M.Sc. Year III (Semester-V)											
			Teaching Scheme (Hours)				Examination Scheme				
Sr. No.	**Course Code**	**Course**	**L**	**T**	**P**	**Credits**	**Theory**	**Tutorial**	**Practical**	**Total Marks**
1	PH 301	Electromagnetics-II	3	1	0	4	100	25	0	125
2	PH 303	Semiconductor Devices	3	1	0	4	100	25	0	125
3	PH 305	Atomic & Molecular Physics	3	1	0	4	100	25	0	125
4	PH 307	Plasma Physics	3	1	0	4	100	25	0	125
5	PH 3XX	Institute Elective– I	3	0	0	3	100	0	0	100
6	PH 309	Experimental Techniques-III	0	0	8	4	0	0	200	200
7	PH 311	Mini Project-I	0	0	4	2	0	0	100	100
		Total	**15**	**4**	**12**	**25**	**500**	**100**	**300**	**900**
									Total Lecture Hours	**31**
									Total Credits	**25**

Institute Elective-I										
			Teaching Scheme (Hours)				Examination Scheme			
Sr. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**	**Theory**	**Tutorial**	**Practical**	**Total Marks**
1	PH 361	Basics of Astronomy and Astrophysics	3	0	0	3	100	0	0	100
2	PH 363	Solar Cell Technologies	3	0	0	3	100	0	0	100

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M.Sc. Year III (Semester-VI)											
			Teaching Scheme (Hours)				Examination Scheme				
Sr. No.	Course Code	Course Name	L	T	P	Credits	Theory	Tutorial	Practical	Total Marks
1	PH 302	Astrophysics and Space Science	3	1	0	4	100	25	0	125
2	PH 304	Mathematical Methods in Physics	3	1	0	4	100	25	0	125
3	PH 306	Digital Electronics	3	1	0	4	100	25	0	125
4	PH 308	Nuclear Physics	3	1	0	4	100	25	0	125
5	PH 3YY	Institute ElectiveII	3	0	0	3	100	0	0	100
6	PH 312	Experimental Techniques-IV	0	0	8	4	0	0	200	200
7	PH 314	Mini Project-II	0	0	4	2	0	0	100	100
		Total	**15**	**4**	**12**	**25**	**500**	**100**	**300**	**900**
									Total Lecture Hours	**31**
									Total Credits	**25**

Institute Elective-II										
			Teaching Scheme (Hours)				Examination Scheme			
Sr. No.	Course Code	Course Name	L	T	P	Credits	Theory	Tutorial	Practical	Total Marks
1	PH 362	Basics Course on Relativity	3	0	0	3	100	0	0	100

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Third year of Five Years Integrated M.Sc. (Physics)
M.Sc. – III, Semester – V

Electromagnetics – II

L	T	P	Credit
03	01	00	04

PH301

1. Course Outcomes (COs):

At the end of the semester students will be able to:

CO1	Inferthe concept of Maxwell's equations and boundary conditions
CO2	Explain the conservation laws in electrodynamics
CO3	Examine the propagations of electromagnetic waves in vacuum and in matters
CO4	Interpret the different potentials and gauge in electrodynamics
CO5	Analyzethe mechanism of electric and magnetic radiations
CO6	Summarize the field of electrodynamics with relativity

2. Syllabus

- **ELECTRODYNAMICS(08 Hours)**
  Electromotive Force and motional emf, Faraday's law of Electromagnetic Induction and energy in the magnetic fields, Maxwell's Equations, How Maxwell Fixed Ampere's Law, Maxwell's Equations in Matter, Boundary Conditions.

- **CONSERVATION LAWS IN ELECTRODYNAMICS(06 Hours)**
  The Continuity Equation, Poynting's Theorem, Newton's Third Law in Electrodynamics, Maxwell's Stress Tensor, Conservation of Momentum, Angular Momentum.

- **ELECTROMAGNETIC WAVES (08 Hours)**
  Waves in One Dimension, Electromagnetic Waves in Vacuum and in Matter, Absorption and Dispersion in matter, Guided waves.

- **POTENTIALS AND FIELDS (07 Hours)**
  Scalar and Vector Potentials, Gauge Transformations, Coulomb Gauge and Lorentz Gauge, Retarded Potentials, Jefimenko's Equations, Lienard-Wiechert Potentials, The Fields of a Moving Point Charge.

- **RADIATION(06 Hours)**
  Electric and Magnetic Dipole Radiation, Radiation from an arbitrary source, Power radiated by a point charges, Radiation reaction.

