National Education Policy-2020

Common Minimum Syllabus for Uttarakhand State Universities and Colleges

Four Year Undergraduate Programme- FYUP/Honours Programme/Master in Science

DEPARTMENT OF PHYSICS

Semester-wise List and Titles of the Papers for B.Sc. Degree in Physics					
Year	**Sem.**	**Course Code**	**Paper Title**	**Theory/ Practical**	**Credits**
Undergraduate Certificate Course in Physics					
FIRS TYEAR	I	DSC A1	Mechanics and Theory of Oscillations	Theory	3
		DSC Pr1	Mechanics and Theory of Oscillations Lab	Practical	1
		GE P1	Basic Physics I	Theory + Tutorial	3+1
		SEC P1	Basic Instrumentation Skills I	Theory	02
	II	DSC A2	Electricity and Magnetism	Theory	3
		DSC Pr2	Electricity and Magnetism Lab	Practical	1
		GE P2	Basic Physics II	Theory + Tutorial	3+1
		SEC P2	Basic Instrumentation Skills II	Theory	02
Diploma in Applied Physics					
SECOND YEAR	III	DSC A3	Thermodynamics and Statistical Physics	Theory	3
		DSC Pr3	Thermodynamics and Statistical Physics Lab	Practical	1
		DSE A1	Waves and Acoustics	Theory	3
		DSE Pr1	Waves and Acoustics Lab	Practical	1
		GE P3	Fundamental Mechanics	Theory + Tutorial	3+1
		SEC P3	Basic Instrumentation Skills III	Theory	(02)
	IV	DSC A4	Optics	Theory	3
		DSC Pr4	Optics Lab	Practical	1
		DSE A2	Solid State and Statistical Physics	Theory	3
		DSE Pr2	Solid State and Statistical Physics Lab	Practical	1
		GE P4	Basic Electricity and Magnetism	Theory + Tutorial	3+1
		SEC P4	Basic Instrumentation Skills IV	Theory	(02)
Bachelor of Science					
THIRD YEAR	V	DSC A5	Modern Physics	Theory	3
		DSC Pr5	Modern Physics Lab	Practical	1
		DSE A3	Basic Quantum Mechanics	Theory	3
		DSE Pr3	Basic Quantum Mechanics Lab	Practical	1
		GE P5	Basics of Heat Transfer	Theory + Tutorial	3+1

		SEC P5	Advanced Instrumentation and Measurement Techniques-I Or Electrical circuit network Skills - I	Theory	(02)
		IAPC	IAPC	-	04
	VI	DSC A6	Electronics	Theory	3
		DSC Pr6	Electronics Lab	Practical	1
		DSE A4	Special Theory of Relativity	Theory	3
		DSE Pr4	Special Theory of Relativity Lab	Practical	1
		DSE A5	Research Methodology in Physics	Theory	3
		DSE Pr5	Research Methodology Lab	Practical	1
		GE P6	Basics of Digital Electronics	Theory + Tutorial	3+1
		SEC P6	Advanced Instrumentation and Measurement Techniques-II or Electrical circuit network Skills – II	Theory	2
		IAPC	IAPC	-	04

Semester-wise List and Titles of the Papers for M.Sc. Degree in Physics

Year	Sem.	Course Code	Paper Title	Theory/ Practical	Credits
Major in Physics					
FOURTH YEAR	VII	DSC A7	Mathematical Physics	Theory	3
		DSE A6	Classical Mechanics	Theory	3
		DSE A7	Quantum Mechanics	Theory	3
		DSE A8	Communication Electronics	Theory	3
			Practical	Practical	4
		DSE A5	Research Methodology in Physics	Theory	3
		GE P7	Renewable Energy Resources	Theory + Tutorial	3+1
		GE P8	Radiation Physics	Theory + Tutorial	3+1
			Dissertation		(06)
	VIII	DSC A8	Electrodynamics	Theory	3
		DSE A9	Atomic and Molecular Physics	Theory	3
		DSE A10	Nuclear Physics	Theory	3
		DSE A11	Elementary Particle Physics	Theory	3

			Practical	Practical	4
		GE P9	Physics of Weather and Climate	Theory +	3+1
				Tutorial	
		GE P 10	Digital Electronics and Computer Architecture	Theory + Tutorial	3+1
			Dissertation		(06)
Master in Physics					
FIFTH YEAR	IX	DSC A9	Advanced Quantum Mechanics	Theory	3
		DSE A12	Plasma Physics	Theory	3
		DSE A13	Advanced Electronics-I/Astrophysics-I/ High Energy-I/Spectroscopy-I/Condensed Matter Physics-I	Theory	3
		DSE A14	Advanced Electronics-II/Astrophysics-II/ High Energy-II/Spectroscopy-II/ Condensed Matter Physics-II	Theory	3
			Practical	Practical	4
		GE P11	BIO physics/ Photonics-I	Theory + Tutorial	3+1
		GE P 12	Nanoscience and Nanotechnology	Theory + Tutorial	3+1
			Dissertation		(06)
	X	DSC A10	Solid State Physics	Theory	3
		DSE A15	Statistical Physics	Theory	3
		DSE A16	Advanced Electronics-III/Astrophysics-III/ High Energy-III/Spectroscopy-III/ Condensed Matter Physics-I	Theory	3
		DSE A17	Advanced Electronics-IV/Astrophysics-IV/ High Energy-IV/Spectroscopy-IV/ Condensed Matter Physics-II	Theory	3
			Practical	Practical	4
		GE P13	Medical Physics/ Photonics-II	Theory + Tutorial	3+1
		GE P 14	Basics of Astrophysics	Theory + Tutorial	3+1
			Dissertation		(06)

Abbreviations-
DSC-Discipline Specific Course; DSE- Discipline Specific Electives; GE-Generic Electives

Programme outcomes (POs):

Students having Degree in B.Sc. (with Physics) should have knowledge of different concepts and fundamentals of Physics and ability to apply this knowledge in various fields of academics and industry. They may pursue their future career in the field of academics, research and industry.

PO 1	1. Competence in the methods and techniques of calculations using Mechanics. 2. Students are expected to have hands-on experience to apply the theoretical knowledge tosolve practical problems.
PO2	1. Students are expected to have deep understanding of electricity and magnetism. 2. Student should be able to make basic electrical circuits and handle electrical instruments.
PO 3	1. Competence in the concepts of Thermodynamics. 2. Students are expected to have hands on experience in Thermal Physics Experiments.
PO 4	1. Knowledge of different concepts in Geometrical Optics. 2. Students are expected to have hands on experience of Experiments of GeometricalOptics
PO 5	1. Knowledge of basic concepts of optical instruments with their applications in technology 2. Students are expected to have an insight in handling electronic instruments.
PO 6	1. Comprehensive knowledge of Analog & Digital Principles and Applications. 2. Learn the integrated approach to analog electronic circuitry and digital electronics forR&D.

