Udai Pratap College, Varanasi

(An Autonomous Institution)

Syllabus of the Subject: Physics

Post Graduate (Physics) Programme

National Education Policy-2020 (NEP-2020)
w.e.f. the session 2024-2025

SUBJECT: PHYSICS

Semester-Wise Titles of the Papers in M.Sc.(Physics)

YEAR	SEMESTER	COURSE CODE	PAPER TITLE	THEORY/ PRACTICAL	CREDIT
BACHELOR (RESEARCH) IN PHYSICS/ FIRST YEAR OF M.Sc. IN PHYSICS					
FIRSTYEAR	I	PHY101T	Mathematical and Computational Physics	Theory	3
		PHY102T	Quantum and Statistical Mechanics-I	Theory	3
		PHY103T	Nuclear Physics-I	Theory	3
		PHY104T	Electronics-I	Theory	3
		PHY105P	Practical-General	Practical	4
		PHY106PRJ	Project Work / Dissertation	Dissertation	4
	II	PHY201T	Atomic and Molecular Physics	Theory	3
		PHY202T	Condensed Matter Physics-I	Theory	3
		PHY203TE1	Mathematical and Classical Physics (Elective)	Theory	3
		PHY203TE2	Quantum and Statistical Mechanics-II(Elective)	Theory	3
		PHY204T	Electronics-II	Theory	3
		PHY205P	Practical-Electronics	Practical	4
		PHY206PRJ	Project Work / Dissertation	Dissertation	4
M.Sc. IN PHYSICS					
SECONDYEAR	III	PHY301T	Laser and Optoelectronics-I	Theory	3
		PHY302TE1	Condensed Matter Physics-II(Elective)	Theory	3
		PHY302TE2	Nuclear Physics-II(Elective)	Theory	3
		PHY303T	Communication Electronics-I	Theory	3
		PHY304T	Digital Electronics-I	Theory	3
		PHY305P	Practical (Digital Electronics-I)	Practical	4
		PHY306PRJ	Project Work /Dissertation	Dissertation	4
	IV	PHY401T	Laser and Optoelectronics-II	Theory	3
		PHY402TE1	Relativistic Electrodynamics (Elective)	Theory	3
		PHY402TE2	Quantum Field Theory (Elective)	Theory	3
		PHY403T	Communication Electronics-II	Theory	3
		PHY404T	Digital Electronics-II	Theory	3
		PHY405P	Practical (Digital Electronics-II)	Practical	4
		PHY406PRJ	Project Work / Dissertation	Dissertation	4

SUBJECT PRE-REQUISITES

To study Physics at PG Level, a student must have had the subject **Physics** in class B.Sc.

PROGRAMME OUTCOMES (POs)

The objectives of the M.Sc. in Physics programme are manifold and imparting students with an in-depth knowledge and understanding through the core courses which form the basis of Physics namely, Classical Mechanics, Quantum Mechanics, Mathematical Physics, Statistical Physics, Electromagnetic Theory, Solid State Physics, Electronics, Nuclear and Particle Physics along with Atomic and Molecular Physics. Computational physics course is aimed to equip the students to use computers as a tool for scientific investigations/understanding. The dissertation(s) are expected to give a flavor of how research leads to new findings. In addition, the M.Sc. course is to lay a solid foundation for a doctorate in Physics/allied subjects later. Physics Post Graduates are expected to be well prepared to become academicians, researchers, team leaders and decision makers in their organizations and shall contribute effectively to the growth and development of their respective organizations.By the end of the M.Sc. in Physics program, the students will be able to

1. Demonstrate knowledge of basic concepts, principles and applications of the specific science discipline.
2. Handle/use appropriate tools/techniques/equipment with an understanding of the standard operating procedures, safety aspects/limitations.
3. Identify and critically analyze pertinent problems in the relevant discipline using appropriate tools and techniques as well as approaches to arrive at viable conclusions/solutions.
4. Demonstrate the knowledge and the scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyse and interpret data and provide solutions. Exhibit organizational skills and the ability to manage time and resources.
5. Apply the knowledge acquired to find solutions of challenges being faced /observed by them by way of review of literature, identification, formulation and analysis of problems to arrive at sustainable conclusions.
6. Be ready to use research-based methods including review, system design, analysis and interpretation of data obtained in a manner as to inspire future generations through their teaching and interpersonal skills, apply ethical principles, commit to professional ethics, duties and responsibilities
7. Exhibit the potential to effectively accomplish tasks independently and as a member or leader in diverse teams, and in multidisciplinary settings.
8. Write dissertations, reports, make effective presentations and documentation.

PROGRAMME SPECIFIC OUTCOMES(PSOs)

BACHELOR (RESEARCH) IN PHYSICS / FIRST YEAR OF M.Sc. IN PHYSICS

FIRSTYEAR

The PSOs of the Bachelor (Research) in Physics program are as follows:

1. The Bachelor (Research) in Physics program provide student the adequate knowledge to use mathematical and computational tools to solve complex physical problems and have the solid background and experience needed to analyze and solve advanced problems in physics.
2. This programme provides a firm foundation in every aspect of Physics and to explain a broad spectrum of modern trends in physics and to develop experimental, computational and mathematics skills of students.
3. This programme provides the student the adequate knowledge, general competence, and analytical skills on an advanced level, needed in industry, consultancy, education, research, or in government organization.
4. The student would also get research oriented experience by doing theoretical and experimental projects/dissertations under the supervision of faculty.

MASTER OF SCIENCE IN PHYSICS

SECONDYEAR

The PSOs of the M. Sc. program in Physics are as follows:

1. The Master of Science (M.Sc.) in Physics programme provides student the adequate knowledge to use mathematical tools to solve complex physical problems and have the solid background and experience needed to analyze and solve advanced problems in physics.
2. This programme would enable the student to acquire scientific skills and the practical knowledge by performing experiments in general physics and electronics.
3. The student would also get research oriented experience by doing theoretical and experimental projects/dissertations under the supervision of faculty.
4. This programme aims to introduce the students to the fundamental and advanced level knowledge in fieldwith Lasers and Optoelectronics, Relativistic Quantum Mechanics as well as Digital and Communication electronics. A deeper in sight in Electronics is provided to address the important components in consumer Optoelectronics, IT and Communication devices and in industrial instrumentation.
5. This programme amalgamates the comprehensive knowledge of Analog & Digital principles and applications. It presents an integrated approach to analog electronic circuitry and digital electronics.
6. Present programme will attract immense recognition in R&D sectors and in the entire cutting edge technology based industry.

FIRST YEAR

DETAILED SYLLABUS

BACHELOR (RESEARCH)

IN

PHYSICS

SUBJECT: PHYSICS

Semester-Wise Titles of the Papers
In
BACHELOR (RESEARCH) IN PHYSICS / FIRST YEAR OF M.Sc. IN PHYSICS

YEAR	SEMESTER	COURSE CODE	PAPER TITLE	THEORY/ PRACTICAL	CREDIT
FIRST YEAR	I	PHY101T	Mathematical and Computational Physics	Theory	3
		PHY102T	Quantum and Statistical Mechanics-I	Theory	3
		PHY103T	Nuclear Physics-I	Theory	3
		PHY104T	Electronics-I	Theory	3
		PHY105P	Practical-General	Practical	4
		PHY106PRJ	Project Work / Dissertation	Dissertation	4
	II	PHY201T	Atomic and Molecular Physics	Theory	3
		PHY202T	Condensed Matter Physics-I	Theory	3
		PHY203TE1	Mathematical and Classical Physics (Elective)	Theory	3
		PHY203TE2	Quantum and Statistical Mechanics-II(Elective)	Theory	3
		PHY204T	Electronics-II	Theory	3
		PHY205P	Practical-Electronics	Practical	4
		PHY206PRJ	Project Work / Dissertation	Dissertation	4

<table>
<tr><td>Programme/Class: M.Sc. (Physics)</td><td>Year: I</td><td>Semester: I</td></tr>
<tr><td colspan="3">Subject:Physics (Paper-1)</td></tr>
<tr><td>CourseCode: PHY101T</td><td colspan="2">CourseTitle: Mathematical and Computational Physics</td></tr>
<tr><td colspan="3">Course Outcomes (COs)
On completion of this course students will able to:
• Learn about the special functions, such as the Hermite polynomial, the Legendre polynomial, the Laguerre polynomial and Bessel functions and their differential equations and their applications in various physical problems such as in quantum mechanics which they will learn in future courses in detail.
• Understand numerical techniques to find the roots of nonlinear equations and solution of system of linear equations.
• Understand numerical differentiation and integration and numerical solutions of ordinary and partial differential equations.
• Applying the basic knowledge of C++ in writing various problem solving programs.</td></tr>
<tr><td>Credits:3</td><td colspan="2">Core: Compulsory</td></tr>
<tr><td>Max. Marks: 25+75</td><td colspan="2">Min. Passing Marks:33</td></tr>
<tr><td colspan="3">Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P:3-0-0</td></tr>
</table>