- **ELECTRODYNAMICS AND RELATIVITY(07 Hours)**
  Special theory of relativity and relativistic mechanics, Relativistic Electrodynamics, Field tensor, Electrodynamics in tensor notation.

(Total Lecture Hours: 42 Hours)

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3. <u>BOOKS RECOMMENDED:</u>

1. David J. Griffiths,Introduction to Electrodynamics, 3rd Edition, Pearson Education 2008.
2. John David Jackson, Classical Electrodynamics, 3rd Edition, Wiley 2018
3. Matthew N. O. Sadiku, Elements of Electromagnetics, 6th Edition, Oxford University Press, 2014
4. L. D. Landau, E. M. Lifshitz, The Classical Theory of Fields, Course of Theoretical Physics: Vol. 2 by, 3rd Edition, Pergamon Press 1967
5. David K. Cheng, Field and Wave Electromagnetics by, 2nd Edition, Pearson Education 2001

Third year of Five Years Integrated M.Sc. (Physics)
M.Sc. – III, Semester – V

Semiconductor Devices

L	T	P	Credit
03	01	00	04

PH 303

1. Course Outcomes (COs):

At the end of the semester students will be able to:

CO1	Understand the working of various FET devices and their applications
CO2	Understand the principle of operation of DIAC and TRIAC devices
CO3	Identify the principle of operation and structure of SCR devices
CO4	Interpret the concept of heterojunction devices and their applications
CO5	Classify the characteristics of various photonic devices
CO6	Examine the properties and applications of microwave devices

2. Syllabus

- **VARIOUS FET DEVICES: INTRODUCTION, CHARACTERISTICS AND APPLICATION** **(10 Hours)**

  Types of FET, JFET, MODFET, SIT, MOSFET, Structure and principle of operation of MOSFET, MOSFET as an amplifier, MOSFET analysis, Threshold voltage. Power MOSFET, HEMT.

- **DIAC, TRIAC: INTRODUCTION, CHARACTERISTICS AND APPLICATION** **(08 Hours)**

  Structure of DIAC, DIAC Principle of operation, Structure and principle of operation of TRIAC, Applications of TRIAC.

- **PNPN: INTRODUCTION, CHARACTERISTICS AND APPLICATION** **(06 Hours)**

  The silicon-controlled rectifier, Device structure, Principle of operation, Equivalent circuit. Applications.

- **INTRODUCTION TO THE HETERO JUNCTIONS AND APPLICATIONS** **(06 Hours)**

  Concept of Heterojunction, Multilayer Heterojunction, Energy band diagram for Heterojunction, Confinement of charge carrier, Application of Heterojunction.

- **PHOTONIC DEVICES: INTRODUCTION, CHARACTERISTICS AND APPLICATION** **(06 Hours)**

  Light Emitting Diode (LED), Characteristics of LED, Materials and wavelength of light, Laser diode, Structure, Characteristics of laser diode, Photodiode and solar cell.

- **MICROWAVE DEVICES: INTRODUCTION, CHARACTERISTICS AND APPLICATION** **(06 Hours)**

  MESFET, HEMT

(Total Lecture Hours: 42 Hours)

3.BOOKS RECOMMENDED:

1. D.L. Schilling and C.Belove, Electronic Circuits : Discrete and Integrated, McGraw Hill, 1989
2. B. Streetman, &S. Banerjee, Solid State Electronic Devices, Prentice Hall, 2005
3. R.L. Boylestad and L. Nahselsky, Electronic Devices and Circuit Theory,Prentice Hall, 2005
4. S. Y. Liao, Microwave Devices and Circuits, Prentice Hall , 1996
5. S.M. Sze, Semiconductor Devices : Physics and Technology, John Wiley & Sons,1986

Third year of Five Years Integrated M.Sc.(Physics)
M.Sc. – III, Semester – V

Atomic & Molecular Physics

L	T	P	Credit
03	01	00	04

PH 305

1. Course Outcomes (COs):

At the end of the semester students will be able to:

CO1	Classifyvarious atomic models and their importance
CO2	Interpret one-electron systems and associated relativistic corrections
CO3	Examine the effects of magnetic and electric fields on the spectral lines
CO4	Analyze the quantum mechanical aspects of hydrogen and helium atom structure
CO5	Explain the hartree theory and the idea of self-consistency
CO6	Analyze the molecular structure by inspecting the rotational, vibrational and electronic transitions

2. Syllabus

- **INTRODUCTION TO ATOMIC STRUCTURE AND MODELS** **(05 Hours)**
  The nuclear atom, Electron orbits, Atomic spectra, The Bohr atom, Energy levels and spectra, Correspondence principle, Nuclear motion, Atomic excitations.

