tribal Development Programs for Scheduled Tribes :** Medical, Education, Economy, Employment & Agriculture Evaluation of Programs **Tribal Welfare & Advisory Agencies in India :** Role of NGO's in tribal development, Role of Christian missionaries in tribal welfare & development. Tribal Welfare Administration.
SUGGESTED READINGS	1. *Tribal Development In India (Orissa)* by Dr. Taradutt 2. *Books on Tribal studies* by PK Bhowmik 3. *Books on 'Tribal Studies'* by W.G. Archer

M.Sc. Semester-III

Paper-V: MSP-C03: MICROWAVE ELECTRONICS

Course Outcomes

After completing the course the students will able to : -

CO -01- Analyze the wave propogation in TE, TM or TEM modes, in structures such as Rectangular waveguides

CO -02- Design various microwave components such as power dividers, hybrid junctions, microwave Solid state dives, ferrite devices and microwave amplifier

CO- 03- Demonstrate various perceive operating principles of basic passive and active microwave devices.

CO -04-.Perform analysis mathematically the operation and working of the various tubes

CO- 05- Demonstrate various microwave bench setup for measuring various parameters.

CO -06- Understand the operation and working of the various tubes or sources for the transmission of the microwave frequencies.

CO -07- Understand and Analyze various parameters and characteristics of the various waveguide components.

CO -08- Understand and analyze various semiconductor devices.

CO -09- Apply Smith chart use for solution of transmission line problems and impedance matching.

CO -10- Analyze the difference between the conventional tubes and the microwave tubes for the transmission of the EM waves.

CO -11- Acquire knowledge about the measurements to be done at microwaves.

CO -12- Acquire complete knowledge about the applications of the microwaves for Radar Communications. Design and simulate waveguide components for various applications.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01		✓				✓				
CO-02			✓			✓				
CO-03										✓
CO-04						✓				
CO-05						✓				
CO-06								✓		
CO-07	✓									
CO-08	✓									
CO-09		✓				✓		✓		
CO-10		✓	✓			✓				
CO-11	✓									
CO-12	✓	✓	✓							

COURSE CODE: MSP C02COURSE TYPE : ECC/CB	
COURSE TITLE: MICROWAVE ELECTRONICS	
CREDIT: 06 **THEORY: 06**	**HOURS : 90** **THEORY: 90**
MARKS : 100 **THEORY: 70 CCA : 30**	

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 20Hrs.	Waveguides and components: Field distribution in rectangular waveguide in TE and TM modes, Phase velocity, Group velocity, Characteristics impedance, wall current, Cavity resonators and their excitation techniques, Scattering matrix for Microwave Tees and hybrid junction directional coupler, Construction and working of precision attenuator and phase shifter.
UNIT-2 20Hrs	CIRCUIT THEORY OF WAVE GUIDES: Power Transmission in Wave Guides, Equivalent Voltages and Currents, Impedance Description of Wave Guide Elements and Circuits, Foster's Reaction Theorem, One Port Circuits, N-Ports Circuits, Scattering Matrix Formulation, Excitation and Coupling of Wave Guides, Dielectric Loaded Wave Guides, Surface Wave Guides.
UNIT-3 20 H rs	ANTENNAS: Familiarity with Different Types of Antennas, Radiation Properties, Strip-Lines and Microstrip Lines, Strip-Line Characteristics, Strip-Line Components, Microstrip Antennas, Radiation Properties of Microstrip Antennas
UNIT-4 15 Hrs	APPLICATIONS OF MICROWAVES: Applications of Microwave in RADAR, Satellite Communication, Mobile Communication, Microwave Heating
UNIT-5 15 Hrs	FERRITES Microwave Propagation in Ferrites, Nano Ferrites, Synthesis of Nano Ferrites, Dielectric Properties of Ferrites, Ferrites as Microwave Absorbers.

SUGGESTED READINGS	1. Foundations for Microwave Engineering: R.E. Collins, Mc. Graw Hills 2. Solid State Electronic Devices: B. Streetman and S.K. Banerjee, PHI 3. Microwave Devices and Circuits: L.S.Y. Liao, PHI 4. Antenna Theory and Design: C.A. Balanis, John Wiley & Sons 5. Basic Microwave Techniques and Laboratory Manual: M. L. Sisodia, G. S. Raghuvanshi. New Age International, Jan 1, 1987

M.Sc. Semester-III

Paper-V: MSP-C03: NANO SCIENCE

Course Outcomes

After completing the course the students will able to : -

CO-O1-Understand the basics of nanoscience.

CO-O2-Describe the various techniques to fabricate nanostructure.

CO-O3-Comprehend the principles and working of characterization tools for analyses of

Grasp the concepts of various physical properties of nanostructures.