Unit	Topics	No. of Lectures
I	**Partial Differential Equation** Laplace Equation and its Solution, Bessel and Legendre differential equations and their solutions, Generating functions, Recurrence relations, Orthogonality conditions, Rodrigue's formula.	15
II	**Numerical Methods of Analysis** Solution of algebraic and transcendental equations: bisection and Newton- Raphson methods, Numerical Integration: Newton-cotes formulae: Trapezoidal rule, Simpson's 1/3 rule, Numerical solution of ordinary differential equations: Euler's, modified Euler's and Runge-Kutta methods.	15
III	**Programming with C++** Algorithms, flowcharts, C++ keywords, various data types, Operators & Expressions: Arithmetic, unary, logical, bitwise, assignment & conditional operators,++ and– – operators. Control Statements: while, do while, for statement, nested loops. IFELSE, switch, Break, continue &go to statement. Simple programs.	15

Suggested Readings:

1. Mathematical Methods for Physicists: Arfken and Weber.
2. Mathematical Method of Physics: Ghatak.
3. Mathematical Methods for Physics: Wyle.
4. Mathematical Methods in Physical Sciences: Boas
5. Computational Methods in Physics and Engineering: Wong.
6. Applied Numerical Analysis: Gerald.
7. Mathematical Physics: H.K. Das
8. Mathematical Physics: B.S. Rajput
9. Programming with C++: Balagurusamy
10. Let us C++: Yashwant Kanetkar

This course can be opted as an elective by the students of following subjects: Open for all

Suggested Continuous Evaluation Methods
20 Marks for Test / Quiz / Assignment / Seminar,
05 Marks for Class Interaction

Programme/Class: M.Sc. (Physics)	Year: I	Semester: **I**
	Subject: **Physics (Paper-2)**	
Course Code: **PHY102T**	Course Title: **Quantum Mechanics and Statistical Mechanics-I**	

Course Outcomes (Cos)

On completion of this course students will able to:

- Express the general formalism of quantum mechanics, the wavefunction space and matrix representation of operators.
- Investigate the addition of angular momenta and calculate the Clebsch-Gordan coefficients.
- Use time independent perturbation theory and approximation methods in various physics problems like stark effect, Zeeman effect etc.
- Understand the concepts of microstate, macrostate, ensemble, phase space, thermodynamic probability and partition function.
- Learn to calculate the macroscopic properties of degenerate photon gas using BE distribution law, understand Bose-Einstein condensation law and liquid Helium. Bose derivation of Plank's law
- Understand the concept of Fermi energy and Fermi level, calculate the macroscopic properties of completely and strongly degenerate Fermi gas, electronic contribution to specific heat of metals.
- Calculate electron degeneracy pressure and ability to understand the Chandrasekhar mass limit, stability of white dwarfs against gravitational collapse.

Credits:4	Core: **Compulsory**
Max. Marks: 25+75	Min. Passing Marks:33

Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P: 3-0-0

Unit	Topics	No. of Lectures
I	**Abstract Formulation of Quantum Mechanics and Angular Momentum** Mathematical properties of Linear Vector space with concept Hilbert space, Postulates of Quantum Mechanics, Dirac Notations: Bra and Ket Notations, Matrix representation of Observable and States, Rotation Operator, Relation, between rotation and angular momentum, Commutation rules, Eigen values of J^2& J_z, Matrix representations, Addition of angular momenta and Clebsch-Gordon coefficients, Pauli spin matrices.	15
II	**Time Independent Approximation Methods** Time-independent Perturbation theory (non-degenerate and degenerate) and applications to Zeeman effect (Normal and anomalous), Hydrogen atom, Stark effect and other simple cases, Variational method and applications to hydrogen atom and simple cases; WKB approximation and applications to simple cases, Tunnelling Probability.	15
III	**Quantum Statistical Mechanics** Evaluation of constant α and β and its thermodynamics interpretation, Equation of state of Bose gases, Bose-Einstein condensation, Thermal properties of Bose- Einstein and liquid He, the Lambda transition, two fluid model, Equation of state of Fermi gas, Thermionic emission (the Richardson effect), Spin Para-magnetism, Equilibrium of Bodies of large mass, Chandrasekhar mass limit, White dwarf and neutron stars.	15

Suggested Readings:

1. Quantum Mechanics: L.I. Schiff.
2. Modern Quantum Mechanics: J.J. Sakurai.
3. Introduction to Quantum Mechanics : B.H. Bransden and C.J. Joachain
4. Introduction of Quantum Mechanics: D.J. Griffiths.
5. Quantum Mechanics- Theory and Application: A Ghatak and S. Loknathan
6. Quantum Mechanics: J.L. Powell & B. Crasemann
7. Statistical Mechanics: Parharia.

8. Statistical Mechanics: Haung.
9. Statistical Mechanics: S.K.Sinha
10. Statistical Mechanics: B.K. Agrawal & M.Eisner
11.Statistical Mechanics: Gupta&Kumar

Thiscoursecanbeoptedasanelectivebythestudentsoffollowingsubjects:Openforall

SuggestedContinuousEvaluationMethods
20 Marks for Test / Quiz / Assignment / Seminar
05Marks forClassInteraction…………………………………………………

Programme/Class: **M.Sc. (Physics)**	Year: I	**Semester: I**
	Subject: **Physics (Paper-3)**	
CourseCode: **PHY103T**	CourseTitle: **Nuclear Physics - I**	

Course Outcomes (COs)

On completion of this course students will able to:

- Explain the deuteron behavior at ground and excited states.
- Apply deuteron physics and the Nucleon- Nucleon scattering for explaining the nuclear forces.
- Can express the reaction equation, Q values and energy of alpha particles.
- Can explain the alpha decay process by using quantum theory.
- Can explain the beta decay process using Fermi theory and also learned about selection rules.
- Can tell about the reaction is possible or not by using conservation laws.

Credits:3	Core: **Compulsory**
Max. Marks: 25+75	Min. Passing Marks:33

Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P:3-0-0

Unit	**Topics**	**No. of Lectures**
I	**Nuclear Reaction** Scattering amplitude and cross section, L-and C- system co-ordinates, method of partial waves, phase-shift scattering by perfect rigid sphere and by a spherically symmetric potential. Q-value, Derivation and discussion of direct and compound nuclear reactions, decay of the compound nucleus,	15
II	**Nuclear Transitions** Radioactive decay, Nucleon emission, separation energy, Alpha decay and its energy spectrum, Q-value, Gamow's theory of alpha decay, β-decay and its energy spectrum, Fermi theory, Need for neutrinos, Q-value for beta decay, selection rules, parity non-conservation in β-decay, electromagnetic transitions (Gamma decay), concept of multi-pole order, selection rules for gamma transitions, life time of emitting states and isomerism.	15
III	**Elementary Particles** Fundamental interactions, Conservation laws, Discrete symmetries - parity; charge conjugation and time reversal; G parity and CPT theorem, Internal symmetries -Isospin formalism; SU2 and SU3 groups and their applications to multiplet mesons and baryons; Quark model -Gell Mann - Okubo mass formula for octet and Decuplet hadrons - charm, bottom and top quarks,Gluons as mediators of strong interaction.	15

SuggestedReadings:

1. Atomic and Nuclear Physics Vol.II : S.N.Ghoshal
2. Nuclear Structure: Preston and Bhaduri
3. Nuclear Structure: Pal
4. Introductory Nuclear Physics: Wong
5. Nuclear Theory: Etlon
6. Nuclear Interactions: De. Benedetti
7. Nuclear Physics: V. Devanathan
8. Nuclear Physics: D.C. Tayal
9. Nuclear Physics: Raj Kumar

This course can be opted as an elective by the students of following subjects: Open for all

Suggested Continuous Evaluation Methods

20 Marks for Test / Quiz / Assignment / Seminar

05 Marks for Class Interaction

Programme/Class: **M.Sc. (Physics)**	Year: I	Semester: I
	Subject: **Physics (Paper-4)**	
CourseCode: **PHY104T**	CourseTitle: **Electronics-I**	

Course Outcomes (COs)

On completion of this course students will able to:

- Analyze modulator and demodulator circuit.
- Understand the detection methods of AM and FM modulated signal.
- Explain to explain the working of class B push pull amplifier and multivibrator.
- Understand propagation of EM wave along wave guide and their different modes

Credits:3	Core: **Compulsory**
Max. Marks: 25+75	Min. Passing Marks:33

Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P:3-0-0

Unit	Topics	No. of Lectures
I	**Modulation& Detection** Amplitude Modulation Linear and Square law modulation, Production of AM wave, Transistor modulator (base modulator, collector modulator), Balanced modulator, Detection of Amplitude modulated wave, Envelope diode detector, Foster-seely discriminator and Ratio detector.	15
II	**Sequential Logic Circuit&Multivibrator** Latches, R-S Flip-Flop, J-K Flip-Flop, Race Problem, Masterslave Flip-Flop, D Flip-Flop, T Flip-Flop, Astable, monostable and bistable multivibrator.	15
III	**Propagation of Electromagnetic Waves:** **(i)** Free Space Propagation: Ground wave, space wave and ionospheric wave propagation, Mathematical analysis of reflection by ionosphere. **(ii)** Bound Media Propagation: Propagation along transmission line and waveguides, TE and TM modes, important matching circuits.	15