Programme specific outcomes (PSOs):
UG I Year /Undergraduate Certificate Course in Physics

After completing this certificate course, the student should have:

1. Acquired the basic knowledge of Mechanics, Electricity and Magnetism.
2. Hands-on experience to apply the theoretical knowledge to solve practical problems of basic physical phenomena. Student should be able to carry out experiments to understand the laws and concepts of Physics.
3. An insight in understanding electrical circuits and in handling electrical instruments.

Programme specific outcomes (PSOs):

UG II Year/ (Diploma in Applied Physics)

After completing this diploma course, the student should have

1. Knowledge of different concepts in Thermodynamics, and Geometrical Optics.
2. Knowledge of different aspects of Thermal Physics which serves as a basis for many physical systems used in industrial applications and deals with the physics and technology of Engines and Refrigerators.
3. A deeper insight in Ray Optics to understand the Physics of many optical instruments which are widely used in research and Industry, Optoelectronics, IT and communication devices, and in industrial instrumentation.

4. Knowledge of basic concepts of optical instruments with their applications in technology.

Programme specific outcomes (PSOs): UG III Year / Bachelor of Science	
After completing this degree course, the student should have:	
PSO 1	1. Knowledge of Mechanics and basic properties of matter. 2. The course will empower him to apply his theoretical knowledge in various physical phenomena that occur in day-to-day life and he can use this scientific knowledge for the betterment of the society.
PSO2	1. Understanding of basic concepts related to Electricity and Magnetism. 2. Students should be proficient in designing and handling different electrical circuits
PSO3	1. Expertise in different aspects of Thermal Physics which serves as a basis for many physical systems used in industrial applications and deals with the physics and technology of Engines and Refrigerators.
PSO4	1. Proficient in the field of Optics which will increase his demand in research and industrial establishments engaged in activities involving optical instruments.
PSO5	1. Basic knowledge in the field of Modern physics, which have utmost importance at both undergraduate and graduate level.
PSO6	1. Comprehensive knowledge of Analog & Digital Principles and Applications. Learn the integrated approach to analog electronic circuitry and digital electronics for R&D.

SEMESTER-I

UNDERGRADUATE CERTIFICATE COURSE IN PHYSICS

DISCIPLINE SPECIFIC COURSE (DSC A1)		
Programme: ***Undergraduate Certificate Course in Physics***	**Year: I**	**Semester: I**

Subject: Physics

Course Title & Code	**Credits**	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
DSC A1: Mechanics and Theory of Oscillations	4	3	0	1	12th pass	Physics and Mathematics in 12th

Course Outcomes

1. Understanding of Vector Algebra and Vector Calculus.

2. Understanding the physical interpretation of gradient, divergence and curl.

3. Study of gravitational field and potential and understanding of Kepler's laws of Planetary motion.

4. Understanding of different frames of references and conservation laws.

5. Understand the dynamics of rigid body and concept of moment of inertia. Study of moment of inertia of different bodies and its applications.

6. Study the properties of matter, response of the classical systems to external forces and their elastic deformation and its applications.

7. Comprehend the dynamics of Fluid and concept of viscosity and surface tension along with its applications.

8. Comprehensive study of the theory of oscillations.

THEORY COMPONENT

Unit	**Topic**	**No. of Lectures**
Unit I	**Vectors Algebra** Vector algebra. Scalar and vector products, scalar and vector triple products Derivative of a vector with respect to a parameter, Line, surface and volume integral of a vector function. Del operator, gradient, divergence and curl,, applications of divergence and curl, Gauss divergence theorem, Stokes curl theorem and Green's theorem and their applications.	**05**

Unit II	**Gravitation field and potential** Gravitational field and potential, Gravitational potential energy, Gravitational field Intensity and potential due to a ring, a spherical shell, solid sphere and circular disc, inertial and gravitational mass, gravitational self-energy, gravitational self-energy of a uniform solid sphere, Inverse square law of forces, Kepler's laws of planetary motion.	**10**
Unit III	**Rotational and translational motion & Conservation Laws** Frames of reference, Concept of inertial and Non-inertial frames of references, Work energy theorem, Conservative and non-Conservative forces, Linear restoring force, Gradient of potential, Conservation of energy for the particle; Energy function, Concept of Centre of mass, translatory and rotatory motion, equation of motion for rotating rigid bodies, Angular momentum and torque, Laws of conservation of total energy, total linear momentum and total angular momentum along with their examples.	**10**
Unit IV	**Dynamics of rigid body and Moment of Inertia and Properties of matter** Moment of inertia, Theorem of parallel and perpendicular axes, Moment of inertia of a rod, lamina, ring, disc, spherical shell and solid sphere, kinetic energy of rotation, basic concepts about elasticity, Hook's law, Young's modulus, Bulk modulus, modulus of rigidity, poisson ratio, relation connecting various elastic constants, bending moment, Viscosity, Equation of continuity of flow, Bernoulli's theorem, Posieuille's formula, Stokes's law, Surface tension and its molecular interpretation.	**10**
Unit V	**Theory of Oscillations** Simple Harmonic Motion (S.H.M.),differential equation of S.H.M. and its solution ,energy of harmonic oscillator, Lissajous' figures for equal frequencies ratio and 2:1 frequencies ratio, damping forces, damped harmonic oscillator , differential equation of damped harmonic oscillator and its solution, power dissipation in a damped harmonic oscillator, relaxation time, quality factor, simple and compound pendulum, forced or driven harmonic oscillator, its differential equation, amplitude resonance, velocity resonance, sharpness of resonance.	**10**

Suggested Reading

1. R. Resnick and D. Hilliday : Physics Vol-I 2.Berkeley Physics Course : Mechanics Vol-I
2. R.P. Feynman, R.B.Lightan and M.Sand : The Feynman Lectures in Physics
3. D.S. Mathur : Mechanics
4. Murray Spiegel, Seymour Lipschutz, Dennis Spellman, "Schaum's Outline Series: Vector Analysis", McGraw Hill, 2017.
5. J. C. Upadhaya: Mechanics, S. Chand

Suggested Online Link:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

PRACTICAL COMPONENT

1. To determine the Moment of Inertia of a Flywheel.
2. To determine g and velocity for a freely falling body using DigitalTiming Technique.
3. To determine Coefficient of Viscosity of water by Capillary FlowMethod (Poiseuille's method).
4. To determine the Young's Modulus of a Wire by Optical LeverMethod.
5. To determine the Young's Modulus by bending of beam.
6. To determine the Modulus of Rigidity of a Wire by Maxwell'sneedle.
7. To determine the elastic Constants of a wire by Searle's method.
8. To determine the coefficient of damping, relaxation time, and quality factor of damped simple harmonic motion using simple pendulum
9. To determine the value of g using Bar Pendulum.
10. To determine the value of g using Kater's Pendulum.
11. To determine Surface Tension.