- **ONE-ELECTRON ATOMIC SYSTEMS** **(12 Hours)**
  Relativistic corrections of energy terms: relativistic mass correction, Darwin term, and spin-orbit term. Fine structure. Lamb shift. Hyperfine structure. LS & JJ coupling, Zeeman, Paschen-Bach &Stark effect, Introduction to time-dependent perturbation theory.

- **HYDROGEN ATOM** **(08 Hours)**
  Limitations of classical mechanics, Schrodinger's time independent wave equation, Orbital angular momentum, parity of eigen functions.

- **HELIUM ATOM** **(06 Hours)**
  Spectrum of Helium, Quantum mechanical explanation of splitting of He terms, Ground state energy of He atom.

- **HARTREE THEORY AND IDEA OF SELF-CONSISTENCY** **(05 Hours)**
  Hartree's self-consistent field, Results of Hartree theory, Atomic orbitals and Hund's rule, the periodic table.

- **MOLECULAR STRUCTURE** **(06 Hours)**
  General nature of molecular structure, Born–Oppenheimer separation, rotation and vibration of diatomic molecules, electronic structure of diatomic molecules

(Total Lecture Hours: 42 Hours)

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3.BOOKS RECOMMENDED:

1. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, 2nd edition. R. Eisberg, R. Resnick. Wiley2006
2. Modern Quantum Mechanics,J. J. Sakurai, PearsonEducation, 2009
3. B. H. Bransden and C. J. Joachaim, Physics of Atoms and Molecules,Benjamin Cumming2003
4. Springer Handbook of Atomic, Molecular, and Optical physics Gordon Drake, Springer-Verlag New York2006
5. Molecular Physics: Theoretical Principles and Experimental Methods 1st edition. W Demtröder Wiley-VCH 2005

Third year of Five Years Integrated M.Sc.(Physics)
M.Sc. – III, Semester – V

Plasma Physics

L	T	P	Credit
03	01	00	04

PH307

1. Course Outcomes (COs):

At the end of the semester students will be able to:

CO1	Interpretthe basic properties and criteria for plasma
CO2	Introspect the particle motions under the influence of external electric and magnetic field
CO3	Analyzethe electrodynamics and fluid equations for plasma
CO4	Examine the diffusion and transport properties of plasma
CO5	Classify the characteristics of plasma oscillations and plasma waves
CO6	Explainthe diagnostic method to study the plasma properties

2. Syllabus

- **INTRODUCTION (02 Hours)**
  General properties of plasma, Criteria for its existence, Occurrence in nature, Sources of plasma generation in laboratory, Applications, Concept of temperature in plasma.

- **MOTION OF CHARGED PARTICLES IN ELECTRIC AND MAGNETIC FIELD (08 Hours)**
  Uniform electric and magnetic field, Non-uniform magnetic field, Non-uniform electric field, Time-varying magnetic field, Time-varying electric field, Adiabatic invariant, Plasma confinement in laboratory, Summary of guiding centre drifts.

- **PLASMA AS FLUID (06 Hours)**
  Electrodynamics equations in plasma, Plasma dielectric constant, Fluid equations of motion, Fluid drifts in the presence of magnetic field.

- **DIFFUSION AND TRANSPORT (10 Hours)**
  Collision parameter, Diffusion parameter, Ambipolar diffusion, Recombination, Diffusion across a magnetic field, Collisions in fully ionized plasma, Plasma resistivity, and The single-fluid MHD equations.

- **PLASMA OSCILLATION AND WAVES (10 Hours)**
  Overview of wave, Phase velocity and Group velocity, Plasma oscillations, Electron plasma waves, Sound waves, Ion waves, Comparison of electron and ion waves, Upper hybrid frequency, Lower hybrid frequency, Electromagnetic plasma waves, Cut-off and resonances.

- **BASIC PLASMA DIAGNOSTICS USING ELECTRICAL METHOD (06 Hours)**
  Debye shielding problem, Plasma sheath - physical mechanism, wall potential and inner structure, Plasma probe.

(Total Lecture Hours: 42 Hours)

3. BOOKS RECOMMENDED:

1. Plasma Physics and Controlled Fusion. F. F. Chen, 2nd Edition Volume 1: Plasma Physics, Springer 2006.
2. Principles of Plasma Discharges and Material Processing. M. A. Liebermann and A. J. Lichtenberg, 2nd Edition, Wiley-Interscience 2005.
3. Fundamentals of Plasma Physics. J. A. Bittencourt, 3rd Edition, Springer 2004.
4. Introduction to Plasma Physics. R. J. Goldston and P. H. Rutherford, 1st Edition, CRC Press 1995.
5. Fundamentals of Plasma Physics. P. M. Bellan, Cambridge University Press 2012.