SuggestedReadings:

1. Integrated Electronics: Millman and Halkias.
2. Electronic Communication Systems: Kennedy
3. Linear Integrated Circuits: Choudhary and Jain.
4. Radio Engineering: Terman

This course can be opted as an elective by the students of following subjects: Open for all

Suggested Continuous Evaluation Methods
20 Marks for Test / Quiz / Assignment / Seminar
05 Marks for Class Interaction

<table>
<tr><td>Programme/Class: M.Sc. (Physics)</td><td>Year: I</td><td>Semester: I</td></tr>
<tr><td colspan="3">Subject: Physics (Paper-5)</td></tr>
<tr><td>Course Code: PHY105P</td><td colspan="2">Course Title: Practical-I (General lab)</td></tr>
<tr><td colspan="3">Course Outcomes (COs)
After this course student is expected to know:
• Calculating wave length using Michelson interferometer.
• To use He-Ne laser for measuring thickness of wire .
• To verify hall effect.
• Calculating losses in optical fiber.
• Calculating g factor from ESR .
• About lattice dynamics , hysteresis curve and characteristics of UJT.</td></tr>
<tr><td>Credits:4</td><td colspan="2">Core: Compulsory</td></tr>
<tr><td>Max. Marks: 25+75</td><td colspan="2">Min. Passing Marks:33</td></tr>
<tr><td colspan="3">Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P:0-0-8</td></tr>
<tr><td colspan="3">1. Michelson Interferometer
2. He-Ne Laser I(Wavelength of Laser)
3. He-Ne Laser II (Thickness of wire)
4. Hall Effect Experiment
5. Angle of Divergence(He-Ne/Diode laser)
6. Optical Fiber Experiment
7. UJT Experiment (Characteristics & relaxation oscillator)
8. To study Electron Spin Resonance
9. Hysteresis loss.
10. Lattice Dynamics.</td></tr>
<tr><td colspan="3">This course can be opted as an elective by the students of following subjects: Open for all</td></tr>
<tr><td colspan="3">Suggested Continuous Evaluation Methods
20 Marks for Test / Quiz / Assignment / Seminar
05 Marks for Class Interaction</td></tr>
</table>

Programme/Class: **M.Sc. (Physics)**	Year: **I**	**Semester: I**
CourseCode: **PHY106PRJ**	CourseTitle: **Project Work/Dissertation**	
Credits:4	Core: **Compulsory**	
Total No. of Lectures-Tutorials-Practical (in hours per week):8		

Course Outcomes (COs)
1. Develop the ability to conduct independent research in a specific area of physics. 2. Enhance critical thinking skills by analyzing and evaluating existing literature and experimental data. 3. Demonstrate the capacity to solve complex physics problems related to the chosen topic. 4. Improve scientific writing skills, including the ability to clearly and concisely communicate research findings. 5. Gain proficiency in data analysis techniques and the use of relevant software and tools. 6. Present research findings through oral presentations or written reports. 7. Make a unique contribution to the field by adding new insights, findings, or experimental data. 8. Understand and adhere to ethical standards in research, including proper citation and plagiarism avoidance.
Note: 1. Every student of third year has to complete a Research Project/Dissertation which will be allotted in the 1st Semester. 2. This Research Project/Dissertation may be Interdisciplinary. 4. The Research Project/Dissertation will be done under the supervision of a teacher. Another Co-supervisor may be taken from any Industry/ University/ Technical institute/Research institute etc. 5.The student will submit a joint report of the research project/Dissertation done in both semesters (1st and 2nd semesters) at the end of the year (end of 2nd Semester), which will be evaluated jointly by the supervisor and the external examiner appointed by the college on total marks 100.

Programme/Class: **M.Sc. (Physics)**	Year: **I**	**Semester: II**
	Subject: **Physics (Paper-1)**	
CourseCode: **PHY201T**	CourseTitle: **Atomic and Molecular Physics**	

Course Outcomes (COs)

After this course students will be able to :

- Understand about He atom in ground state and first exited states.
- Understand about LS and JJ coupling schemes.
- Explain molecular orbital theory.
- Explain rotational , vibrational, and electronic spectra of diatomic molecule.
- Understand Theory of EMR and ESR

Credits:3	Core: **Compulsory**
Max. Marks: 25+75	Min. Passing Marks:33

Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P:3-0-0

Unit	Topics	No. of Lectures
I	**ManyElectronAtoms** He atom, Ground and First excited states, spin functions, Spectra of Alkaline earth atoms, LS and JJ coupling schemes, Idea of normal and inverted terms, Hund's rule, Width and shape of spectral lines, Elementary idea of Lamb shift, Hyper fine structure of lines.	15
II	**Rotational-Vibrational Spectra** Rotational spectra of diatomic molecule as a rigid rotator, Energy level and spectra of Non-rigidrotator, Rotational Raman spectra and Diatomic molecule as a simple harmonic Oscillator, Modification due to Anharmonicity, Morse Potential Vibrational structure and vibrational analysis, Normal modes vibration of H_2O molecules, IR and Raman Spectra.	15
III	**Electronic Spectra** Electronic spectra of diatomic molecule, Vibrational and Rotational transitions in the electronic spectra of diatomic molecules, Sequence and Progressions, Pre-dissociation in diatomic molecules, Franck-Condon Principle, Dissociation Energy, Theory of ESR.	15

Suggested Readings:

1. Introduction to Atomic Spectra: H.E. White
2. Physics of Atoms and Molecules: B.H. Bransden, C.J. Jochain.
3. Atom, Laser and Spectroscopy: S.N. Thakur and D.K. Rai
4. Fundamentals of Molecular Spectroscopy: C.N. Banwell and E.M. McCash
5. Molecular Spectra of molecular structure: G. Herzberg

This course can be opted as an elective by the students of following subjects: Open for all

Suggested Continuous Evaluation Methods

20 Marks for Test / Quiz / Assignment / Seminar

05 Marks for Class Interaction

<table>
<tr><td>Programme/Class: M.Sc. (Physics)</td><td>Year: I</td><td>Semester: II</td></tr>
<tr><td colspan="3">Subject: Physics (Paper-2)</td></tr>
<tr><td>CourseCode: PHY202T</td><td colspan="2">CourseTitle: Condensed Matter Physics-I</td></tr>
<tr><td colspan="3">Course Outcomes (COs)
After this course students will
Learn about crystalline and amorphous substances, about lattice, unit cell,
Learn about miller indices, reciprocal lattice,
Learn about the concept of Brillouin zones and diffraction of X-rays by crystalline materials.
Learn about Boltzmann Transport Equation and Electrical and Thermal Conductivity
Understand the band theory of solids and must be able to differentiate insulators, conductors and semiconductors
Learn about Liquid crystals, Nano materials and superionic Solids and their properties</td></tr>
<tr><td>Credits:3</td><td colspan="2">Core: Compulsory</td></tr>
<tr><td>Max. Marks: 25+75</td><td colspan="2">Min. Passing Marks:33</td></tr>
<tr><td colspan="3">Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P:3-0-0</td></tr>
</table>

Unit	Topics	No. of Lectures
I	**Free Electron Theory of Solids** Classical free electron Theory, Quantum Free electron theory, Fermi and mean energy of electrons, Boltzmann transport Equation, Sommerfeld theory of Electrical Conductivity of metals, Thermal conductivity of metals.	15
II	**Band theory of Solids** Formation of Bands in solid, Bloch formulation, Kroning-Penny Model, Tight binding approximation, Effective mass of electron, Basic of Hall Effect, band gap of semiconductor, Hall Effect in semiconductors.	15
III	**Super Conductivity** Super Conductivity and its basic features, Soft and hard superconductors, Thermodynamics of Superconducting transitions, London equation, Coherence length, Elements of BCS theory. **Modern Materials** Liquid crystals, Nano Materials and Superionic solids and their applications (Qualitative descriptions only).	15

Suggested Readings:

1. Introduction to Solid State Physics: C. Kittel.
2. Crystallography Applied to Solid State Physics: A.R. Verma and O.N. Srivastava.
3. Solid State Physics–Structure and Properties of Materials: M.A. Wahab
4. Principles of Condensed Matter Physics: P.M. Chaikin and T.C. Lubensky.
5. Solid State Physics: N.W. Ashcroft and N.D. Mermin.
6. Crystallography for Solid State Physics: Verma and Srivastava..
7. Solid State Physics: A.J. Decker
8. Solid State Physics: S.O. Pillai
9. Solid State Physics: R.K. Puri & V.K. Babbar

This course can be opted as an elective by the students of following subjects: Open for all

Suggested Continuous Evaluation Methods
20 Marks for Test / Quiz / Assignment / Seminar,
05 Marks for Class Interaction

Programme/Class: **M.Sc. (Physics)**	Year: **I**	**Semester: II**
	Subject: **Physics (Paper-3, Elective-1)**	
CourseCode: **PHY203TE1**	CourseTitle: **Mathematical and Classical Physics**	

Course Outcomes (COs)

On completion of this course students will able to:

- Demonstrate contour integrals in relevant problems in physics.
- Enable to apply integral transform to solve mathematical problems of interest in physics. Can use Fourier transforms as an aid for analyzing experimental data.
- Understand Poisson Brackets and Lagrange Brackets.
- Transform rotating body frame of reference and static space frame of reference using Euler's angle.
- Explain motion of symmetric top.