Suggested Readings:

1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd.,London, 1962.
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd.,2015.
3. Indu Prakash: Practical Physics
4. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014.

Suggestive Digital Platforms / Web Links:

1. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=74
2. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists byindividual Universities

GENERAL ELECTIVE (GE P1) -- BASIC PHYSICS-I						
Programme: **General Elective**				**Year: I**	**Semester: I**	
Course Title & Code	**Credits**	**Credit distribution of the course**			**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**	**Practical**		
GE P1: Basic Physics I	4	3	1	0	12th pass	12th pass

Course Outcomes:

1. To understand the nature of forces and Newton's laws of motion.
2. To understand the rotational motion and angular variables.
3. To explore the concepts of work and energy.

Unit	Topic	No. of Lectures
Unit I	Rest and motion, Distance and displacement, Speed, velocity and acceleration, Motion in a straight line, Motion in a plane, Newton's first, second and third law of motion, Pseudo forces, Vector and scalars, Equality of vectors, addition and subtraction of vectors, Resolution of vectors, scalar and vector product of two vectors.	15
Unit II	Forces: Gravitational, electromagnetic, nuclear and weak forces, scope of classical physics, Friction as a component of central force, Kinetic and static frictions, Laws of Frictions, Friction at atomic levels.	` 15
Unit III	Circular Motion, angular variables, acceleration in a circular motion, Dynamics of a circular motion, Circular turnings and banking of roads, Centrifugal and centripetal forces, Effect of Earth's rotation on apparent weight.	15
Unit IV	Work and energy: Kinetic and potential energy, Work and work energy theorem, Calculation of work done, work energy theorem for a system of particles, Conservative and non-conservative forces, Gravitational potential energy, Conservation of mechanical energy, mass-energy equivalence.	15

Suggested Reading

1. H. C. Verma: Concepts of Physics
2. Robert Resnick Jearl Walker, David Halliday: Principles Of Physics
3. Halliday, Resnick , Walker: Fundamentals of Physics Extended(Old Edition)

Suggested Online Link:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

SKILL ENHANCEMENT COURSE (SEC P1) - Basic Instrumentation Skills -I						
Programme: **Skill Enhancement Course**				**Year: I**	**Semester: I**	
Course Title & Code	**Credits**	**Credit distribution of the course**			**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture/Theory	**Tutorial**	**hands on training**		
SEC P1: Basic Instrumentation Skills -I	2	1	0	2	12^{th} pass	Physics and Mathematics in 12^{th}

Course Outcomes:

1. To understand the basic gain of mechanical tools and errors.
2. To understand the hand on experience of different mechanical and electrical tools.
3. To gain the knowledge of electrical cables, and their specifications.

Unit	Topic (Theory / Experiments/hands on training)	No. of Lectures
Unit I	**Errors and Mechanical Tools:** Instruments accuracy, precision, sensitivity, resolution, range, least count of different instruments, Errors in measurements, Types of errors. Hand tools and their Uses: Identification, specifications, uses and maintenance of commonly used hand tools: Tweezers Screwdriver (Combination Set), Pliers, Wire Cutters, Wire Strippers, Crimping Tools, Sockets & Hex drivers, Clamps, Rotary Tools: Grinders, Portable Drill Machine, Small Hand Saws.	**15**
Unit II	**Electrical & Electronics Cables and Connector** Different type of electrical cables and their Specifications. Types of wires & cables, Standard wire gauge (SWG), Practice on different type of cable joint, Testing phase , neutral and Earth by tester and multi-meter and test lamp.	**15**

Suggested Reading

1. B L Theraja : A text book in Electrical Technology
2. M G Say: Performance and design of AC machines
3. S. Salivahanan & N. S. Kumar : Electronic Devices and Circuits, , 3rd Edn
4. Shashi Bhushan Sinha, Handbook of Repair and Maintenance of Domestic Electronics Appliances hand book.
5. M. Lotia, Modern Basic Electrical & House Wiring Servicing

SEMESTER-II

UNDERGRADUATE CERTIFICATE COURSE IN PHYSICS

DISCIPLINE SPECIFIC COURSE (DSC A2)						
Programme: ***Undergraduate Certificate Course in Physics***					**Year: I**	**Semester: II**
Subject: Physics						
Course Title & Code	**Credits**	**Credit distribution of the course**			**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**	**Practical**		
DSC A2: Electricity and Magnetism	4	3	0	1	As per the university ordinance	As per the university ordinance

Course Outcomes:

1. Understanding of Electric Field and Potential. Evaluation of Electric Field and Potential for different types of charge distributions.
2. Study of Electric and Magnetic Fields in matter. Understand the concept of polarizability, Magnetization and Electric Displacement Vector.
3. Study of Steady and Varying electric currents.
4. Understanding of different aspects of alternating currents and its applications.
5. Understand the Magnetostatics, Lorentz Force and Energy stored in magnetic Field.
6. Comprehend the different aspects of Electromagnetic induction and its applications.

Theory Component

Unit	**Topic**	**No. of Lectures**
Unit I	**Electric field and potential** Coulomb law, Gauss' theory, its integral and differential forms, line integral of Electric field, Electric field and potential due to an arbitrary charge distribution. Electrostatic energy, energy stored in an Electric field. Electric field and potential due to long charged wire, Spherical shell, sphere, disc, dipole.	**08**
Unit II	**Electric and Magnetic fields in Matter** Moments of charge distributions, Polar and non-polar molecule, polarization vector, electric displacement vector, three electric vectors, dielectric susceptibility and permittivity, polarizability, Clausius-Mossotti relation. Magnetization, magnetic susceptibility, diamagnetic, paramagnetic and ferromagnetic substances, Hysteresis and B-H curve, Langevin's theories of Diamagnetism and paramagnetism, Weiss theory of ferromagnetism.	**10**