CO -04- The ability to develop case studies of nanomaterials with a focus on fundamentals, fabrication, characterization, and applications.

CO -05- Gain experience in applying unique properties of nanomaterials to solve problems and challenges in our life.

CO -06- Understand the quantum nanostructures, such as quantum dots, nanowires and quantum wells and their density of states.

C0-O7- Gain the knowledge in dispersion relation of electron in solids.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01								✓		
CO-02	✓									
CO-03	✓									
CO-04	✓									
CO-05						✓				
CO-06	✓									
CO-07	✓					✓				

M.Sc. in PHYSICS		THIRD SEMESTER
COURSE CODE: MSPC03	**COURSE TYPE :** ECC/CB	
COURSE TITLE: NANO SCIENCE		
CREDIT: 06 **THEORY: 06**		**HOURS : 90** **THEORY: 90**
MARKS : 100 **THEORY: 70**	**CCA : 30**	

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 20Hrs.	Introduction to Nanoparticles Introduction - Historical perspective of nanoparticle - Classification of nanomaterials - Nanorods - Nanoparticle - Nanomaterial preparation - Plasma arching - Chemical vapour deposition - Solgel electrodeposition - Ball milling technique.
UNIT-2 20Hrs	Nanocrystals Synthesis of metal nanoparticles and structures - Background on quantum semiconductors - Background on reverse Miceller solution - Synthesis of semiconductors - Cadmium telluroid nano crystals - Cadmium sulfide nano crystals - Silver sulfide nano crystals - Nano manipulator - Nano tweezes - Nanodots.
UNIT-3 20 Hrs	Characteristics of Nanomaterials Magnetism in particle of reduced size dimension - Variation of magnetism with size - Magnetic behavior of small particle - Diluted magnetic semiconductor (DMS) - Fe DME and its applications. Nanoparticle as chemical reagents - Specific heat of nanoparticle crystals - Melting point of Nanoparticle material - Nanolithography - Estimation of nanoparticle size using AFM.
UNIT-4 15 Hrs	Nano Tubes New form of carbon - Types of nanotubes - Formation of nanotubes - Various techniques - Preparation and properties of nanotubes - Uses of nanotubes and applications - Nano material processing for nanotube - Light and Nano technology - Nanoholes and photons - Quantum electronic devices - Quantum electronic devices - Quantum information and Quantum Computers.
UNIT-5 15 Hrs	Applications Micromechanical systems - Robots - Ageless materials - Nanomechanics - Nano electronics - Optoelectronic devices - LED - Applications - Colourants and pigments - Nano biotechnology - DNA chips - DNA array devices - Drag delivery systems.
SUGGESTED READINGS	1. NANOSCIENCE AND NANO TECHNOLOGY : FRONTIERSOF FUNDAMENTALS BY : M.S. RAMCHANDRA RAO . 2. NANO : THE ESSENTIALS . BY : T. PRADEEP

M.Sc. Semester-III

Paper-V: MSP-C04: HIGH ENERGY PHYSICS – III

Course Outcomes

After completing the course the students will able to : -

CO-O1- Understand the complex properties and behaviour of high energy particles at the microscopic level.

CO-O2- Learn about the knowledge of different types of high energy particles.

CO-O3- Understanding of spin parity concept & magic no. Related to shell.

CO-O4- Learn about the classification of fundamental particles and their interactions according to the Standard Model quark structure of mesons and baryons.

CO-O5- Explain the experimental evidence for quarks, gluons, quark confinement, asymptotic freedom, sea quarks, the running coupling constant and colour charge

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓									
CO-02			✓					✓		
CO-03	✓									
CO-04								✓		
CO-05							✓			

M.Sc. in PHYSICS		THIRD SEMESTER
COURSE CODE:	**MSP C04COURSE TYPE : ECC/CB**	
COURSE TITLE:	**HIGH ENERGY PHYSICS – III**	
CREDIT: 06 **THEORY: 06**		**HOURS : 90** **THEORY: 90**
MARKS : 100 **THEORY: 70 CCA : 30**		

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 20Hrs.	Local gauge invariance and Yang-Mills fields, Lagrangian of the Spontaneous symmetry breaking and the Higgs mechanism, The Weinberg-Salam model and beyond.
UNIT-2 20Hrs	Unified models of weak and electromagnetic interactions, Standard Model, flavor group, flavor-changing neutral currents. Weak isospin.
UNIT-3 20 H rs	Quark and lepton mixing. CP violation. Neutrino oscillations.
UNIT-4 15 Hrs	CKM quark mixing matrix, GIM mechanism, rare processes, neutrino masses, seesaw mechanism
UNIT-5 15 Hrs	QCD confinement and chiral symmetry breaking, instantons, strong CP problem.
SUGGESTED READINGS	1. Francis Halzen and Allan D. Martin, Quarks and Leptons: An Introductory Course in Modern Particle Physics, John Wiley and Sons 2. B.R. Martin and G. Shaw, Particle Physics, 2nd edition, J. Wiley and Sons (1997). 3. Particle Data Group, The Review of Particle Physics, 4. David Griffiths, Introduction to Elementary Particles 5. Donald Perkin, Introduction to high energy physics.