Credits:3	Core: **Elective**
Max. Marks: 25+75	Min. Passing Marks:33

Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P:3-0-0

Unit	Topics	No. of Lectures
I	**Complex Variables** Functions of a complex variable. analytic functions, Cauchy-Riemann differential equations, integration in the Complex plane, Cauchy's Integral theorem, Cauchy's integral formula, Taylor's series and Laurent's series expansion, Zeroes, poles andSingular points of an analytic function, Residues, evaluation of residues, Cauchy's Residue theorem, evaluation of definite integrals, Contours integration and its application to simple problems.	15
II	**The Laplace Transforms and Fourier transforms** Laplace transforms of simple functions, Properties, Laplace transforms of derivatives, Initial and final value theorem, Methods of finding Laplace transforms, Inverse Laplace transforms and its properties, Laplace transform method of solving differential equations. Fourier (sine, cosine and complex) transforms properties of Fourier transforms, Modulation theorem, Convolution Theorem.	15
III	**Rigid Body Dynamics** Poisson brackets, properties of poison brackets, Jacobi identity, Invariance of Poisson Bracket, Lagrange's Bracket, Properties and invariance of Lagrange's Brackets. Space-fixed and body-fixed systems of coordinates, Moment of inertia tensor, principal moments of inertia, Euler's equations of motion for a rigid body, torque free motion of a rigid body, Motion of symmetric top.	15

Suggested Readings:

1. Mathematical Methods for Physicists: Arfken and Weber.
2. Mathematics for Physicists and Engineers: Pipes.
3. Mathematical Methods in Physical Sciences: Boas
7. Computational Methods in Physics and Engineering: Wong.
8. Applied Numerical Analysis: Gerald.
9. Mathematical Physics: H.K. Das
10. Mathematical Physics: B.S. Rajput
11. Classical Mechanics: H. Goldstein.
12. Mechanics: L. D. Landau and E. M. Lifshitz
13. Introduction to Classical Mechanics: R. G. Takwale and Puranik.

14. Classical Mechanics of Particles and Rigid Bodies: K. C. Gupta. 15. Introduction to Classical Mechanics: N. C. Rana and P. Joag
This course can be opted as an elective by the students of following subjects: Open for all
Suggested Continuous Evaluation Methods **20** Marks for Test / Quiz / Assignment / Seminar **05** Marks for Class Interaction

Programme/Class: **M.Sc. (Physics)**	Year: **I**	**Semester: II**
	Subject: **Physics (Paper-3, Elective-2)**	
Course Code: **PHY203TE2**	Course Title: **Quantum Mechanics and Statistical Mechanics-II**	

Course Outcomes (COs)

On completion of this course students will able to:

- This basic course will form a firm basis to understand quantum many body problems.
- Solve simple problem in Schrödinger and Heisenberg picture of quantum mechanics.
- To use Fermi golden rule to calculate transition probability in beta decay.
- Form wave function of system of two or more fermions or bosons.
- Distinguish between first and second order phase transition.
- Will learn Langevin's equation of Brownian motion.

Credits:3	Core : **Elective**
Max. Marks: 25+75	Min. Passing Marks:33

Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P:3-0-0

Unit	Topics	No. of Lectures
I	**Dependent Problems** Schrödinger and Heisenberg pictures. Heisenberg equation of motion, Time-dependent perturbation theory. Transition probability calculations, Fermi's golden rule. Adiabatic and sudden approximations. Beta decay. Semi classical Theory of Interaction of radiation with matter (Probability of Induced absorption and emission). Einstein A and B coefficients, Dipole selection Rules, introduction to the quantization of electromagnetic field.	15
II	**Identical Particles** Indistinguishability in Quantum Mechanics, Permutation symmetry, Symmetrization postulates, Symmetric and anti-symmetric wave functions, Incorporation of spin, Exchange Symmetry, Ground and first excited states of two electron systems, Self consistent field approximation, Slater determinant, Hartree Fock method, Slater determinants, Pauli exclusion principle	15
III	**Phase Transitions** First and Second Order Phase Transition, Phase Equilibria, Critical Point Ising model, Bragg-Williums Approximation, Mean field theories of the Ising model, Exact solutions in one dimension, Landau theory of phase transition, Critical indices.	15

Suggested Readings:

1. Quantum Mechanics: L.I. Schiff.
2. Modern Quantum Mechanics: J.J. Sakurai.
3. Introduction to Quantum Mechanics : B.H. Bransden and C.J. Joachain
4. Introduction of Quantum Mechanics: D.J. Griffiths.
5. Quantum Mechanics- Theory and Application: A Ghatak and S. Loknathan
6. Statistical Mechanics : R.K. Pathria.
7. Statistical Mechanics: B.K. Agrawal & M. Eisner
8. Statistical Mechanics:Gupta&Kumar

This course can be opted as an elective by the students of following subjects: Open for all

Suggested Continuous Evaluation Methods
20 Marks for Test / Quiz / Assignment / Seminar
05Marks for Class Interaction

Programme/Class: **M.Sc. (Physics)**	Year: I	**Semester: II**
	Subject: **Physics (Paper-4)**	
Course Code: **PHY204T**	Course Title: **Electronics-II**	

Course Outcomes (COs)

After this course student will be able to:

- Understand working of operational amplifier and its different parameters.
- Design circuits to perform different arithmetic and logic operation using operational amplifier.
- Design fundamental logic gates using MOS and C-MOS.
- Understand the generation of microwave.

Credits:3	Core: **Compulsory**
Max.Marks: 25+75	Min. Passing Marks:33

Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P:3-0-0

Unit	**Topics**	**No. of Lectures**
I	**Operational Amplifiers& its Application** Fundamentals, Differential Amplifier, Ideal & Real operational amplifier, Characteristics, Parameters: off-set current and voltage, off-set error compensation, CMRR, Slew Rate, Inverting and Non-inverting operational amplifier, & their equivalent circuits & their uses, Concept of virtual grounds. Uses of OP AMP as Summing Amplifier, Subtractor, Differentiator and integrator circuits, Current to voltage and voltage to current convertors, logarithmic and antilogarithmic amplifiers, comparators, Schmitt trigger,	15
II	**Logic Circuits** ASCII and EBCDIC codes and their advantages and disadvantages, Data representation, MOS and C-MOS logic circuits (OR, AND & NOT gates), Programmable Logic Array (PLA).	15
III	**Microwave Generation**: **Microwave Tubes**: Limitation of Gridded tubes at high frequencies, Two cavity and multi cavity Klystron amplifier, Reflex Klystron oscillator, Application of microwaves, Traveling wave tube amplifier, Magnetron oscillator and Gun-oscillator.	15

Suggested Readings:

1. Op-Amps and Linear Integrated Circuits: R.A. Gayakwad.
2. Integrated Electronics: Millman and Halkias.
3. Microwave: K.C.Gupta
4. Radio Engineering: Terman
5. Digital Fundamental: Floyed.
6. Digital Electronics: Jain.
7. Microwaves and Radar: A.K. Mani

This course can be opted as an elective by the students of following subjects: Open for all

Suggested Continuous Evaluation Methods

20 Marks for Test / Quiz / Assignment / Seminar

05 Marks for Class Interaction

Programme/Class: M.Sc. (Physics)	Year: **I**	**Semester:II**
Subject:**Physics** (Paper –**5)**		
CourseCode: **PHY205P**	CourseTitle: **Practical-Electronics**	

Course Outcomes (COs)

After this course student will be able to :

- Use ICs 7400,7402,7410,7427 and verify different logic circuits and their truth table.
- Design circuits for multivibrator, and use OP-Amp for different application.
- Design FET amplifier and phase shift oscillator.
- Can calculate H parameter of a transistor in CE configuration.

Credits:4	Core: **Compulsory**
Max. Marks: 25+75	Min. Passing Marks:33

Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P: 0-0-8

1. Digital I(IC-7400)
2. Digital II(IC-7402)
3. Flip Flop I(IC-7400 & 7410)
4. Flip Flop II(IC-7402 & 7427)
5. Astable Multivibrator
6. C-E Amplifier(Design and study the frequency response curve).
7. FET Amplifier (frequency response curve).
8. OP-Amplifier (Inverting, Non-inverting, Summing, Integrating, Differentiating etc)
9. Phase Shift Oscillator
10. Hybrid parameters(h_{ie},h_{re}, h_{fe} and h_{oe})
11. Study of Offset currents and voltages of Op-AMP-741

This course can be opted as an elective by the students of following subjects: Open for all

Suggested Continuous Evaluation Methods

20 Marks for Test / Quiz / Assignment / Seminar

05 Marks for Class Interaction

Programme/Class: M.Sc. (Physics)	Year: II	**Semester: II**
CourseCode: **PHY206PRJ**	CourseTitle: **Project work/Dissertation**	
Credits:4	Core: **Compulsory**	
Total No. of Lectures-Tutorials-Practical(in hours per week):8		

At the end of the year, student will submit Combined Research Project / Dissertation of semester I and II and will be evaluated by supervisor and an external expert.