Unit III	**Electric Currents (Steady and Varying)** Current density, Equation of Continuity, Ohm's law and electrical conductivity, Lorentz Drude theory, Wiedmann-Frenz law, Kirchhoff's laws and their applications, Transient current, Growth and decay of D. C. in L - R and L - C circuits, charging and discharging of a capacitor through a resistance.	**08**
Unit IV	**Magnetostatics** Lorentz force, Bio-Savert's law, Ampere's law, Application of Bio-Savert law, magnetic field due steady current in a long straight wire, Interaction between two wires, field due a Helmholtz coil, solenoid and current loop, magnetic vector potential, permeability, Energy stored in Magnetic field.	**09**
Unit V	**Electromagnetic Induction and Alternating Current** Faraday's laws of induction, Lenz's law, Electromotive force, Measurement of magnetic field, Eddy current, Mutual inductance, Self-inductance. Impedance, admittance and reactance, R-C, R-L and L-C circuits with alternating e.m.f. source, series and parallel L-C-R circuits, resonance and sharpness, Quality factor, Power in A. C. circuits, Choke coil.	**10**

Suggested Reading

1. Edward M. Purcell : Electricity and Magnetism
2. J.H. Fewkes&J.Yarwood : Electricity & Magnetism, Vol. I
3. D C Tayal : Electricity and Magnetism ", Himalaya Publishing House Pvt. Ltd., 2019.
4. D.J.Griffiths : Introduction to Electrodynamics .
5. Lal and Ahmed : Electricity and Magnetism
6. H. K. Malik and A.K. Singh "Engineering Physics", McGraw Hill Education (India) PrivateLimited, 2018.
7. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on PhysicsVol. 2", Pearson Education Limited, 2012.

Suggested Online Link:

2. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
4. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Practical Component

1. Calibration of Voltmeter by potentiometer.
2. Calibration of ammeter by potentiometer.
3. Specific resistance determination.
4. Conversion of a Galvanometer into a Voltmeter.
5. Conversion of a Galvanometer into Ammeter.

6. Variation of magnetic field along the axis of a current carrying circular coil.
7. Comparison of capacities by Ballistic Galvanometer.
8. Determination of Ballistic Constant.
9. Electrochemical equivalent.
10. De Sauty's bridge- C1/ C2
11. R1/R2 by potentiometer.
12. Determination of self inductance, mutual inductance.
13. Magnetic field determination by search coil and ballistic galvanometer
14.

Suggested Readings:

1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd.,London, 1962.
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd.,2015.
3. Indu Prakash: Practical Physics
4. S.L. Gupta, V. Kumar, "Practical Physics", PragatiPrakashan, Meerut, 2014.

Suggestive Digital Platforms / Web Links:

1. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=74
2. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists byindividual Universities

GENERAL ELECTIVE (GE P2) -- BASIC PHYSICS-II						
Programme: **General Elective**				**Year: I**	**Semester: II**	
Course Title & Code	**Credits**	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
GE P2: Basic Physics II	4	3	1	0	As per University Ordinance	As per University Ordinance

Course Outcomes:
1. To understand the linear and angular motion
2. To understand the Gravitational field and Simple Harmonic Motion
3. To learn about the mechanical properties of matter.

Unit	**Topic**	**No. of Lectures**
Unit I	Center of mass, Motion of the center of mass, Linear momentum and its conservation, Rocket propulsion, Collision, Elastic collision in one dimensions, Impulse and Impulsive forces, Rotation of rigid body about a given fixed line, Rotational dynamics, Torque of force about the axis of rotation. Angular momentum and conservation of angular momentum.	**15**
Unit II	Gravitation: Historical introduction, measurement of gravitational constant 'G', Gravitational potential energy, Gravitational potential, Gravitational field, Relation between gravitational field and potential, Variation in the value of acceleration due to gravity, Planets and satellites, Kepler's law, Weightlessness in a satellite, Escape velocity, Gravitational binding energy, Black holes.	**15**
Unit III	Simple Harmonic Motion (SHM): Qualitative nature of SHM, Equation of motion of a SHM, Terms associated with SHM, SHM as a projection of a circular motion, Energy conservation in SHM, Angular SHM.	**15**
Unit IV	Mechanical properties of matter: Molecular structure of a material, Elasticity, Stress, Strain, Hooke's law and the modulus of elasticity, Relation between longitudinal stress and strain, Elastic potential energy of a strained body, Surface tension and energy, Viscosity, Poiseuille's equation, Stoke's law.	**15**

Suggested Reading

1. H. C. Verms: Concepts of Phyiscs
2. Robert Resnick Jearl Walker, David Halliday: Principles Of Physics
3. Halliday, Resnick , Walker: Fundamentals of Physics Extended(Old Edition)

SKILL ENHANCEMENT COURSE (SEC P2) - **Basic Instrumentation Skills -II**						
Programme: **Skill Enhancement Course**				**Year: I**	**Semester: II**	
Course Title & Code	**Credits**	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture/Theory	Tutorial	**Hands-on training**		
SEC P2: Basic Instrumentation Skills -II	2	1	0	2	As per University Ordinance	The student should have done the Basic Instrumentation Skill **I** course in Sem I

Course Outcomes:

1. To understand the different types of batteries, maintenances and their uses.
2. Knowledge of secondary cells
3. To get the knowledge of the testing of batteries.

Unit	Topic (Theory / Experiments/hands on training)	No. of Lectures
Unit I	**Batteries and Maintenance:** Types of Batteries, Primary Cell, Secondary Cell, Wet charged, Dry-charged, Low maintenance, Construction of Battery, Case Cover plates, Separator, Cells, Electrolyte, Principles of Batteries, Lead Acid battery, Electrochemical reaction, Measure the voltages of the given cells/battery using analog/ digital multimeter, Charge and discharge the battery through load resistor, Maintain the secondary cells, Measure the specific gravity of the electrolyte using hydrometer.	**15**
Unit II	**Testing of Batteries:** Testing Factors affecting charging, Cause of battery failure, diagnosis and testing, visual inspection, Heavy load test Professional, Test a battery and verify whether the battery is ready for use of needs recharging.	**15**

Suggested Reading

1. B L Theraja : A text book in Electrical Technology
2. M G Say : Performance and design of AC machines
3. S. Salivahanan& N. S.Kumar : Electronic Devices and Circuits, , 3rd Edn
4. Shashi Bhushan Sinha, Handbook of Repair and Maintenance of Domestic Electronics Appliances hand book.
5. M. Lotia, Modern Basic Electrical & House Wiring Servicing

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2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

SEMESTER-III
DIPLOMA IN APPLIED PHYSICS

DISCIPLINE SPECIFIC COURSE (DSC A3)						
Programme: ***DIPLOMA IN APPLIED PHYSICS***					**Year: II**	**Semester: III**
Subject: Physics						
Course Title & Code	**Credits**	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
DSC A3: Thermodynamics and Statistical Physics	4	3	0	1	As per the university ordinance	As per the university ordinance