M. Sc. in PHYSICS **FACULTY OF SCIENCE**

FOURTH SEMESTER (EVEN SEMESTER)

Eligibility Criteria (Qualifying Exams)	Course Code	Course Type	Course (Paper/Subjects)	Credits	Contact Hours Per WeeK			EoSE Duration (Hrs.)	
					L	T	P	Thy	P
After appearing in the Third semester examination irrespective of any number of back/ arrear papers	MSP 401	CCC	**Materials Science and Laser Physics**	6	4	3	0	3	0
	MSP 411/412	CCC	**Lab Course A/ Lab Course B**	6	00	00	6	00	6
	MSP 402	CCC	**Spectroscopy**	6	4	3	0	3	0
	MSP 403	CCC	**Statistical Physics**	6	4	3	0	3	0
	MSP 421	SSC/PRJ	Dissertation	6	00	00	9	0	4
	MSP D01	ECC/CB	Energy Physics	6	4	3	00	3	00
	MSP D02	ECC/CB	Satellite Communication and Remote Sensing						
	MSP D03	ECC/CB	Crystal Growth & Thin film Physics						
	MSP D04	ECC/CB	Renormalization and Supersymmetry						
	MINIMUM CREDITS IN INDIVIDUAL SUBJECT IS 6 AND IN COMPLETE SEMESTER IT WOULD BE 30			TOTAL= 36					

M.Sc. Semester-IV

Paper-I: MSP-401:MATERIAL SCIENCE AND LASER PHYSICS

Course Outcomes

After completing the course the students will able to : -

CO -01- Analyze the Structure of materials at different levels, basic concepts of crystalline materials like unit cell, FCC, BCC, HCP, APF (Atomic Packing Factor), Co-ordination Number etc.

CO -02- know the Mechanical response of Materials under applied load such as elastic response, stress-strain curve, viscoelasticity, Plastic deformation.

CO -03- understand and explain Corrosion and degradation of materials and corrosion inhibition

CO -04- Understand concept of mechanical behavior of materials and calculations of same using appropriate equations

CO -05- Explain the concept of phase & phase diagram & understand the basic terminologies associated with metallurgy. Construction and identification of phase diagrams and reactions

CO -06- Explain features, classification, applications of newer class materials like smart materials, piezoelectric materials, biomaterials, composite materials etc.

CO -07- Compare among different of crystal imperfections.

CO -08- Gain knowledge on laser rate équations for Two, Three, Four-level laser systems.

CO -09- Understand Einstein relations for émission and absorption of radiation.

CO -10- Gain knowledge on classification of laser systems.

CO -11- Gain knowledge on application of various laser systems

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓							✓		
CO-02	✓		✓							
CO-03	✓									
CO-04	✓									
CO-05						✓				
CO-06	✓									
CO-07						✓				
CO-08	✓									
C0-09	✓							✓	✓	
CO-10	✓									
CO-11	✓									

M.Sc. in PHYSICS		FOURTH SEMESTER
COURSE CODE: MSP 401	**COURSE TYPE :** CCC	
COURSE TITLE: MATERIAL SCIENCE AND LASER PHYSICS		
CREDIT: 06 **THEORY:** 06 **PRACTICAL:** 00		**HOURS:** 90 **THEORY:** 90 **PRACTICAL:** 00
MARKS: 100 **THEORY:** 70 **CCA :** 30		**PRACTICAL:** 50

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 20 Hrs.	**Phase Diagram**: Phase Diagram - Basic principle - Simple binary systems - Solid solutions - Application, Solid Solution - Interstitial and substitutional solid solutions - Hume -Rothery electron compounds, Intermediate and interstitial phases - Intermetallic compounds. Elementary ideas of corrosion - Oxidation - Creep and fracture.
UNIT-2 15 Hrs	**Defects** Point defects - Schottky and Frenkel defects - number of defects as a function of temperature - Diffusion in metals - Diffusion and ionic conductivity in inonic crystals. Dislocations - Edge and screw dislocations - Burgers vector - Plastic deformation, Effect of grain size on dislocation motion - Effect of solute atoms on dislocation motion.
UNIT-3 20 Hrs	**Optical Properties, Dielectric Properties and Ferro Electrics** - Color centers - Photo conductivity - electronic transitions in photo conductors - Trap, Capture, recombination centers - General mechanism - Luminescence - Excitation and emission - Decay mechanisms. Internal electric field in a dielectric - Clausius - Mossotti and Lorentz - Lorenz equations .
UNIT-4 15Hrs	**Elastic Behaviour, Polymer and Ceramics** Anelastic and visco elastic behaviour - Atomic model of elastic behaviour - rubber like elasticity - An elastic deformation - Relaxation process, Polymers - Polymerization mechanism -Deformation of polymers - Behaviour of polymers. Ceramics - Ceramic phases - Structure - classes - Effect of structure on the behaviour of ceramic phases.
UNIT- 5 20Hrs	**Laser Physics** Introduction - Einstein co-efficient - Possibility of amplification - Population inversion - Laser pumping Rate equations - Three level and four level system - Optical resonator - Types and modes of resonator - Oscillation - Threshold condition. Spontaneous and stimulated emission - Conditions for oscillation to occur - Frequency of oscillation of the system.