Course Outcomes (COs)
1. Develop the ability to conduct independent research in a specific area of physics.
2. Enhance critical thinking skills by analyzing and evaluating existing literature and experimental data.
3. Demonstrate the capacity to solve complex physics problems related to the chosen topic.
4. Improve scientific writing skills, including the ability to clearly and concisely communicate research findings.
5. Gain proficiency in data analysis techniques and the use of relevant software and tools.
6. Present research findings through oral presentations or written reports.
7. Make a unique contribution to the field by adding new insights, findings, or experimental data.
8. Understand and adhere to ethical standards in research, including proper citation and plagiarism avoidance.
Note: 1. Every student of third year has to complete a Research Project/Dissertation which will be allotted in the 1st Semester. 2. This Research Project/Dissertation may be Interdisciplinary. 4. The Research Project/Dissertationwill be done under the supervision of a teacher. Another Co-supervisor may be taken from any Industry/ University/ Technical institute/Research institute etc. 5. The student will submit a joint report of the research project/Dissertation done in both semesters (1st and 2nd semesters) at the end of the year (end of 2nd Semester), which will be evaluated jointly by the supervisor and the external examiner appointed by the college on total marks 100.

SECOND YEAR

DETAILED SYLLABUS

MASTER OF SCIENCE

IN

PHYSICS

SUBJECT: PHYSICS

Semester-Wise Titles of the Papers
In
MASTER OF SCIENCE IN PHYSICS

YEAR	SEMESTER	COURSE CODE	PAPER TITLE	THEORY/ PRACTICAL	CREDIT
SECONDYEAR	III	PHY301T	Laser and Optoelectronics-I	Theory	3
		PHY302TE1	Condensed Matter Physics-II(Elective)	Theory	3
		PHY302TE2	Nuclear Physics-II(Elective)	Theory	3
		PHY303T	Communication Electronics-I	Theory	3
		PHY304T	Digital Electronics-I	Theory	3
		PHY305P	Practical (Digital Electronics-I)	Practical	4
		PHY306PRJ	Project Work /Dissertation	Dissertation	4
	IV	PHY401T	Laser and Optoelectronics-II	Theory	3
		PHY402TE1	Relativistic Electrodynamics (Elective)	Theory	3
		PHY402TE2	Quantum Field Theory (Elective)	Theory	3
		PHY403T	Communication Electronics-II	Theory	3
		PHY404T	Digital Electronics-II	Theory	3
		PHY405P	Practical (Digital Electronics-II)	Practical	4
		PHY406PRJ	Project Work / Dissertation	Dissertation	4

Programme/Class: **M.Sc. (Physics)**	Year: **II**	**Semester: III**
Subject: **Physics (Paper-1)**		
CourseCode: **PHY301T**	CourseTitle: **Laser and Optoelectronics-I**	

Course Outcomes (COs)

After this course student is expected to be able to :

- Understand spontaneous and stimulated transition and also calculate their probability.
- Explain laser action and properties of laser beam and also application of laser.
- Understand origin of nonlinearity when EM wave propagates through solid dielectric.
- Understand different order of harmonic generation.
- Understand propagation of light pulse through optical fiber

Credits:3	Core: **Compulsory**
Max. Marks: 25+75	Min. Passing Marks: 33

Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P:3-0-0

Unit	Topics	No. of Lectures
I	**Einstein Coefficients and Light Amplification** Theory for the Evaluation of the Transition Rates and Einstein Coefficients, General ideas of laser action, various means of creating population inversion, Two levels laser system-solution, Rate equations for three systems, Optical resonators. Characteristics of laser radiation, Coherence properties of Laser Light, Temporal Coherence, Spatial Coherence, Directionality,	15
II	**Non linear optics** Propagation of EM waves in a solid dielectric, Physical origin of optical nonlinearities, second order nonlinearities, Non liner frequency mixing, Crystal symmetry, Phase matching, Third order non linear media. Harmonic generation, mixing and parametric effects. Multi phonon processes, Two-photon absorption, saturated absorption, Optical Kerr effect and Self focusing.	15
III	**Fiber Optical Communication** Basic principles of optical fibers, step and graded index fiber,Optical wave guide, Absorption losses in fibers, Mono-mode and multimode propagation, Dispersion effects, basic optical communication system, wave propagation in optical fiber media, optical fiber source and detector, optical joints and coupler, Advantages and disadvantages of optical communication system.	15

Suggested Readings:

1. Laser theory and Applications: A. Ghatak and K. Thyagrajan
2. Principle of Lasers: O. Swelto
3. Quantum Theory of light: R. Loudan.
4. Optical Fiber Communication: Kaiser.
5. Digital and Analog Communication Systems: K. San Shanmugam.
6. Communication Systems: Simon Haykin.
7. An Introduction of optical fiber to Fiber Optics: Ajoy Ghatak
8. Laser Cooling and Trapping : P.N. Ghosh.

This course can be opted as an elective by the students of following subjects: Open for all

Suggested Continuous Evaluation Methods
20 Marks for Test / Quiz / Assignment / Seminar
05 Marks for Class Interaction

Programme/Class: **M.Sc. (Physics)**	Year: **II**	**Semester: III**
	Subject:**Physics (Paper-2, Elective-1)**	
CourseCode: **PHY302TE1**	CourseTitle: **Condensed Matter Physics-II**	

Course Outcomes (COs)

At the end of the course the student is expected to learn and assimilate the following:

- At knowledge of different types of magnetism from diamagnetism to ferromagnetism and hysteresis loops and energy loss.
- Secure an understanding about the dielectric and ferroelectric properties of materials.
- Understand about the defects in crystals and their uses
- Secure an understanding about Materials Characterization Techniques

Credits:4	Core: **Elective**
Max. Marks: 25+75	Min. Passing Marks: 33

Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P: 4-0-0

Unit	**Topics**	**No. of Lectures**
I	**Magnetic Properties of Solids** Dia-, Para- and Ferromagnetic Materials, Classical Langevin Theory of Dia– and Paramagnetic Domains, Quantum Mechanical Treatment of Paramagnetism, Curie's law, Weiss's Theory of Ferromagnetic Domains, Discussion of B-H Curve, Hysteresis and Energy Loss, Anti-Ferromagnetism and ferrimagnetism.	15
II	**Dielectric and Ferroelectric Properties of Solids** Basic features of dielectric, Polar and Non-polar dielectric, Local field inside a dielectric, Electric Susceptibility, Polarizability, Clausius-Mossotti Relation, Classical Theory of Electric Polarizability, Normal and Anomalous Dispersion, Cauchy and Sellmeir relations, Complex Dielectric Constant. Pyroelectric, Piezoelectric, Ferroelectric and Anti-ferroelectric materials, Classification, Theories and applications of Ferro-electric materials Electrostrictive effect	15
III	**Defects in Crystal** Crystal Defects, Point defects (Schottky & Frankel Defects), Color centers, F-centers, Line defects (Edge& Screw dislocations), Burger vector & Burger Circuit, Role of dislocation in plastic deformation and crystal growth.	15

Suggested Readings:

1. Introduction to Solid State Physics: C. Kittel.
2. Crystallography Applied to Solid State Physics: A.R. Verma and O.N.Srivastava.
3. Solid State Physics–Structure and Properties of Materials: M.A. Wahab
4. Principles of Condensed Matter Physics: P.M. Chaikin and T.C. Lubensky.
5. Solid State Physics: N.W. Ashcroft and N.D. Mermin.
6. Solid State Physics: A.J. Decker
7. Solid State Physics: S.O. Pillai
8. Solid State Physics: R.K.Puri & V.K. Babbar

This course can be opted as an elective by the students of following subjects: Open for all