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Third year of Five Years Integrated M.Sc.(Physics)
M.Sc. – III, Semester – V

Basics of Astronomy and Astrophysics

L	T	P	Credit
03	00	00	03

PH 361

1. Course Outcomes (COs):

At the end of the semester students will be able to:

CO1	Relatethe basic understanding of the Astronomy and Astrophysics
CO2	Interpretthe important concepts as applied to Astronomy and Astrophysics
CO3	Apply the concepts learned to find the properties of Celestial objects and phenomena
CO4	Analyze the results available in literature or those derived in the course
CO5	Evaluate the limitations and robustness of the concepts as applied to Astronomy and Astrophysics

2. Syllabus

- **UNIVERSE AND CELESTIAL BODIES(18 Hours)**
  Matter vs Radiation Dominated universe, The early universe, structure formation, Galaxies, Nebulae, Stars, Classification of celestial bodies, other celestial objects.

- **SOLAR SYSTEM(10 Hours)**
  Birth, Life and death of a star, H-R diagram, Solar system & its members.

- **EARTH AND ITS ATMOSPHERE (07 Hours)**
  Formation and structure of the Earth, different surface features of the earth, earth's Atmosphere and its different parts, radio window, ozone depletions.

- **SPACE EXPLORATIONS(07 Hours)**
  Radiation in the universe, its effect on human and other non-living mechanisms, types Space vehicles, manned space explorations.

(Total Lecture Hours: 42 Hours)

3. BOOKS RECOMMENDED:

1. S. S. Degaonkar,Space Science, Gujarat University Press, 1968
2. M. Patrick,Atlas of the Universe, Cambridge University Press, 2000
3. A. Beiser,Concept of the Modern Physics, TMH, 2008
4. M. Mukhanov, Physical Foundations of Cosmology, CUP, 2005.
5. J. N. Islam, An Introduction to Mathematical Cosmology, CUP, 2004.

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Third year of Five Years Integrated M.Sc.(Physics)
M.Sc. – III, Semester – V

Solar Cell Technologies

L	T	P	Credit
03	00	00	03

PH 363

1. Course Outcomes (COs):

In the end of semester the students will be able to:

CO1	Summarize the status of energy crisis and appreciate role of Solar PV
CO2	Interpret the physics of semiconductor materials and junctions
CO3	Identify the designing aspects of solar cells and modules
CO4	Examine the silicon based solar cell technologies
CO5	Inspect the thin-film solar cell, concentrator solar PV technologies

2. Syllabus

- **Energy Scenario and Solar Photovoltaics (PV) (4 Hours)**
  World energy requirement, review of renewable energy sources, economics and global energy market, role of solar PV, solar radiation as energy source, solar spectrum, Sun-Earth system, movements and radiation collection. sun-tracking. measurement of solar radiation.

- **Physics of Semiconductor Materials and Junctions(8 Hours)**
  Fundamentals of semiconductors, formation of energy bands, direct and indirect band gap, charge carriers in semiconductors, carrier concentration and distribution, density of energy states, carrier motion in semiconductors, electric field and energy band bending, generation & recombination of carriers, p-n junction: equilibrium condition, space charge region, p-n junction in non-equilibrium condition, p-n junction under illumination: solar cell, generation of photovoltage, light generated current, i-v equations of solar cells, solar cell characteristics.

- **Design of Solar Cells and Modules (8 Hours)**
  Solar cell parameters, losses in solar cell, models of solar cell, effect of series, shunt resistance, radiation and temperature on efficiency, solar cell design, solar simulator, quantum efficiency measurement, minority carrier lifetime and diffusion length measurement, Solar PV modules for solar cells, mismatch in series and parallel connections, design and structure of PV modules, PV module power output.

- **Silicon Based Solar Cell Technologies(8 Hours)**
  Growth of solar PV industry silicon, production of Si wafers, monocrystalline Si ingots: CZ and FZ processes, multicrystalline Si ingots, wafer dicing: ID and wire sawing, solar grade silicon, process flow of commercial Si cell technology, high efficiency Si solar cells.

- **Thin-Film Solar Cell Technologies(6Hours)**
  Advantages of thin films technologies, material for thin film technologies, use of TCO and light trapping, possible solar cell structure, substrate and superstrate configuration, thin film module manufacturing, amorphous Si solar cell technology, CdTe solar cell technology, CIGS solar cell technology, thin film Si based technologies.