SUGGESTED READINGS	1. Lawrence H. Vlack, 1998, Elements of Materials Science and Engineering, 6th Edition, Second ISE reprint, Addison-Wesley. 2. H. Iabch and H. Luth, 2001, Solid State Physics, An introduction to principles of Material Science, 2nd Edition, Springer. 3. B.B. Laud, 1991, Lasers and Non linear optics, Wiley Eastern Ltd. 4. Verdayan J.J. 1993, Laser Electronics, Prentice-Hall India, New Delhi.

M.Sc. in PHYSICS			FOURTH SEMESTER
COURSE CODE: MSP 411			COURSE TYPE : CCC
COURSE TITLE: Lab Course A			
CREDIT: 03		HOURS: 90	
THEORY: 00	PRACTICAL: 03	THEORY: 00	PRACTICAL: 100
Marks			
THEORY: 00		PRACTICAL: 100 (EXPERIMENT:60; VIVA-VOCE:20 & SESSIONAL:20)	

LABORATORY WORK
MSP 411

LAB COURSE A:

1. C++ program for aitken's delta squire method.
2. C++ program for steffensed method.
3. C++ program for striling formula.
4. C++ program for iteration method.
5. C++ program for cholesky method
6. C++ program for ramberg's method
7. C++ program for successive approximation DAC method
8. C++ program for Gaussian integration method.
9. C++ program for global illumination formula.
10. C++ program for libemann method.

M.Sc. in PHYSICS			FOURTH SEMESTER
COURSE CODE: MSP 412			COURSE TYPE : CCC
COURSE TITLE: Lab Course B			
CREDIT: 03		HOURS: 90	
THEORY: 00	PRACTICAL: 03	THEORY: 00	PRACTICAL: 100
Marks			
THEORY: 00		PRACTICAL: 100 (EXPERIMENT:60; VIVA-VOCE:20 & SESSIONAL:20)	

LABORATORY WORK

MSP 412

LAB COURSE B:

1. To study working of OP- AMP as a square wave generator using.
2. To study the working of OP-AMP as a inverting amplifier.
3. To study the working of OP-AMP as a non-inverting amplifier.
4. To study the working of OP-AMP as subtractor.
5. To study the working of OP-AMP as adder amplifier.
6. To study the working of OP-AMP as a Integrator.
7. To study the working of OP-AMP as a differentiator.
8. To study the characteristics of Thyraton

M.Sc. Semester-IV

Paper-II: MSP-402: Spectroscopy

Course Outcomes

After completing the course the students will able to : -

CO -01- Recognize spectroscopy in microwave, Rotational spectra of rigid diatomic molecules, selection rules, interaction of spectral lines

CO -02-Study of Vibrating diatomic molecule, energy levels of a diatomic molecule, simple harmonic and anharmonic oscillator, Scattering of light and Raman Spectrum. rotational and vibrational Raman Spectra

CO -03-Make Students aware of the fine structure of ESR absorption, Hyperfine structure, Double resonance in ESR, Techniques of ESR spectroscopy

CO -04-Understand Principles and Applications of Mossbauer spectroscopy

CO -05-Understand concepts of Nuclear and Radiation Chemistry. Applications of Radioisotopes.

CO -06-Understand Micro-wave, IR and RAMAN spectroscopy and interpret the data from these measurements.