Suggested Continuous Evaluation Methods

20 Marks for Test / Quiz / Assignment / Seminar,

05 Marks for Class Interaction

<table>
<tr><td colspan="2">Programme/Class: M.Sc. (Physics)</td><td>Year: II</td><td>Semester:III</td></tr>
<tr><td colspan="4">Subject: Physics (Paper-2, Elective-2)</td></tr>
<tr><td colspan="2">CourseCode: PHY302TE2</td><td colspan="2">CourseTitle: Nuclear Physics-II</td></tr>
<tr><td colspan="4">Course Outcomes (COs)
After this course student will be able to:
• Understand the principle and working of different types of particle detector
• Explain energy generation in nuclear reactor.
• Know basics of neutron physics.
• Understand working of different types of reactor and their critical size.</td></tr>
<tr><td colspan="2">Credits:3</td><td colspan="2">Core: Elective</td></tr>
<tr><td colspan="2">Max. Marks: 25+75</td><td colspan="2">Min. Passing Marks:33</td></tr>
<tr><td colspan="4">Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P: 3-0-0</td></tr>
<tr><td>Unit</td><td colspan="2">Topics</td><td>No. of Lectures</td></tr>
<tr><td>I</td><td colspan="2">Nuclear Radiation Detectors
Detection: Simple model of detector, energy measurement, position and time measurement.
Solid State Detectors: Semiconductor detectors, Surface barrier detectors, Scintillation counters: Organic and inorganic Scintillators, Photomultiplier tubes, Gamma Ray Scintillation Spectrometer.
High Energy Particle Detectors: General principles, Nuclear emulsions, Cloud chambers, Bubble chamber.</td><td>15</td></tr>
<tr><td>II</td><td colspan="2">Nuclear Reactor Theory
Fundamentals of Nuclear Fission: Fission fuels, Prompt and delayed neutrons, Chain reaction, Multiplication factor, Condition for criticality, Breading phenomena.
Diffusion of neutrons: Neutron current density, The equation of continuity, Fick's law, The diffusion equation, Measurement of diffusion parameters.</td><td>15</td></tr>
<tr><td>III</td><td colspan="2">Criticality of an Infinite Homogenous Reactor:
The critical equation, Optimum reactor shapes, Material and geometrical bucklings, Neutron balance in a thermal reactor, Four factor formula, Calculation of critical size and composition in simple cases.
Nuclear Electronics: Pulse shaping Linear amplifiers, Pulse height discriminators, Single channel and Multichannel analyzer</td><td>15</td></tr>
<tr><td colspan="4">Suggested Readings:
1. Atomic and Nuclear Physics Vol.II: S.N. Ghoshal
2. NuclearStructure:PrestonandBhaduri
3. Introductory Nuclear Physics: Wong
4. Nuclear Theory: Etlon
5. Nuclear Physics: V. Devanatha
6. Nuclear Physics: D.C. Tayal</td></tr>
<tr><td colspan="4">This course can be opted as an elective by the students of following subjects: Open for all</td></tr>
<tr><td colspan="4">Suggested Continuous Evaluation Methods
20 Marks for Test / Quiz / Assignment / Seminar,
05 Marks for Class Interaction</td></tr>
</table>

<table>
<tr><td colspan="2">Programme/Class: M.Sc. (Physics)</td><td>Year: II</td><td>Semester: III</td></tr>
<tr><td colspan="4">Subject: Physics (Paper-3)</td></tr>
<tr><td colspan="2">Course Code: PHY303T</td><td colspan="2">Course Title: Communication Electronics-I</td></tr>
<tr><td colspan="4">Course Outcomes (COs)
After this course student will be able to:
• Understand sampling of analog signal and use sampling theorem.
• Explain different types of modulation of digital signal PAM, PWM, PPM.
• Apply the theory that they have learned in the theory class to gain hands on experience in building modulation and demodulation circuits; Transmitters and Receivers for AM and FM.
• Understand elements of communication system , noise ,rate of information, and channel capacity.
• Understand about satellite communication, frequency allocation, transponders and command</td></tr>
<tr><td colspan="2">Credits:3</td><td colspan="2">Core: Compulsory</td></tr>
<tr><td colspan="2">Max. Marks: 25+75</td><td colspan="2">Min. Passing Marks: 33</td></tr>
<tr><td colspan="4">Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P: 3-0-0</td></tr>
<tr><td>Unit</td><td colspan="2">Topics</td><td>No. of Lectures</td></tr>
<tr><td>I</td><td colspan="2">Sampling theory and Pulse Modulation& Digital Communication
Introduction, Sampling theorem, Nyquist rate and interval, signal reconstruction, sampling technique (instantaneous and Natural sampling), Pulse amplitude modulation (PAM), Pulse Width modulation (PWM), Pulse Position modulation (PPM), Generation, detection, advantage & disadvantage, MODEM.
Modulation technique of digital communication, Pulse code modulation and Delta modulation, Quantization of signals and quantization error, Companding, Compander characteristics, applications, advantages and disadvantages of PCM. Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Multiplexing, TDM, FDM.</td><td>15</td></tr>
<tr><td>II</td><td colspan="2">Information Theory
Block diagram of communication system, Noise in communication, types of noise, External and internal noise, signal to noise ratio, average mutual information and entropy, joint entropy & conditional entropy,chain rule for entropy, information content of message, rate of information- channel capacity, Shannon- Hartly Theorem and Shannon limit.</td><td>15</td></tr>
<tr><td>III</td><td colspan="2">Satellite Communication
Principle of Satellite Communication, general and technical characteristics, Active and passive satellite, Kepler's law, Satellite frequency allocation , Satellite orbits and positioning, Satellite height, Speed, Angle of inclination, Geo synchronous orbits, Position coordinates, Azimuth and elevation,Satellite link design,Repeaters and Satellite Transponders, Frequency allocations for Transponder channels, Satellite sub-systems, Transponder configurations, Multi channel Architecture, Satellite orbit control, Power sub-systems, Telemetry, Command and Control sub-systems., Multiple Access technique, Satellite Applications.</td><td>15</td></tr>
<tr><td colspan="4">Suggested Readings:
1. Communication System: Simon Haykin.
2. Electronics communication: Roddy and Coolen.
3. Digital and analog communication systems: K.San Shanmugam.
4. Satellite Communication: Pratt and Bostiern.</td></tr>
<tr><td colspan="4">Suggested Continuous Evaluation Methods
20 Marks for Test / Quiz / Assignment / Seminar,
05 Marks for Class Interaction</td></tr>
</table>

Programme/Class: **M.Sc. (Physics)**	Year: **II**	**Semester: III**
Subject:**Physics (Paper-4)**		
CourseCode: **PHY304T**	CourseTitle: **Digital Electronics-I**	

Course Outcomes

After this course student will be able to :

- Understand different methods of fabrication of integrated circuits.
- Oscilloscope (CRO) and applications and usage of oscilloscopes for measuring voltages, currents and study of waveforms, Different rectifiers and voltage regulation using capacitors, Zener diode.
- Understand working of combinational logic circuits decoder , Encoder, de-multiplexer and multiplexer.
- Design circuits to convert digital to analog and analog to digital signal.
- Understand different parameters of D/A and A/D circuits.

Credits:3	Core: **Compulsory**
Max. Marks: 25+75	Min. Passing Marks: 33

Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P: 3-0-0

Unit	**Topics**	**No. of Lectures**
I	**IC 555 Timer and applications** 555 Timer, Description, Monostable operation, Frequency divider, Astable operation, Phase Locked Loops, Basic principles, Analog phase detector ,Voltage Controlled Oscillator , Voltage to Frequency conversion,	15
II	**Combinational logic** Decoder BCD system, BCD to Decimal Decoder, Demultiplexers, 4- to 16 line decoder/Demultiplexer, Multiplexer, Parallel to serial conversion, Sequential data selection, Encoder Encoding matrix to transform Decimal to BCD.	15
III	**A/D and D/A Converters** Signals and systems, Classification of signals, Concept of frequency in continuous time and discrete – time signals. Theory of A/D and D/A conversion, Binary weighted Resistor D/A Converter, Ladder Network D/A Converter. D/A Converter Specifications: Resolution, Accuracy, Linearity, Settling Time, Temperature Sensitivity. Flash A/D Converter, Ramp A/D Converter, Successive Approximation A/D Converter,	15

Suggested Readings:

1. Communication System: Simon Haykin.
2. Electronics communication: Roddy and Coolen.
3. Digital and analog communication systems : K. San Shanmugam
4. Digital Technology : Principle and practice by Virendra Kumar ; New Age International.

This course can be opted as an elective by the students of following subjects: Open for all

Suggested Continuous Evaluation Methods

20 Marks for Test / Quiz / Assignment / Seminar,

05 Marks for Class Interaction.

Programme/Class: M.Sc. (Physics)	Year: II	**Semester:III**
Subject:**Physics (**Paper –5)		
CourseCode: **PHY305P**	CourseTitle: **Practical- (Digital Electronics-I)**	
Course outcome		
After this course student will be able to: • Design circuits for PAM , PWM, PPM. • Measure resistivity using four probe apparatus. • Design BCD Encoder and Decoder circuits. • Use microprocessor (8085) for pulse code modulation. • Use IC-7476 and 7420 to design ripple counter.		
Credits:4	Core: **Compulsory**	
Max. Marks: 25+75	Min. Passing Marks: 33	
Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P: 0-0-8		
List of Experiments 1. Pulse Amplitude Modulation & Demodulation 2. Pulse Width Modulation & Demodulation 3. Pulse position Modulation & Demodulation 4. Multiplexer (16:1 MUX) 5. De Multiplexer (1:16 DEMUX) 6. Encoder (Binary to Decimal) 7. Decoder BCD to Decimal and BCD to seven segment 8. Pulse Code Modulation. 9. Analog to Digital (A/D) convertor 10. Digital to Analog (D/A) convertor		
This course can be opted as an elective by the students of following subjects: Open for all		
Suggested Continuous Evaluation Methods **20** Marks for Test / Quiz / Assignment / Seminar **05** Marks for Class Interaction.		