- **Concentrator Solar PV and Other Emerging Solar Cell Technologies(8 Hours)**
  Concentrator PV Cells, concentration ratio, optics for concentrator PV, tracking requirement of CPV, cooling requirements, minority carrier injections under high concentration, high concentrator solar cells, organic solar cell, dye-sensitized solar cell, perovskties solar cells, Gas solar cells, thermo-photovoltaics,

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need to go beyond current cell technologies.

(Total Lecture Hours: 42 Hours)

3. BOOKS RECOMMENDED:

1. Chetan Singh Solanki,Solar Photovoltaics: Fundamentals, Technologies and Applications,PHI Learning Pvt. Ltd. Publication, 2015
2. Martin Green,Solar Cells: Operating Principles, Technology, and System Applications, Prentice Hall Publications, 1983
3. K. L. Chopra and S. R. Das,Thin Films Solar Cells,; Springer Publications, 1983
4. Stephen Fonash,Solar Cell Device Physics,Academic Press Publication,2010
5. P. Jayarama Reddy,Science and Technology of Photovoltaics, BS Publications,2009

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Third year of Five Years Integrated M.Sc.(Physics)
M.Sc. – III, Semester – V

Experimental Techniques III

L	T	P	Credit
00	00	08	04

PH 309

This course comprises the experiments related to the theory courses of Electromagnetics-II, Semiconductor Devices, Atomic & Molecular physics, Plasma Physics and fundamental physics.

Third year of Five Years Integrated M.Sc.(Physics)
M.Sc. – III, Semester – V

Mini Project-I

L	T	P	Credit
00	00	04	02

PH 311

This course comprises the project work related to either theoretical and/or experimental topics of physics.

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Third year of Five Years Integrated M.Sc.(Physics)
M.Sc. – III, Semester – VI

Astrophysics and Space Science

L	T	P	Credit
03	01	00	04

PH302

1. Course Outcomes (COs):

At the end of the semester students will be able to:

CO1	Interpret the concepts of Astrophysics, and Space Science
CO2	Analyze how astrophysical processes are studied, understood and utilized for furthering our understanding of the universe
CO3	Apply the concepts of space science to different problems
CO4	Evaluate the applications to various problems related to Astrophysics and Space Sciences
CO5	Analyze the satellite system such as GPS, Galileo, IRNSS.

2. Syllabus

- **Introduction to the course(02 Hours)**

- **Large Scale objects(10 Hours)**
  Astrophysical objects of interests like Galaxies, stars, their Evolution, Clusters, techniques to study these objects.

- **Stellar objects(10 Hours)**
  Types of stars, their properties. Evolution of stellar objects. The Sun, the standard model. Quiescent Sun, Disturbed sun.

- **Solar Terrestrial Relationship(08 Hours)**
  The quiet and disturbed solar features and their impact on space weather. Magnetosphere, Ionosphere, atmosphere.

- **Radio Wave Propagation through Ionosphere(06 Hours)**
  Refraction, effect of the ionosphere on wave propagation. Quiet ionsophere, disturbed ionosphere. The effects on technological systems.

- **Advanced topics of relevance(06 Hours)**
  Global Navigational Satellite System like GPS, Galileo, IRNSS.

(Total Lecture Hours: 42 Hours)

3. BOOKS RECOMMENDED:

1.Ratcliff, J. A., Introduction to ionosphere & Magnetosphere, Cambridge University Press. 1975
2.Hargreaves, J. K., The Solar Terrestrial Environment, Cambridge University Press 1995
3.Kievelson, M. J., Introduction to Space Physics Cambridge University Press. 1995
4.Lang, K. R. Sun, Earth and Sky Springer 2006
5.BasuBaidyabath, T. Chattopadhyay and S. N. Biswas, An Introduction to Astrophysics, PHI Learning Pvt. Ltd., 2018

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Third year of Five Years Integrated M.Sc.(Physics)
M.Sc. – III, Semester – VI

Mathematical Methods in Physics

L	T	P	Credit
03	01	00	04

PH304

1. Course Outcomes (COs):

At the end of the semester students will be able to:

CO1	Explain the basis of vector spaces, determinants and matrices to apply it for linear transformation
CO2	Utilize the eigenvalues and eigenvectors
CO3	Analyze the vectors with indices and extend it to understand the tensors and interpret the types and properties of tensors
CO4	Solve the second order ODE including Bessel, Hermite, Legendre, Hypergeometric and Confluent Hypergeometric equations
CO5	Interpret the Legendre polynomials and Bessel functions and relate their applications

2. Syllabus

- **VECTOR SPACES (06 Hours)**
  Subspaces, Basis and dimension, co-ordinates, row space, column space, nullspace.