CO -07-Understand the basic principles of NMR and ESR spectroscopy and its applications

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓					✓				
CO-02			✓				✓	✓		
CO-03								✓		
CO-04								✓		
CO-05	✓									
CO-06	✓				✓					
CO-07	✓									

M.Sc. in PHYSICS	**FOURTH SEMESTER**
COURSE CODE: MSP **402**	**COURSE TYPE : CCC**
COURSE TITLE: SPECTROSCOPY	
CREDIT: 06 **THEORY: 06 PRACTICAL: 00**	**HOURS: 90** **THEORY: 90 PRACTICAL: 00**
MARKS: 100 **THEORY: 70 CCA : 30 PRACTICAL: 00**	

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 18 HrS.	Microwave spectroscopy Pure rotational spectra of diatomic molecules - Polyatomic molecules - Study of linear molecules, Hyperfine structure and quadruple moment of linear molecules, Molecular structure determination - Stark effect - inversion spectrum of ammonia.
UNIT-2 18 Hrs	Infrared spectroscopy Vibrational spectroscopy of diatomic and simple ployatomic molecules - Harmonic Oscillator - Anharmonic Oscillator - Rotational vibrators - Normal modes of vibration of Polyatomic molecules - Experimental techniques - Applications of infrared spectroscopy, Reflectance spectroscopy.
UNIT-3 18 Hrs	Raman Spectroscopy Classical and quantum theory of Raman Scattering - Raman effect and molecular structure - Raman effect and crystal structure - Raman effect in relation to inorganic, organic and physical chemistry - Experimental techniques - Coherent anti-Stokes Raman Spectroscopy.
UNIT-4 18Hrs	NMR and NQR Techniques Theory of NMR - Bloch equations - Steady state solution of Bloch equations - Theory of chemical shifts, Applications of NMR to quantitative measurement, Quadruple Hamiltonian of NQR - Nuclear quadruple energy levels for axial and non-axial symmetry - Experimental techniques and applications.
UNIT- 5 18Hrs	ESR and Mossbauer Spectroscopy Quantum mechanical treatment of ESR - Nuclear interaction and hyperfine structure - Relaxation effects - Basic principles of spectrographs - Applications of ESR method. Mossbauer effect, Mossbauer spectrum - Experimental methods - Massbauer spectrometer - Hyperfine interactions - Magnetic hyperfine interactions - Electric quadruple interactions.

SUGGESTED READINGS	1. C.N. Banwell and E.M. McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw-Hill Publications, New Delhi. 2. G. Aruldas, 2001, Molecular Structure and Spectorscopy, Prentice - Hall of India Pvt.Ltd., New Delhi. 3. D.N. Satyanarayana, 2004, Vibrational Spectroscopy and Applications, New Age International Publications, New Delhi. 4. Atta Ur Rahman, 1986, Nuclear Magnetic Resonance, Spinger Verlag, New York. 5. Towne and Schawlow, 1995, Micorwave Spectroscopy, McGraw-Hill, 6. Raymond Chang, 1980, Basic Principles of Spectroscopy, Mc Graw-Hill, Kogakusha, Tokyo. 7. D.A. Lang, Raman Spectroscopy, Mc Graw-Hill International, N.Y.

M.Sc. Semester-IV

Paper-III: MSP-403: Statistical Physics

Course Outcomes

After completing the course the students will able to : -

CO -01- Explain the fundamentals of statistical physics and thermodynamics as logical consequences of the postulates

CO -02- Gain knowledge about classical and quantum statistical mechanics, including Boltzmann, Fermi-Dirac, and Bose-Einstein statistics.

CO -03- Apply the formalism of statistical mechanics and probability theory to derive relations between thermo dynamical quantities.

CO -04- Understand and explain the importance of Phase transition of first and second order, Landau theory of phase transition, Ising model, Brownian motion, Langevin theory, Fokker- Planck equation. Weiss theory of ferromagnetism

CO -05- broad understanding of Statistical Mechanics, and show a critical awareness of the significance and importance of the topics, methods and techniques.

CO -06- Understand the physical statistics and its relation to information theory and able to Solve statistical mechanics problems for simple non-interacting systems.

CO -07- Understand the phase transitions and universality in second order phase transitions.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓					✓	✓			
CO-02	✓		✓							
CO-03		✓				✓				
CO-04	✓									
CO-05	✓									
CO-06	✓				✓					
CO-07	✓									

M.Sc. in PHYSICS	**FOURTH SEMESTER**
COURSE CODE: MSP 403	**COURSE TYPE : CCC**
COURSE TITLE: STATISTICAL PHYSICS	
CREDIT: 06 **THEORY: 06**	**HOURS: 90** **THEORY: 90**
MARKS: 100 **THEORY: 70 CCA : 30**	