Course Outcomes:
1. Understand First, Second and Third Law of Thermodynamics and concept of Entropy.
2. Understand the physical significance of thermodynamical potentials.
3. Comprehend the kinetic model of gases with respect to various gas laws.
4. Study the implementations and limitations of fundamental radiation laws.
5. Understand basics of statistical Physics and concept of thermodynamic probability

Theory Component

Unit	Topic	No. of Lectures
Unit I	**Laws of thermodynamics**: Zeroth and first law of thermodynamics, Heat Capacities, Adiabatic Processes, Vander Wall equation, Distinction between Joule, Joule-Thompson and Adiabatic expansion of a gas, Carnot's Engine and Carnot's Cycle, Second law of thermodynamics, Carnot's Theorem, Thermodynamic scale of temperature, Entropy, T-S diagram and its applications, Evaluation of Entropy changes in simple cases, Third law of thermodynamics.	**10**
Unit II	**Thermodynamic Relations:** Thermodynamic potentials, Maxwell's equation from thermodynamic potentials, Some useful manipulations with partial derivatives (cooling in adiabatic processes and Adiabatic stretching of a wire), The Clausius–Clapeyron's equations, Triple point, Applications of Maxwell's thermodynamical relations.	**10**
Unit III	**Transport of Heat :** Conduction, Convection and Radiation, Fourier's law, One dimensional steady state conduction, Thermal conductivity and its experimental detection, Newton's law of cooling, Black body radiation, Thermodynamics of radiations inside a hollow enclosure, Kirchoff's Laws, Stefan Boltzmann Law, Wien's displacement law, Raleigh Jean's Law, Quantum theory of Radiation, Planck's formula, Wien's law.	**10**

Unit IV	**Basics of Statistical Physics:** Basic postulates of Statistical Physics, Macro and Micro States, Phase Space, Condition of equilibrium, Postulate of equal a priori probability, Entropy and Thermodynamic probability, Boltzmann entropy relation, Maxwell-Boltzmann (M-B) statistics and Distribution law.	**08**
Unit V	**Kinetic Theory of Gases:** Kinetic theory of gases, Microscopic description of an Ideal gas, Degrees of freedom, Law of Equipartition of Energy, Distribution law of velocities, Most probable speed, Average speed and root mean square velocity of molecules, Pressure exerted by a perfect gas, Kinetic Interpretation of Temperature.	**07**

Suggested Reading

1. S. Loknathan : Thermodynamics, Heat and Statistical Physics
2. Sharma and K.K. Sarkar : Thermodynamics, and Statistical Physics
3. Brijlal and Subrahmanyam : Heat and Thermodynamics
4. Garg, Bansal and Ghose : Thermal Physics, McGraw Hill, 2012.
5. M.W. Zemansky, R. Dittman, "Heat and Thermodynamics", McGraw Hill, 1997.
6. Enrico Fermi, "Thermodynamics", Dover Publications, 1956.
7. MeghnadSaha, B.N. Srivastava, "A Treatise on Heat", Indian Press, 1973
8. F.W. Sears, G.L. Salinger, "Thermodynamics, Kinetic theory & Statistical thermodynamics", Narosa Publishing House, 1998.
9. Singhal and Prakash: Heat and Thermodynamics, Pragati Prakashan

Suggested Online Link:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Practical Component

1. Thermal conductivity of a bad conductor by Lee's method.
2. Mechanical equivalent of heat by Searle's method.
3. Stefan's law
4. Platinum resistance thermometer.
5. J by Callendar and Barnes method.
6. Random throw- statistical method.
7. Newton's law of cooling, sp. heat of Kerosene oil.
8. Constant volume thermometer.
9. Variation of thermo-emf across two junctions of a thermocouple with temperature.

Suggested Readings:

1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962.
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015.

3. Indu Prakash: Practical Physics
4. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014

Suggestive Digital Platforms / Web Links:

1. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=74
2. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by individual Universities

DISCIPLINE SPECIFIC ELECTIVE (DSE A1)						
Programme: ***DISCIPLINE SPECIFIC ELECTIVE***					**Year: II**	**Semester: III**
Course Title & Code	**Credits**	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
DSE A1: Waves and Acoustics	4	3	0	1	As per the university ordinance	As per the university ordinance

Course Outcomes:

1. To understand the wave motion
2. To understand the Ultrasonic waves and its application
3. Measurement of acoustic intensity and energy density
4. To understand the application of wave propagation in various physical cases.

Theory Component

Unit	Topic	No. of Lectures
Unit I	**Analysis of wave motion:** Characteristics, Differential equation of a wave motion, principle of superposition, Interference, Beats, stationary waves, Energy of stationary waves, Wave velocity and group velocity, Fourier theorem, Fourier analysis of square, triangular and saw-tooth waves.	**15**
Unit II	**Ultrasonics:** Classification of Sound waves, Ultrasonics, Quartz crystal and Piezo electric effect, Magnetostriction effect, Properties of Ultrasonic, Detection of ultrasonicwaves, Determination of velocity of ultrasonic waves in liquid (Acoustic grating method) . Application of Ultrasonics.	**10**
Unit III	**Acoustics** : Energy density of plane acoustic waves, Acoustic intensity, Measurement of acoustic intensity – the dB scale, Characteristics and loudness of Musical sound, Acoustic impedance, Reflection and transmission of acoustic waves.	**10**
Unit IV	**Applications** : Application of wave propagation in various physical cases, Applications of Ultrasonics, Acoustics of buildings, reverberation time, Sabine's formula, Principle of sonar system.	**10**

Suggested Reading

1. R. Resnick and D. Hilliday : Physics Vol-I

2. D.S. Mathur : Mechanics
3. Brijlal and Subrahmanyam : Waves and Oscillations
4. B.S.Semwal and M.S.Panwar : Wave Phenomena and MaterialScience
5. Berkeley Physics Course : Mechanics Vol-I
6. R.K.Ghose : The mathematics of waves an Vibrations
7. D.P.Khandelwal : Oscillations and Waves
8. I.I.Pain : Physics of Vibration
9. A. P. French : Vibrations and Waves

Suggested Online Link:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

PRACTICAL COMPONENT

1. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity.
2. To determine the frequency of tuning fork with the help of sonometer.
3. To determine the frequency of AC mains with a Sonometer using magnetic wire.
4. To determine the frequency of AC mains with a Sonometer using non- magnetic wire.
5. To determine the frequency of AC mains by Melde's experiment.
6. To determine the velocity of sound in air at room temperature with Kundt's tube.
7. To determine the velocity of Ultrasonic wave in a given liquid.
8. To compare the velocities of sound in two gasses at room temperature.