- **LINEAR TRANSFORMATION (10 Hours)**
  Representation of linear transformation by Matrices, rank-nullity theorem, duality and transpose, determinant, linear functional, dual space.

- **EIGEN VALUES & EIGEN VECTORS (04 Hours)**
  Minimal & characteristic polynomials, diagonalisations, Cayley Hamilton theorem.

- **TENSOR ANALYSIS (08 Hours)**
  Vectors and Indices: Transformation Properties of Vectors, Covariant and Contravariant Vectors; From Vectors to Tensors: Algebraic Properties of Tensors, Numerical Tensors; Metric Tensor: Index Raising and Lowering, Differentiation of Tensors: Covariant Derivative, Metric Connection.

- **SOLUTIONS TO BESSEL, HERMITE, LEGENDRE, HYPER GEOMETRIC AND CONFLUENT HYPER- GEOMETRIC EQUATIONS (04 Hours)**

- **BESSEL FUNCTIONS AND THEIR APPLICATIONS (04 Hours)**
  Bessel Function of the first kind, Orthogonality, Neumann functions, Modified Bessel's functions, Asymptotic Expansions, Spherical Bessel function.

- **LEGENDRE POLYNOMIALS AND SPHERICAL HARMONICS (06 Hours)**
  Generating Function, Recurrence relations, Orthogonality, Associate legendre functions, Spherical harmonics, Legendre functions of the second kind, Vector spherical harmonics.

(Total Lecture Hours: 42 Hours)

3. BOOKS RECOMMENDED:

1.K. Hoffman, and R.Kunze, Linear Algebra, PHI, 1991
2. S. Lang, Introduction to Linear Algebra (Undergraduate text in Mathematics), Springer, 1986
3.Grinfeld, Pavel. Introduction to tensor analysis and the calculus of moving surfaces. New York: Springer, 2013
4.Riley, Kenneth Franklin, Michael Paul Hobson, and Stephen John Bence. Mathematical methods for physics and engineering: a comprehensive guide. Cambridge university press, 2006.
5.Hassani, Sadri. Mathematical methods: for students of physics and related fields. Vol. 720. Springer Science & Business Media, 2008.

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Third year of Five Years Integrated M.Sc.(Physics)
M.Sc. – III, Semester – VI

Digital Electronics

L	T	P	Credit
03	01	00	04

PH 306

1. Course Outcomes (COs):

At the end of the semester students will be able to:

CO1	Explain the basic concepts and terminology of number systems, binary codes and logic gates
CO2	Interpret the basic relations of logic gates conversations by using Boolean algebra and Karnaugh maps
CO3	Analyze various combination circuits, flip-flops and timing circuits
CO4	Identify the basic principles of A to D and D to A conversions
CO5	Design and implement application-oriented digital circuits

2. Syllabus:

- **INTRODUCTION, NUMBER SYSTEM (04 Hours)**
  Digital & Analog System, Logic Levels and Pulse Waveforms, Elements of Digital Logic, Functions of Digital Logic, Digital Integrated Circuits, The Decimal Number System, The Binary Number System, Representation of Signed Numbers and Binary Arithmetic in Computers, Different Number Systems.

- **BINARY CODES & LOGIC GATES (03 Hours)**
  Different Codes, and Gates, , Inhibit circuits, 7400 series ICs, ANSI/IEEE Standard Logic symbols, Pulsed operation of Logic Gates.

- **BOOLEAN ALGEBRA (03 Hours)**
  Logic Operations, Axioms and Laws of Boolean Algebra, Duality, Reducing Boolean Expressions, Boolean Expression and Logic Diagrams, Converting AND/OR/Invert Logic to NAND/NOR logic, Determination of Output lev0el from the diagram.

- **THE KARNAUGH AND QUINE-McCLUSKY METHODS(06 Hours)**
  Expansion of a Boolean Expression to SOP & POS form, Computation of total Gate inputs, All variables K-map, Don't care combinations, Hybrid logic, Minimization of Multiple output circuits, Variable mapping, Quine-McClusky Method, Function minimization of multiple output circuits.

- **COMBINATION CIRCUITS(06 Hours)**
  The Half- Full-adder -Subtractor, Parallel Binary Address, the look-ahead carry adder, IC parallel adders, Two's complement addition & subtraction using parallel Adders, serial Adders, BCD Adders, Binary multipliers, code converters, Parity generators/checkers, Comparators, IC Comparator, Decoders, BCD to seven segment decoders, Display devices, Encoders, Multiplexers, Demultiplexers and Applications.