Programme/Class: **M.Sc. (Physics)**	Year: II	**Semester:III**
Course Code: **PHY306PRJ**	Course Title: **Project work/Dissertation**	
Credits:4	Core: **Compulsory**	
Total No. of Lectures-Tutorials-Practical(in hours per week):8		

Course Outcomes (COs)
1. Develop the ability to conduct independent research in a specific area of physics. 2. Enhance critical thinking skills by analyzing and evaluating existing literature and experimental data. 3. Demonstrate the capacity to solve complex physics problems related to the chosen topic. 4. Improve scientific writing skills, including the ability to clearly and concisely communicate research findings. 5. Gain proficiency in data analysis techniques and the use of relevant software and tools. 6. Present research findings through oral presentations or written reports. 7. Make a unique contribution to the field by adding new insights, findings, or experimental data. 8. Understand and adhere to ethical standards in research, including proper citation and plagiarism avoidance.
Note: 1. Every student of third year has to complete a Research Project/Dissertation which will be allotted in the 5th Semester. 2. This Research Project/Dissertation may be Interdisciplinary. 4. The Research Project/Dissertation will be done under the supervision of a teacher. Another Co-supervisor may be taken from any Industry/ University/ Technical institute/Research institute etc. 5.The student will submit a joint report of the research project/Dissertation done in both semesters (3rd and 4th semesters) at the end of the year (end of 4^{th} Semester), which will be evaluated jointly by the supervisor and the external examiner appointed by the college on total marks 100.

Programme/Class: **M.Sc. (Physics)**	Year: II	**Semester: IV**
	Subject:**Physics (Paper-1)**	
CourseCode: **PHY401T**	CourseTitle: **Laser and Optoelectronics-II**	

Course Outcomes (COs)

After this course student will be able to:

- Explain principle and working of solid state lasers, Ruby and Nd- yag lasers, Electrically pumped lasers, He-Ne, N_2 and CO_2 lasers and Dye laser.
- Understand application of Lasers in Cooling and Trapping of Atoms.
- Understand Laser radiation as carrier wave, Modulation mechanism, Encoding procedures for digital communication.
- Explain Principle of photodiodes, Photo detectors principle and operations.
- Understand The Principle of the OLED

Credits:3	Core: **Compulsory**
Max. Marks: 25+75	Min. Passing Marks:33

Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P: 3-0-0

Unit	Topics	No. of Lectures
I	**Basic Principle and Different Lasers** Optically pumped solid state lasers, Ruby and Nd- Yag lasers, Electrically pumped lasers, He-Ne, N_2 and CO_2 lasers, Principle and working of Dye lasers, Semiconductor lasers and Free Electron Laser.	15
II	**Novel Applications of Laser** Cooling and Trapping of Atoms, Principles of Doppler and Polarization Gradient Cooling, Qualitative Description of Ion Traps, Optical Traps and Magneto-Optical Traps, charge couple device (CCD).	15
III	**Fiber Transmission and Photo detectors** Laser radiation as carrier wave, Modulation mechanism, Encoding procedures for digital communication, Luminescent properties of solid, effects of various types of impurities, Principle of photodiodes, Photo detectors principle and operations, figure of merits of detectors, Noise, Response time and other characteristics of photo detectors, temperature effects on gain, comparison of photo detectors.	15

Suggested Readings:

1. Laser theory and Applications: A. Ghatak and K. Thyagrajan
2. Principle of Lasers: O. Swelto
3. Introduction to Modern Quantum Optics: Peng and Li
4. Quantum Theory of light: R. Loudan.
5. Quantum Optics: M.O. Scully and M.S. Zubairy
6. Digital and Analog Communication Systems: K. San Shanmugam.
7. Communication Systems: Simon Haykin.
8. Optical Fiber Communication: Kaiser.
9. Quantum Optics: An Introduction: Mark Fox

This course can be opted as an elective by the students of following subjects: Open for all

Suggested Continuous Evaluation Methods
20 Marks for Test / Quiz / Assignment / Seminar,
05 Marks for Class Interaction

Programme/Class: **M.Sc. (Physics)**	Year: **II**	**Semester:IV**
Subject: **Physics (Paper-2, Elective-1)**		
CourseCode: **PHY402TE1**	CourseTitle: **Relativistic Electrodynamics**	

Course Outcomes (COs)

After this course student will be able to :

1. Understand the four vector formulation of Maxwell's Equations
2. Derive the Lienard-Wiechert potentials for a point charge.
3. Understand about the Klein Gordon Equation, and its Physical Interpretation,
4. Explain Dirac equation and its interpretation.

Credits:3	Core: **Elective**
Max. Marks: 25+75	Min. Passing Marks:33

Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P: 3-0-0

Unit	Topics	No. of Lectures
I	**Maxwell's Equations and four Vector Formulation** Maxwell's equation, Displacement current, electromagnetic waves in conducting and non-conducting medium, Poynting theorem, Four vector potential, electromagnetic field tensor, Lorentz force, covariant form of Maxwell'sequations, electromagnetic energymomentumtensor, Motion of charge particle inelectromagnetic field, Lorentz force	15
II	**Electromagnetic fields and Radiation by Moving Charges** Electromagnetic scalar and vector potentials, Maxwell's equations in terms of scalar and vector potentials, Non-uniqueness of Electromagnetic potentials and concept of Gauge. Lorentz gauge and coulomb gauge. Retarded potentials, Lienard-Wiechert potentials for a point charge, the potentials and fields of a charged particle moving with variable velocity and constant velocity, Total power radiated by a point charge: Larmor's formula and its relativistic generalization.	15
III	**Relativistic Quantum Mechanic** Klein Gordon (KG) Equation, Plane wave solution of Klein Gordon Equation, Physical Interpretation, KG equation in Covariant form, Equation of continuity, Probability Density and current, Klein Gordon Equation in presence of electromagnetic field, Inadequacies of K.G. Equation. Dirac equation and its interpretation, Covariant form of Dirac equation, Algebra of Dirac matrices, Solution of Dirac equation for free particle, Negative energy states and Dirac hole theory, Dirac equation in central force field and Spin angular momentum, Helicity.	15

Suggested Readings:

1. Introduction to Electrodynamics (3rd Edition): David J. Griffiths.
2. EM Waves and Fields: P. Lorrain and O. Corson
3. Electromagnetism : B. B. Laud
4. Principles of Electrodynamics: Melvin M. Schwartz.
5. Classical Electrodynamics: J.D. Jackson.
6. Introduction to Electrodynamics: David J. Griffiths.
7. EM Wave and Fields: P. Lorrain and O. Corson.
8. Electrodynamics of Continuous Media Landau &Lifshitz :

This course can be opted as an elective by the students of following subjects: Open for all

Suggested Continuous Evaluation Methods

20 Marks for Test / Quiz / Assignment / Seminar

05 Marks for Class Interaction

Programme/Class: **M.Sc. (Physics)**	Year: II	**Semester:IV**
Subject:**Physics (Paper-2, Elective-2)**		
CourseCode: **PHY402TE2**	CourseTitle: **Quantum Field Theory**	

Course Outcomes (COs)

After this course student will be able to :

5. Understand the quantization of field due to Bosons
6. Understand the quantization of field due to Fermions
7. Understand the about Lagrangian and Hamiltonian Density
8. Understand about the second quantization

Credits:3	Core : **Elective**
Max. Marks: 25+75	Min. Passing Marks:33

Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P: 3-0-0

Unit	Topics	No. of Lectures
I	**Quantization of Bosonic Fields** Classical field theory; relativistic fields; identical bosons and quantum fields; Klein–Gordon propagator and relativistic causality; quantum electromagnetic fields and photons. Lorentz symmetry and spinor fields; Dirac equation and its solutions; second quantization of fermions and particle-hole formalism; quantum Dirac field; Weyl and Majorana spinor fields.	15
II	**Lagrangian and Hamiltonian Formalism** Definition of Field, Lagrangian and Hamiltonian Formalism for fields, Lagrangian and Hamiltonian density, Derivation of Lagrangian and Hamilton's equation, Poisson Bracket for field, simple problems on algebra of annihilation and creation operators	15
III	**Field Quantization** Concept of Second quantization, Lagrangian density and equation of motion for field, Second quantization of Scalar field, Second quantization of Klein Gordon Equation, Second quantization of Dirac fields, Second quantization of electromagnetic field in radiation gauge.	15

Suggested Readings:

1. Relativistic Quantum Mechanics: J.D. Bjorken and S.D. Drell.
2. Relativistic Quantum Fields: J.D. Bjorken and S.D. Drell.
3. Advanced Quantum Mechanics: Satya prakash
4. Introduction to Electrodynamics (3rd Edition): David J. Griffiths.
5. EM Waves and Fields: P. Lorrain and O. Corson
6. Electromagnetism : B. B. Laud
7. Classical Electricity and Magnetism: W.K.H Panofsky and M. Phillips.
8. Principles of Electrodynamics: Melvin M. Schwartz.
9. Classical Electrodynamics: J.D. Jackson.
10. Introduction to Electrodynamics: David J. Griffiths.
11. EM Wave and Fields: P. Lorrain and O. Corson.