Suggested Readings:

1. B.L. Worsnop, H.T. Flint, “Advanced Practical Physics for Students”, Methuen & Co., Ltd.,London, 1962.
2. S. Panigrahi, B. Mallick, “Engineering Practical Physics”, Cengage Learning India Pvt. Ltd.,2015.
3. Indu Prakash: Practical Physics
4. S.L. Gupta, V. Kumar, “Practical Physics”, Pragati Prakashan, Meerut, 2014.

Suggestive Digital Platforms / Web Links:

1. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=74
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GENERAL ELECTIVE (GE P3)						
Programme: **General Elective**					**Year: II**	**Semester: III**
Course Title & Code	**Credits**	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
GE P3: Fundamental Mechanics	4	3	1	0	As per University Ordinance	As per University Ordinance

Course Outcomes:

1. To gain the knowledge of vector algebra.
2. To understand the frames of references and Newton's law of motion.
3. Study of the Keplelr's laws of motion .
4. To understand the elasticity related to different laws.

Unit	Topic	No. of Lectures
Unit I	**Vectors Algebra and Ordinary Differential Equations** Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients.	**15**
Unit II	**Translatory and Rotatory Motion and Conservation Laws** Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass, Conservation of momentum. Work and energy Conservation of energy. Motion of rockets, Angular velocity and angular momentum. Torque. Conservation of angular momentum.	**15**
Unit III	**Gravitation** Newton's Law of Gravitation. Motion of a particle in a central force field (motion in a plane, angular momentum conservation). Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Basic idea of global positioning system (GPS). Weightlessness. Physiological effects on astronauts.	**15**
Unit IV	**Elasticity** Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire.	**15**

Suggested Reading

1. Sears, Zemansky and Young : University Physics
2. Berkeley Physics Course : Volume-1 Mechanics
3. Resnick, Halliday & Walker Fundamentals of Physics

4. Basudeb Bhattacharya : Engineering Mechanics 2nd Edn
5. Ronald Lane Reese : University Physics
6. B.L. Flint and H.T. Worsnop : Advanced Practical Physics forStudents

Suggested Online Link:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

SKILL ENHANCEMENT COURSE (SEC P3)						
Programme: **Skill Enhancement Course**				**Year: II**		**Semester: III**
Course Title & Code	**Credits**	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture/Theory	Tutorial	**Hands-on training**		
SEC P3: Basic Instrumentation Skills -III	2	1	0	2	As per University Ordinance	As per University Ordinance

Course Outcomes:

1. Hands on practice of domestic wiring and electrical systems.
2. To understand the soldering and practice it's on different electronic components.

Unit	**Topic (Theory and hands on practice)**	**No. of Lectures**
Unit I	**Domestic Wiring** Introduction and explanation of electrical wiring systems, cleat wiring, casing & Capping, house wiring, specification and types, rating & material, Demonstration & Practice on connecting common electrical accessories in circuits and testing them in series board., Testing & replacement of different types of fuses, switches, plug, sockets. Identification of different wiring materials and their specification, Removal of insulation from assorted wires and cable, Making a switchboard with electrical accessories, Making an Extension board.	**15**
Unit II	**Soldering :** Solders, flux and soldering technique. Different types of soldering guns related to Temperature and wattages, types of tips, Solder materials and their grading, Use of flux and other materials, Selection of soldering gun for specific requirement, Soldering and De-soldering stations and their specifications. Soldering/ De-soldering and Various Switches, Practice soldering on different electronic components, small transformer, Practice de-soldering	**15**

Suggested Reading

1. B L Theraja : A text book in Electrical Technology
2. M G Say : Performance and design of AC machines
3. S. Salivahanan& N. S. Kumar : Electronic Devices and Circuits, , 3rd Edn
4. Shashi Bhushan Sinha, Handbook of Repair and Maintenance of Domestic Electronics Appliances hand book.
5. M. Lotia, Modern Basic Electrical & House Wiring Servicing

SEMESTER IV

DIPLOMA IN APPLIED PHYSICS

DISCIPLINE SPECIFIC COURSE-DSC A4		
Programme: ***DIPLOMA IN APPLIED PHYSICS***	**Year: II**	**Semester: IV**
Subject: Physics		

Course Title & Code	**Credits**	**Credit distribution of the course**			**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	Tutorial	Practical		
DSC A4: Optics	4	3	0	1	As per the university ordinance	As per the university ordinance

Course Outcomes:

1. Study of Fermat's Principle of Extremum Path and understand fundamental physics behindreflection and refraction of light.
2. Understand the theory of image formation by an optical system.
3. Study of different types of optical Aberrations and techniques for their reduction.
4. Study of different types of optical instruments used in industry and research
5. Study of Interference of light. Interference by division of wavefront and division of amplitude.
6. Understanding Diffraction of Light and concept of Zone Plate.
7. Understand the polarization of light.
8. Study of different types of associated optical instruments based on interference and diffraction oflight which are widely used in industry and research.

Theory Component

Unit	**Topic**	**No. of Lectures**
Unit I	**Fermat's Principle and Theory of Image Formation:** Fermat's principle of extremum path and its application to deduce laws of reflection and refraction, Refraction at concave surface, Principal foci, Lateral and longitudinal magnifications, Aplanatic points of spherical surface; Gauss's general theory of image formation, Coaxial symmetrical system, Cardinal points of an optical system, Thick and Thin lens, Newton's formula, Coaxial lens system, Lagrange's equation of magnification, Refraction through a thick lens; Nodal Slide, Eyepiece, Ramsden's, Huygen's and Gaussian eyepieces, Astronomical refracting telescope, Microscopes, Spectrometer and its uses.	**10**

Unit II	**Optical Aberrations and Dispersion:** Aberrations in images, Spherical aberration, Monochromatic and Chromatic aberration, Condition of achromatism, Achromatic combination of lenses in contact and separated lenses, Spherical mirrors and Schmidt corrector plates, Theory of dispersion.	**O7**
Unit III	**Interference:** The principle of superposition, Two slit interference, coherence, Optical path retardations, lateral shift of fringes, Fresnel biprism, Interference with multiple reflection, Thin films, Application for precision measurements, Haidinger fringes, Fringes of equal thickness and equal inclination; Michelson intereferometer and its application for precise measurement of wavelength, Wavelength difference and width of spectral lines, Fabry-Perot interferometer and Etalon	**10**
Unit IV	**Diffraction:** Fresnel's and Fraunhofer diffraction: Diffraction of single slit, Zone plates, intensity distribution, Resolution of image, Rayleigh criterion, Resolving power of telescopes and microscopes, Diffraction due to 2-slits and N-slits, Diffraction grating, Resolving power of grating and comparison with resolving powers of prisms.	**08**
Unit V	**Polarization:** Plane polarized, Circular polarized and elliptically polarized light, Malus law, Brewster's law, Double reflection and uniaxial crystals, Application of bi-refringence, Dichroism, Optical rotation, Rotation of plane of polarization, Optical rotation in liquids and crystals, Polarimeter.	**10**

Suggested Reading

1. D.P. Khandelwaland : Optics and Atomic Physics
2. Jenkins and White : Fundamentals of Optics
3. A.K. Ghatak : Physical Optics
4. Brijlal and Subrahmanyam : Optics
5. K.D. Moltev : Optics
6. B. K. Mathur : Optics
7. B. D. Guenther : Modern Optics, Oxford Press
8. E. Hecht: Optics, Pearson.