- **FLIP-FLOPS AND TIMING CIRCUITS (04 Hours)**
  The S-R latch, Gated latches, Edge-trigged Flip-Flops, Asynchronous inputs, Flip-flop operating characteristics, Master Slave (Pulse-triggered) flip-flop, Conversion of Flip-flops, Applications of Flip-flops, ANSI/IEEE Symbols, Schmitt Trigger, Multivibrators , crystal controlled clock generators.

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- **SHIFT REGISTERS , COUNTERS(06 Hours)**
  Buffer register, Controlled Buffer register, Shift Registers & Data Transmission in shift register, Counters, Pulse Train Generators, Pulse Generators using shift registers, Cascading of Synchronous counters.

- **LOGIC FAMILIES AND ANALOG-TO-DIGITAL AND ANALOG–TO-ANALOG CONVERTERS(06 Hours)**
  Digital IC Specification Technology, Logic Families, Transistor Transistor Logic (TTL), Open – collector Gates, Digital-to-Analog(D/A) Conversion, The R-2R Ladder Type DAC, The Weighted – resistor Type DAC, The Switched Current-source Type DAC, Analog-to-Digital Conversion, The Counter-type A/D Converter, The Tracking-type A/D Converter, The Flash-type A/D Converter, The Dual-slop Type A/D Converter, The Successive-approximation Type ADC.

- **DESIGNING DIGITAL CIRCUITS(04 Hours)**
  Reactor design, Traffic signal, Stepper motor.

(Total Lecture Hours: 42 Hours)

3. <u>BOOKS RECOMMENDED:</u>

1. Floyd T. L, Jain R. P., Digital Fundamentals, Dorling Kindersley (India) Pvt Ltd 2008.
2. Morris Mano M.Digital Logic & Computer Design, Dorling Kindersley (India) Pvt. Ltd. 2008.
3. A. Anand Kumar, Fundamentals of Digital Circuits,Prentice-hall of India Pvt. Ltd. 2009.
4. Jain. R. P., Modern Digital Electronics, Tata McGraw Hill Publishing Company Ltd.2009.
5. Malvino A.P., Leach P. D., Digital Principals & Applications., Tata McGraw Hill Publishing Company Ltd.2008.

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Third year of Five Years Integrated M.Sc.(Physics)
M.Sc. – III, Semester – VI

Nuclear Physics

L	T	P	Credit
03	01	00	04

PH 308

1. Course Outcomes (COs):

At the end of the semester students will be able to:

CO1	Interpretthe concept of structure of nuclei, and simple nuclear models such as the liquid drop model and the shell model
CO2	Explain the deuteron behavior at ground and excited states
CO3	Classifythe techniques in scattering theory which are relevant in nuclear physics
CO4	Understand the differences between various decay modes, state selection rules, and determine whether a given decay can take place
CO5	Identify the key features of nuclear fission and fusion and their applications

2. Syllabus:

- **Properties of Nuclei(08 Hours)**
  Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density, matter density and its experimental determination, binding energy, average binding energy, Packing fraction, BE/A vs. A plot, stability of nuclei (N Vs Z plot), angular momentum, parity, magnetic moment, electric moments.

- **Nuclear Models(08 Hours)**
  Liquid drop model approach, Weizsacker's semi-empirical mass formula and significance of its various terms, condition of nuclear stability, Mass parabolas -Prediction of stability against beta decay for members of an isobaric family, Stability limits against spontaneous fission. Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, Rotational spectra, concept of mean field, residual interaction, concept of nuclear force, Deuteron problem, Meson theory of nuclear forces.

- **RADIOACTIVITY DECAY(08 Hours)**
  Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy, decay Chains. Β-decay: energy kinematics for β-decay, β-spectrum, positron emission, electron capture, neutrino hypothesis. Gamma decay: Gamma rays emission from the excited state of the nucleus & kinematics, internal conversion.

- **INTERACTION OF NUCLEAR RADIATION WITH MATTER(06 Hours)**
  Energy loss due to ionization (Bethe-Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter (photoelectric effect, Compton scattering, pair production), neutron interaction with matter.

- **NUCLEAR REACTIONS(06 Hours)**
  Types of Reactions, Coulomb scattering (Rutherford scattering) Coulomb barrier, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, Optical model, resonance reaction.