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 20 Hrs.	Basic Principles, Canonical and Grand Canonical ensembles : Concept of statistical distribution, phase space, Liouville's theorem, systems and ensemble, entropy in statistical mechanics Connection between thermodynamic and statistical quantities, micro canonical ensemble, specific heat and entropy of a perfect gas using micro-canonical ensemble.
UNIT-2 15 Hrs	Canonical ensemble, thermodynamic functions for the canonical ensemble, calculation of means values, grand canonical ensemble, thermodynamic functions for the grand canonical ensemble.
UNIT-3 20 Hrs	Partition functions and Statistics: Partition functions and properties, partition function for an ideal gas and calculation of thermodynamic quantities, Gibbs Paradox, determination of translational, rotational and vibration contributions to the partition function of an ideal diatomic gas. Specific heat of a diatomic gas.
UNIT-4 20Hrs	Identical particles and symmetry requirement, difficulties with MaxwellBoltzmann statistics, quantum distribution functions, Bose Einstein and Fermi-Dirac statistics and Planck's formula, Bose Einstein condensation, quantization of harmonic oscillator and creation and annihilation of phonon operators.
UNIT- 5 15 Hrs	Theory of Metals : Fermi-Dirac distribution function, density of states, temperature dependence of Fermi energy, specific heat, use of Fermi Dirac statistics in the calculation of thermal conductivity and electrical conduction band.

SUGGESTED READINGS	1. Huag : Statistical Mechanics 2. Reif : Fundamentals of Statistical and Thermodynamical Physics. 3. Rice : Statistical mechanics and Thermal Physics. 4. Kittle : Elementray statistical mechanics.

M.Sc. Semester-IV

Paper-IV: MSP-412: DISSERTATION

Course Outcomes

Upon successful completion, students will have the knowledge and skills to:

CO-01: gain in-depth knowledge and use adequate methods in the major subject/field of study.
CO-02: create, analyze and critically evaluate different technical/research solutions
CO-03: clearly present and discuss the conclusions as well as the knowledge and arguments that form the basis for these findings
CO-04: identify the issues that must be addressed within the framework of the specific dissertation in order to take into consideration.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓			✓		✓				✓
CO-02			✓			✓	✓			✓
CO-03	✓						✓			
CO-04		✓			✓	✓				

M.Sc. in PHYSICS			**FOURTH SEMESTER**
COURSE CODE: MSM 421			**COURSE TYPE: SSC/PRJ**
COURSE TITLE: DISSERTATION			
CREDIT:6		**HOURS: 135**	
THEORY: 0	**PRACTICAL: 6**	**THEORY: 0**	**PRACTICAL:135**
MARKS: 100			
THEORY: 0		**PRACTICAL:100** **(Course Report Submission:50 and Viva Voce:50)**	

OBJECTIVE: The main objective of the dissertation is to enable the students to learn on their own as well development of skill related to research and developmental activities.

Dissertation should be related to the field of Physics. Dissertation should include declaration by the candidate, certificate by supervisor, Acknowledgement, title and introduction along with the following points:

1. Introduction
2. Review of Literature
3. Materials and Methods
4. Results and Discussions
5. Summary
6. Bibliography

M.Sc. Semester-IV

Paper-V: MSP-D01:ENERGY PHYSICS

Course Outcomes

After completing the course the students will able to : -

CO -01- Understanding of the nucleus at low energy.

CO -02- Develop basics to solve some of the problems of nuclear physics and their limitations in nature.

CO -03- Gain the knowledge Energy Sources and their availability-prospects of renewable energy sources.

CO -04- Explain the Solar cell electrical characteristics, Efficiency-Solar water Heater-Solar, And Solar Cooking-Solar Green House.

CO- 05- Understand the basic Principles of wind energy conversion-power in the wind-forces in the blades.

CO- 06- learn the Biomass conversion Technologies and apply in daily life.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓									
CO-02			✓			✓				
CO-03	✓									
CO-04										
CO-05	✓							✓		
CO-06		✓			✓			✓		

M.Sc. in PHYSICS		FOURTH SEMESTER
COURSE CODE: MSP **D01**		**COURSE TYPE : ECC/CB**
COURSE TITLE: ENERGY PHYSICS		
CREDIT: 06 **THEORY: 06**		**HOURS : 90** **THEORY: 90**
MARKS : 100 **THEORY: 70 CCA : 30**		

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 20Hrs.	Introduction to Energy Sources : Energy Sources and their availability-prospects of renewable energy sources- Energy from other sources-Chemical energy-Nuclear energy-Energy Storage and distribution.
UNIT-2 20Hrs	Energy from the oceans- Energy utilization- Energy from tides-Basic Principle of tidal power-Utilization of tidal energy.
UNIT-3 20 H rs	Basic Principles of wind energy conversion-power in the wind-forces in the blades- Wind energy conversion-Advantages and Disadvantages of wind energy conversion systems(WECS) Energy Storage-Applications of Wind Energy.
UNIT-4 15 Hrs	Energy from Biomass: Biomass conversion Technologies-Wet and Dry Process-Photosynthesis. Biomass Generation: Introduction-Basic Process and energetic- Advantages of anaerobic digestion-Factors affecting bio-digestion and generation of gas- Biogas from waste fuel-Properties of biogas-utilization of biogas.
UNIT-5 15 Hrs	Solar radiation and its measurements-Solar Cells, Solar Cells for direct conversion of Solar energy to electric powers- Solar cell parameter- Solar cell electrical characteristics-Efficiency-Solar water Heater-Solar Distillation-Solar Cooking-Solar Green House.