Suggested Online Link:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Practical Component

1. Nodal slide assembly, Location of cardinal points of lens system.
2. Newton's formula.
3. Dispersive power of prism.
4. Resolving power of a telescope.

5. To determine the Resolving Power of a Prism.
6. To find the thickness of the wire using optical bench.
7. To determine the thickness of mica-sheet by using Biprism
8. Biprism- determination of λ.
9. Newton's ring experiment- Determination of λ.
10. Zone-plate experiment study of different orders.
11. Malus Law
12. Polarimeter: Specific rotation of sugar solution.

Suggested Readings:

1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd.,London, 1962.
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd.,2015.
3. Indu Prakash, Practical Physics
4. S.L. Gupta, V. Kumar, "Practical Physics", PragatiPrakashan, Meerut, 2014.

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DISCIPLINE SPECIFIC ELECTIVE (DSE A2)						
Programme: ***DISCIPLINE SPECIFIC ELECTIVE***					**Year: II**	**Semester: IV**
Subject: Physics						
Course Title & Code	**Credits**	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
DSE A2 Elementary Solid-State Physics	4	3	0	1	As per the university ordinance	As per the university ordinance

Theory Component

Unit	Topic	No. of Lectures
Unit I	Crystalline and non - crystalline sate of solids. Single and polycrystalline forms of matters, Lattice, Basis, primitive and non-primitive unit cells, coordination number. Translational vectors, symmetry operations, point and space groups. Types of lattices and seven crystal system. Lattice planes and Miller indices. Structure of SC, BCC, FCC (with examples) and closed packed structures. Structure of diamond.	**10**
Unit II	Lattice constant, Inter-planar spacing, density of lattice points, atomic packing fractions. Reciprocal lattices and their properties, X-rays diffraction by matter, Bragg's law, Laue methods of X-rays diffraction. Brillouin zones and their applications.	**10**
Unit III	Free electron theory of metals, Lorentz Drude theory and its limitations, Somerfield theory of free electrons. Specific heat, Dulong and Petit's law, departure of the law at low temperatures. Einstein's theory of specific heat and its limitations, Debye's theory of specific heat of solids,	**15**
Unit IV	Motion of an electron in periodic potential, Kronig-Penny model. Energy bands in solids, distinction between conductors, semiconductors and insulators, Intrinsic and Extrinsic semiconductors, Fermi level and Fermi energy, effective mass of electron.	**10**

Suggested Reading

1. Agarwal and Agarwal "Fundamentals of Modern Physics" (Pragati Prakashan- Meerut)
2. Dekker "Solid State Physics" (Laxmi Publications)
3. C.Kittel "Introduction to Solid State Physics"(Wiley)
4. S.O.Pillai "Solid State Physics"(New Age International)
5. Saxena, Gupta and Saxena, "Fundamental of Solid-State Physics" (PragatiPrakashan-Meerut)

Practical Component

1. Thermal conductivity of a good conductor by Searle's method.
2. To determine Hall voltage and Hall coefficient in n-type semiconductor.
3. To determine the number of charge carriers per unit volume in n-type semiconductor.
4. To determine Hall angle and mobility in n-type semiconductor.
5. To determine the band gap in a semiconductor using a p-n junction diode.
6. To determine the ionization potential of gas filled Thyratorn.
7. To plot the characteristics of thermistor and hence find the temperature coefficient of resistance.

Suggested Readings:

1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd.,London, 1962.
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd.,2015.
3. Indu Prakash, Practical Physics
4. S.L. Gupta, V. Kumar, "Practical Physics", PragatiPrakashan, Meerut, 2014.

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GENERAL ELECTIVE (GE P4)						
Programme: **General Elective**					**Year: II**	**Semester: IV**
Course Title & Code	**Credits**	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
GE P4: Basic Electricity and Magnetism	4	3	1	0	As per University Ordinance	As per University Ordinance

Course Outcomes:

1. Understanding of Electric Field and Potential. Evaluation of Electric Field and Potential for differenttypes of charge distributions.
2. Study of Steady and Varying electric currents.
3. Understanding of different aspects of alternating currents and its applications.
4. Understand the Magnetostatics, Lorentz Force and Energy stored in magnetic Field.

Unit	Topic	No. of Lectures
Unit I	**Electrostatics:** Electrostatic Field, electric flux, Gauss's theorem of electrostatics Applications of Gauss theorem- Electric field due to point charge infinite line of charge, uniformly charged spherical shell and solid sphere plane charged sheet, charged conductor. Electric potential as line integral of electricfield, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere.	**10**
Unit II	**Magnetism** Magnetostatics: Biot-Savart's law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para-and ferromagnetic materials.	**15**
Unit III	**Electromagnetic Induction and Alternating Current** Faraday's laws of electromagnetic induction, Lenz's law, self and mutualinductance, L of single coil, M of two coils. Energy stored in magnetic field. Basic concepts of alternating currents.	**10**
Unit IV	**Maxwell`s equations and Electromagnetic wave propagation** Equation of continuity, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave and its transverse nature.	**10**

Suggested Reading

1. Edward M. Purcell : Electricity and Magnetism

2. J.H. Fewkes & J.Yarwood : Electricity & Magnetism, Vol. I
3. D C Tayal : Electricity and Magnetism
4. Ronald Lane Reese : University Physics
5. D.J.Griffiths : Introduction to Electrodynamics, 3rd Edn.
6. B.L.Flint & H.T.Worsnop : Advanced Practical Physics for Students
7. M. Nelson and J. M. Ogborn : Advanced level Physics Practicals, 4th Ed
8. I.Prakash & Ramakrishna : A Text Book of Practical Physics, 11th Ed
9. S.Panigrahi & B.Mallick : Engineering Practical Physics

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2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