- **NUCLEAR ENERGY(FUSION AND FISSION** **(06 Hours)**

Introduction,Asymmetric fission -Mass yield, Emission of delayed neutrons, Nuclear energy release in fission, Nature of fission fragments, Energy released in the fission of U235, Fission of lighter nuclei, Fission chain reaction, Neutron cycle in a thermal nuclear reactor (Four Factor Formula), Nuclear power and breeder reactors, Natural fusion Possibility of controlled fusion.

(Total Lecture Hours: 42 Hours)

3. <u>Books Recommended:</u>

1. Kenneth S. Krane,Introductory Nuclear Physics Wiley India Pvt. Ltd., 2008.
2. S. N. Ghoshal,Nuclear Physics, First edition, S. Chand Publication, 2010.
3. S.B. Patel, Nuclear Physics,New Age International (P) Ltd. 2012.
4. D. C. Tayal,Nuclear Physics, 5th ed., Himalayan Publishing House 2009.
5. K Heyde,Basic Ideas and concepts in Nuclear Physics: An introductory Approach, Third edition, IOP Publication, 1999.

Additional Books:

1.Bernard L Cohen Concepts of Nuclear Physics, Tata McGraw Hill Publication, 1974.
2.G.F. Knoll,Radiation detection and measurement, John Wiley & Sons, 2010.
3.William R Leo,Technique for Nuclear and Particle Physics experiments, Springer, 1994.

Third year of Five Years Integrated M.Sc.(Physics)
M.Sc. – III, Semester – VI

Basic course on Relativity

L	T	P	Credit
03	00	00	03

PH 362

1. Course Outcomes (COs):

At the end of the semester students will be able to:

CO1	Interpret the concepts of special and general theory of relativity
CO2	Analyse how relativistic processes are studied, understood and utilised for furthering our understanding of the universe
CO3	Apply the concepts and theories to a range of problems related to relativity
CO4	Approach and solve new problems in the range of relativity
CO5	Evaluate and analyse the recent observations of objects/events

2. Syllabus:

- **INTRODUCTION TO THE COURSE(04 Hours)**
  Inertial Frames, Universality of Newton's second law in all inertial frames, Classical Relativity, Does universal rest (ether) exists? Michelson Morley Experiment.

- **SPECIAL THEORY OF RELATIVITY(08 Hours)**
  Postulates of Special Theory of Relativity, Concept of transformation, Galilean Transformation, Simultaneity of two events in different inertial frames of reference and its frame dependence. Lorentz Transformation. Length Contraction and Time dilation with examples. Velocity Transformation, Relative velocity with examples, Time like and Space Like intervals, Causality.

- **FOUR VECTORS (06 Hours)**
  Need to redefine Momentum, Vector and Four-Vectors. Proper time interval, Velocity and Momentum-Energy Four Vector. Mass-Energy Relationship, Relationship between new energy and momentum.

- **ELECTRODYNAMICS IN LIGHT OF RELATIVITY(06 Hours)**
  Four Dimensional forms of Maxwell's equations. Four dimensional Vector Potential.

- **GENERAL RELATIVITY(10 Hours)**
  Special and General Principle of Relativity, The Gravitational Field, The Equality of Inertial and Gravitational Mass as an Argument for the General Postulate of Relativity.

- **THE EXPERIMENTAL CONFIRMATIONS(08 Hours)**
  Motion of the Perihelion of Mercury, Deflection of Light by a Gravitational Field, Displacement of Spectral Lines towards the Red, Gravitational Waves.

(Total Lecture Hours: 42 Hours)

3. Books Recommended:

1. Einstein A., Relativity: The Special And General Theory, Henry Holt And Company, 1920
2. Ryder L., Introduction to General Relativity, Lewis Ryder, Cambridge University Press, 2009
3. Misner C. W., Kip Thorne, J. A. Wheeler, Gravitation, W. H. Freeman and Co, 1970.
4. Schutz B. F., A First Course in General Relativity , Cambridge University Press, 2009
5. Weinberg S., Gravitation and Cosmology, J. Wiley & sons, 1972.

21/10/2020

Third year of Five Years Integrated M.Sc.(Physics)
M.Sc. – III, Semester – VI

Experimental Techniques IV

L	T	P	Credit
00	00	08	04

PH 312

This course comprises the experiments related to the theory courses of Astrophysics and Space Science, Mathematical Methods in Physics, Digital Electronics, Nuclear Physics and fundamental physics.

Third year of Five Years Integrated M.Sc.(Physics)
M.Sc. – III, Semester – VI

Mini Project-II

L	T	P	Credit
00	00	04	02

PH 314

This course comprises the project work related to either theoretical and/or experimental topics of physics.

21/08/2020