SUGGESTED READINGS	1.Non-Conventional Sources of Energy by G.D.Rai,4th edition, Khanna Publishers, New Delhi(1996) 2.Energy technology by S.Rao and Dr Paru Lekar 3.John Twidell and Tony Weir ,Renewable Energy Sources,Taylor and Francis Group, London and New York. 4.M.P.Agrawal,Solar Energy, S. Chand and Co. 5.A.B. Meinel and A.P. Meinal, Applied Solar Energy 6.Solar Energy,Principles of Thermal Collection and Storage by S.P. Sukhatme, 2nd edition, Tata Mc Graw –Hill Publishing Co. Ltd. New Delhi(1997)

M.Sc. Semester-IV

Paper-V: MSP-D02:SATELLITE COMMUNICATION AND REMOTE SENSING

Course Outcomes

After completing the course the students will able to : -

CO -01- The knowledge about the Satellite communications Principles and Properties

CO -02- Know about the Space craft subsystems and Launch vehicles.

CO -03- Design the Satellite Earth station antennas.

CO -04- analyze the effects of various parameters on Satellite System performance.

CO -05- understand the applications of Satellite Communication.

CO -06- learn the dynamics of the satellite.

CO -07- understand the communication satellite design.

CO -08- understand how analog and digital technologies are used for satellite communication networks.

CO -09- learn the design of satellite links.

CO -10- study the design of Earth station and tracking of the satellites.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓									
CO-02	✓		✓							
CO-03		✓				✓				
CO-04					✓	✓				
CO-05	✓									
CO-06	✓				✓					
CO-07	✓									
CO-08					✓	✓				
CO-09					✓			✓		
CO-10	✓		✓			✓				

M.Sc. in PHYSICS	FOURTH SEMESTER
COURSE CODE: MSP **D02**	**COURSE TYPE : ECC/CB**
COURSE TITLE: SATELLITE COMMUNICATION AND REMOTE SENSING	
CREDIT: 06 **THEORY: 06**	**HOURS : 90** **THEORY: 90**
MARKS : 100 **THEORY: 70 CCA : 30**	

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 20Hrs.	Principle of Satellite Communication:General and Technical characteristics, Active and Passive satellites, Modem and Code communication Satellite Link Design:General link design equation, Atmospheric and Ionospheric effect on link design, Earth station parameters.
UNIT-2 20Hrs	Satellite Analog Communication: Baseband analog signal, FDM techniques, S/N and C/N ratio in FM in satellite link.
UNIT-3 20 H rs	Digital Satellite transmission: Advantages, Elements of digital satellite communication, Digital base band signal, Digital modulation Techniques, Digital link Design, TDM, TDMA, some applications of satellite communications.
UNIT-4 15 Hrs	Concept and Foundations of Remote Sensing: Electromagnetic Radiation (EMR), interaction of EMR with atmosphere and earth surface, Application area of remote Sensing. Characteristics of Remote Sensing Platform & Sensors: Ground, Air & Space platforms, Return Beam Vidicon, Multispectral Scanner, Brief idea of Digital Image Processing.
UNIT-5 15 Hrs	Microwave Remote Sensing Tools: Radar Remote Sensing, Microwave Sensing, Lidar (Single and double ended system), (Radar & Lidar): Data Characteristics. Earth Resource Satellites: Brief description of Landsat and Indian remote sensing satellites (IRS) Satellites.

SUGGESTED READINGS	1. Satellite Communication : D.C. Agrawal and A. K. Maini. 2. Satellite Communication: T. Pratt and C. W. Bostiern. 3. Satellite Communication System: M. Richharia. 4. Introduction of Remote Sensing: J.B. Campbell.

M.Sc. Semester-IV

Paper-V: MSP-D03:CRYSTAL GROWTH AND THIN FILM PHYSICS

Course Outcomes

After completing the course the students will able to : -

CO 01- Understand the fundamentals of crystal growth and nucleation.

CO 02- Analyse the low temperature method of crystal growth.

CO 03- Understand the melt growth technique of crystal growing.

CO 04- Be aware of Thin film formation through vapour deposition

CO 05- Introduce Characterization techniques

.