This course can be opted as an elective by the students of following subjects: Open for all

Suggested Continuous Evaluation Methods

20 Marks for Test / Quiz / Assignment / Seminar

05 Marks for Class Interaction.

Programme/Class: **M.Sc. (Physics)**	Year: **II**	**Semester: IV**
Subject: **Physics (Paper-3)**		
CourseCode: **PHY403T**	CourseTitle: **Communication Electronics-II**	

Course Outcomes (COs)

After this course student will be able to:

- Understand antenna action and parameters of antenna.
- Learn principle of different types of antenna.
- Understand working of radar and elements used in radar system.
- Understand basic principle of television and its elements.

Credits:3	Core: **Compulsory**
Max.Marks: 25+75	Min.PassingMarks:33

Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P: 3-0-0

Unit	Topics	No. of Lectures
I	**Antenna** Introduction, Antenna definition, action, Current and voltage distribution in a short electric dipole,Antenna Parameters, Power radiated and radiative resistance by a short antenna, antenna equivalent circuits, coordinate system, radiation fields, polarization, isotropic radiator, power gain of an antenna, effective area of an antenna, effective length of an antenna, Hertzian dipole , Half wave dipole vertical antennas. Ground reflections, Grounded vertical antennas , long wire antenna, Antenna remote from the ground: thin linear vertical and horizontal antenna, Field radiated, radiative resistance, Driven arrays, Broad side array, end-fire array ,turnstile antenna Parasitic arrays, Parasitic reflectors, Parasitic directors.	15
II	**Radar** Principle of radar, Basic arrangement of radar system, operating characteristics of radar systems, free space radar range equation, factors affecting range of radar, Pulsed radar system, Radar transmitter and receiver, Duplexer, Indicators, Plan position indicator, Doppler effect, continuous wave Doppler radar, , FMCW RADAR, MTI Radar, scanning and tracking with Radar.	15
III	**Television** Basic principles, Elements of television system: picture elements, Scanning and composite video signal, Television Camera tube:Image orthicon, vidicon and plumbic on tubes, television transmitter and receiver, Basic principle of colour television, luminance, saturation and hue, bandwidth for colour signal transmission.	15

Suggested Readings:

1. Electronic Communication System by G. Kennedey
2. Antennas by J. D. Kraus
3. Microwave and Radar Engineering: M. Kulkarni.
4. Colour Television: R.R. Gulati
5. Radio Engineering: Terman

This course can be opted as an elective by the students of following subjects: Open for all

Suggested Continuous Evaluation Methods
20 Marks for Test / Quiz / Assignment / Seminar,
05 Marks for Class Interaction.

Programme/Class: M.Sc. (Physics)	Year: **II**	**Semester: IV**
Subject: **Physics (Paper-4)**		
Course Code: **PHY404T**	Course Title: **Digital Electronics-II**	

Course Outcomes (COs)

After this course student will be able to:

- Understand characteristics and parameters of ROM ,PROM, EROM, EEPROM and RAM.
- Understand different mode of operation of Register and counter.
- Understand basics of Microprocessor 8085 and perform Arithmetic Logic and Branch operation.
- Explain Memory mapped I/O, Address decoding, Interfacing of I/O devices with 8085
- Perform , Simple Assembly language programming: 8-bit addition, 8-bit subtraction, 8-bit multiplication.

Credits:3	Core: **Compulsory**
Max. Marks: 25+75	Min. Passing Marks:33

Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P: 3-0-0

Unit	Topics	No. of Lectures
I	**Registers and Counters** Register, Shift register, Mode of operation of shift register and Dynamic shift register Serial in serial out (SISO) , Parallel in parallel out (PIPO), Serial in parallel out (SIPO) parallel in serial out (PISO), Tri state switches, Tri state register, Universal shift register, Ring Counter, Twisted or (Johnson Counter), Asynchronous and synchronous counter, Up/Down counters, Modulo-n counters, Decade counter.	15
II	**Microprocessor** Introduction to Microprocessor, Microprocessor systems with bus organization, Address, Data and Control Buses, Microprocessor 8085 Architecture & Operations**,** Data transfer instructions, Arithmetic Logic and Branch operations, Pin Functions, Classification of Instructions, Addressing Modes, 8085 Instruction Set.	15
III	**Memory interfacing and I/O with 8085 microprocessors& Applications** Memory mapped I/O and I/O mapped I/O, Address decoding, Interfacing of I/O devices with 8085, Microprocessor Application (interfacing scanned multiplexed displays and Liquid crystal displays). Simple Assembly language programming: 8-bit addition, 8-bit subtraction, 8-bit multiplication, Ascending and descending arrangement of given numbers,. Introduction to 8086 Microprocessor	15

Suggested Readings:

1. Integrated Electronics: Analog and Digital circuits and Systems by J. Millman & C. C Halkias
2. Digital Technology : Principle and practice by Virendra Kumar ; (New Age International)
3. Microprocessor Architecture, Programming and Applications with the 8085" by R.S. Gaonkar
4. Digital Principles and Applications by D. P. Leach, A. P. Malvino & G. Saha.
5. Microprocessors and Interfacing; by Douglas V Hall; McGraw-Hill.
6. Microprocessors and Microcontrollers Architecture, programming and system Design 8085,8086,8051,8096 by KrishnaKant;
7. Fundamentals of Microprocessor and microcontroller by B. Ram;
8. The 8086 Microprocessor: Programming & Interfacing the PC-Kenneth J. Ayala, Delmar Cengage Learning, Indian Ed

This course can be opted as an elective by the students of following subjects: Open for all

Suggested Continuous Evaluation Methods
20 Marks for Test / Quiz / Assignment / Seminar
05 Marks for Class Interaction

Programme/Class: **M.Sc. (Physics)**	Year: **II**	Semester:**IV**
	Subject: **Physics (Paper-5)**	
CourseCode: **PHY405P**	CourseTitle: **Practical (Digital Electronics-II)**	

Course Outcomes (COs)

After this course student will be able to:

- Design shift register operating in different mode.
- Design Modulo-n counter.
- Design counter , voltage regulator and multivibrator using ICs-74193 ,723 and Timer 555.
- Design Analog to Digital (A/D) convertor and Digital to Analog (D/A) convertor .
- Execute Assembling language programs using Microprocessor 8085.

Credits:4	Core: **Compulsory**
Max. Marks: 25+75	Min. Passing Marks: 33

Total No. Of Lectures-Tutorials-Practical(in hours per week):L-T-P: 0-0-8

List of Experiments

1) Shift register (parallel and Serial, Left Shift/ Right Shift)
2) Modulo- n Counter (Modulo-6, Modulo-9, Modulo-10, Modulo-12, counter using IC 7476 and 7420).
3) Design of Up/down Counter using IC 74193
4) Voltage regulator using IC-723
5) IC Timer-555 as Astable and Monostable multivibrator.
6) Assembling language programs using Microprocessor 8085
7) Resistivity Experiment (Four probe method)

This course can be opted as an elective by the students of following subjects: Open for all

Suggested Continuous Evaluation Methods
20 Marks for Test / Quiz / Assignment / Seminar
05 Marks for Class Interaction.

Programme/Class: **M.Sc. (Physics)**	Year: II	Semester: IV
Course Code: **PHY406PRJ**	Course Title: **Project work/Dissertation**	
Credits:4	Core: **Compulsory**	
Total No. of Lectures-Tutorials-Practical(in hours per week):8		

At the end of the year, student will submit Combined Research Project / Dissertation of semester III and IV and will be evaluated by supervisor and an external expert.

Course Outcomes (COs)
1. Develop the ability to conduct independent research in a specific area of physics.
2. Enhance critical thinking skills by analyzing and evaluating existing literature and experimental data.
3. Demonstrate the capacity to solve complex physics problems related to the chosen topic.
4. Improve scientific writing skills, including the ability to clearly and concisely communicate research findings.
5. Gain proficiency in data analysis techniques and the use of relevant software and tools.
6. Present research findings through oral presentations or written reports.
7. Make a unique contribution to the field by adding new insights, findings, or experimental data.
8. Understand and adhere to ethical standards in research, including proper citation and plagiarism avoidance.
Note: 1. Every student of third year has to complete a Research Project/Dissertation which will be allotted in the 5th Semester. 2. This Research Project/Dissertation may be Interdisciplinary. 4. The Research Project/Dissertation will be done under the supervision of a teacher. Another Co-supervisor may be taken from any Industry/ University/ Technical institute/Research institute etc. 5.The student will submit a joint report of the research project/Dissertation done in both semesters (3rd and 4th semesters) at the end of the year (end of 4th Semester), which will be evaluated jointly by the supervisor and the external examiner appointed by the college on total marks 100.