CO 06- Understand the formation of thin film mechanism.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓									
CO-02			✓			✓				
CO-03	✓									
CO-04								✓		
CO-05		✓					✓			
CO-06	✓									

M.Sc. in PHYSICS	FOURTH SEMESTER
COURSE CODE: MSP **D03**	**COURSE TYPE : ECC/CB**
COURSE TITLE: CRYSTAL GROWTH AND THIN FILM PHYSICS	
CREDIT: 06 **THEORY: 06**	**HOURS : 90** **THEORY: 90**
MARKS : 100 **THEORY: 70 CCA : 30**	

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 20Hrs.	Nucleation and Growth Nucleation – Different kinds of nucleation - Concept of formation of critical nucleus – Classical theory of nucleation - Spherical and cylindrical nucleus - Growth Kinetics of Thin Films - Thin Film Structure – Crystal System and Symmetry.
UNIT-2 20Hrs	Growth Techniques Solution Growth Technique: Low temperature solution growth: Solution - Solubility and super solubility – Expression of super saturation – Miers T-C diagram - Constant temperature bath and crystallizer - Seed preparation and mounting - Slow cooling and solvent evaporation methods.
UNIT-3 20 H rs	Melt and Vapour Growth Techniques Melt technique: Bridgman technique - Basic process – Various crucibles design - Thermal consideration – Vertical Bridgman technique - Czochralski technique – Experimental arrangement – Growth process. Vapour technique: Physical vapour deposition – Chemical vapour deposition (CVD) – Chemical Vapour Transport.
UNIT-4 15 Hrs	Thin Film Deposition Techniques Thin Films – Introduction to Vacuum Technology - Deposition Techniques - Physical Methods – Resistive Heating, Electron Beam Gun, Laser Gun Evaporation and Flash Evaporations, Sputtering - Reactive Sputtering, Radio-Frequency Sputtering - Chemical Methods – Spray Pyrolysis – Preparation of Transparent Conducting Oxides.
UNIT-5 15 Hrs	Characterization Technique X – Ray Diffraction (XRD) – Powder and single crystal - Fourier transform Infrared analysis (FT-IR) – Elemental analysis – Elemental dispersive X-ray analysis (EDAX) - Scanning Electron Microscopy (SEM) – UV-Vis-NIR Spectrometer – Etching (Chemical) – Vickers Micro hardness.

SUGGESTED READINGS	1. J.C. Brice, Crystal Growth Processes, John Wiley and Sons, New York (1986) 2. P. SanthanaRagavan and P. Ramasamy, Crystal Growth Processes and Methods, KRU Publications, Kumbakonam (2001) 3. A. Goswami, Thin Film Fundamentals, New Age International (P) Limited, New Delhi (1996) 4. H.H. Willard, L.L. Merritt, J.A. Dean, F.A. Settle, CBS, Publishers and Distributors, New Delhi

M.Sc. Semester-IV

Paper-V: MSP-D04: RENORMALIZATION AND SUPERSYMMETRY

Course Outcomes

After completing the course the students will able to : -

CO -01- Understand the algebraic origin of supersymmetry as an extension of Special Relativity.

CO -02- Understand research papers dealing with the phenomenology of supersymmetric particles and supersymmetric model building.

CO -03- Interpret the current and future experimental results from searches for supersymmetry.

CO -04- Understand the fundamental arguments in favor of supersymmetry at low energies, and the problems that the theory faces.

CO -05- Carry out calculations in perturbation theory of supersymmetric particle production, scattering on ordinary matter, annihilation and decay.

.

MAPPING OF CO (COURSE OUTCOME) AND PO (PROGRAMME OUTCOME):

POs / COs	PO-01	PO-02	PO-03	PO-04	PO-05	PO-06	PO-07	PO-08	PO-09	PO-10
CO-01	✓									
CO-02	✓		✓							
CO-03						✓		✓		
CO-04	✓									
CO-05	✓			✓						

M.Sc. in PHYSICS		FOURTH SEMESTER
COURSE CODE: MSP **D04**		**COURSE TYPE : ECC/CB**
COURSE TITLE: RENORMALIZATION AND SUPERSYMMETRY		
CREDIT: 06 **THEORY: 06**	**HOURS : 90** **THEORY: 90**	
MARKS : 100 **THEORY: 70 CCA : 30**		

Scheme of marks:

i. Objective type questions: Twelve questions carrying 1 marks each to be asked ten to be attempted
ii. Short answer type questions: Five questions carrying 6 marks each to be asked three to be attempted (Word limit 100 words).
iii. Middle answer type questions: Five questions carrying 9 marks each to be set three to be attempted (Word limit 250 words).
iv. Long answer type questions: three questions carrying 11 marks each to be set two to be attempted (Word limit 750 words).

UNIT-1 20Hrs.	Theory of renormalization. The renormalization group and applications to the theory of phase transitions.
UNIT-2 20Hrs	Renormalization of Yang-Mills theories.
UNIT-3 20 H rs	Applications of the renormalization group of quantum chromodynamics.
UNIT-4 15 Hrs	Perturbation theory anomalies. Applications to particle phenomenology.
UNIT-5 15 Hrs	Grand unification, The supersymmetric Standard Model