SKILL ENHANCEMENT COURSE (SEC P4)		
Programme: **Skill Enhancement Course**	**Year: II**	**Semester: IV**

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture/Theory	Tutorial	**Hands-on training**		
SEC P4: Basic Instrumentation Skills -IV	2	1	0	2	As per University Ordinance	As per University Ordinance

Course Outcomes:

1. To understand the theory and use of CRO
2. To understand the Signal and pulse Generators

Unit	Topic (Theory and hands on practice)	No. of Lectures
Unit I	**Impedance Bridges:** Block diagram of bridge. Working principles of basic (balancing) RLC bridge, Specifications of RLC bridge, Block diagram and working principle as of a Q-meter, Digital LCR bridges.	**15**
Unit II	**Electronic Voltmeter:** Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter, AC millivoltmeter: Type of AC millivoltmeters, Block diagram ac milli -voltmeter, specifications and their significance.	**15**

Suggested Reading

1. B L Theraja: A text book in Electrical Technology
2. M G Say: Performance and design of AC machines
3. S. Salivahanan& N. S. Kumar: Electronic Devices and Circuits, , 3rd Edn
4. Shashi Bhushan Sinha, Handbook of Repair and Maintenance of Domestic Electronics Appliances hand book.
5. M. Lotia, Modern Basic Electrical & House Wiring Servicing

SEMESTER V
BACHELOR IN SCIENCE

DISCIPLINE SPECIFIC COURSE (DSC A5)						
Programme: DISCIPLINE SPECIFIC COURSE				**Year: III**	**Semester: V**	
Subject: Physics						
Course Title & Code	**Credits**	**Credit distribution of the course**			**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**	**Practical**		
DSC A5: Modern Physics	4	3	0	1	As per the university ordinance	As per the university ordinance

Course Outcomes:

1. **Study of different atomic models.**
2. **Study of optical spectra, X- rays and LASERS.**
3. **Study of structure of atomic nucleus**
4. **X-rays: their production and spectra: continuous and characteristic X-rays, Moseley Law.**
5. **Lasers and their working principle, spontaneous and stimulated emissions and absorption.**
6. **Einstein's A and B coefficients, Metastable states, components of a laser and lasing action in He-Ne lasers and free electron laser.**

Theory Component

Unit	**Topic**	**No. of Lectures**
Unit I	**Atomic Models :** Thomson model, Rutherford model, Bohr model and spectra of hydrogen atom, Fine structure, Bohr Magnetron, Larmor‟s precession, Somerfield model, Stern-Gerlach experiment, Vector atomic model, Space Quantization and Spinning of an electron.	**08**
Unit II	**Optical Spectra and X-rays :** Optical spectra, Spectral notations, L-S, J-J coupling, Selection rules and intensity rules, Explanation of fine structure of Sodium D line, Zeeman effect, X-ray spectra(characteristics and continuous), Moseley‟s law.	**07**
Unit III	**Theory of Lasers : Einstein A and B coefficients, Spatial and Temporal coherence, Optical pumping, Population inversion, Laser action, Basic idea of LASER and MASER, Ruby Laser and He-Ne laser, Some applications.**	**10**
Unit IV	**Molecular Spectroscopy : Franck-Condon Principle, Molecular spectra, Rotational, Vibration and Electronic spectra of diatomic molecules, General features of electronic spectra, Luminescence, Basics of Raman effect.**	**10**

Unit V	**Subatomic Physics** **Structure of atomic nucleus, nuclear properties (charge, mass, spin, shape), nuclear binding energy, liquid drop model and semi-empirical mass formula**	**10**

Suggested Reading

1. H.S. Mani and Mehta : Introduction to Modern Physics
2. A. Beiser : Perspective of Modern Physics
3. Ahmad and Lal, : Modern Physics
4. B.V.N. Rao : Modern Physics
5. R. Murugeshan : Modern Physics
6. S.N. Ghosal : Nuclear Physics
7. C. B. Banwell : Fundamentals of Molecular Spectroscopy

Suggested Online Link:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Practical Component

1. Absorption coefficient of a liquid with the help of voltaic cell.
2. Frank-Hertz Experiment.
3. To verify Malus law using MASER and LASER.
4. Stern-Gerlach experiment.
5. To determine the wavelength and angular spread of He-Ne laser
6. Determination of Ionization Potential using thyratron valve.
7. To determine the value of electronic change by Millikan's method.

Suggested Readings:

1. B.L. Worsnop, H.T. Flint, “Advanced Practical Physics for Students”, Methuen & Co., Ltd.,London, 1962.
2. S. Panigrahi, B. Mallick, “Engineering Practical Physics”, Cengage Learning India Pvt. Ltd.,2015.
3. Indu Prakash: Practical Physics
4. S.L. Gupta, V. Kumar, “Practical Physics”, Pragati Prakashan, Meerut, 2014.

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DISCIPLINE SPECIFIC ELECTIVE (DSE A3)						
Programme: DISCIPLINE SPECIFIC ELECTIVE					**Year: III**	**Semester: V**
Course Title & Code	**Credits**	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		

DSE A3: Basic Quantum Mechanics	4	3	0	1	As per the university ordinance	As per the university ordinance

Course Outcomes:

1. Main aspects of the inadequacies of classical mechanics as well as understanding of the historical development of quantum mechanics.
2. Heisenberg's Uncertainty principle and its applications, photoelectric effect and Compton scattering.
3. The Schrodinger equation in 1-dimension, wave function, probability and probability, current densities, normalization
4. Particle in a box problem, energy levels.

Theory Component

Unit	Topic	No. of Lectures
Unit I	**Origin of Quantum theory:** Origin of quantum theory, limitation of Classical Physics, Black body Radiation, Planck's radiation law and Einstein's explanation, The photo electric effect and Einstein correction, Compton effect.	**10**
Unit II	**Wave-Particle Duality:** De Broglie's Hypothesis, Wave-Particle Duality, Davisson-Germer Experiment, G.P Thomson experiment, Taylor's experiment, Wave description of Particles by Wave Packets, Group and Phase Velocities, Principle of Complimentarity, Heisenberg Uncertainty principle, Gamma ray microscope, Single slit experiment.	**10**
Unit III	**Formalism of Quantum mechanics:** Linear vector space, Linear Operator, Definition of position, momentum , Energy and Angular momentum operator, Eigen value and Eigen functions, Hermitian operators, Postulates and basic theorems of Quantum mechanics, Operator method for solving Eigen values problem, Energy of Harmonic oscillator.	**10**
Unit IV	**Schrödinger equation – The first law of Quantum Mechanics :** Origin of non relativistic Quantum Mechanics, Overview of wave mechanics, Simple one dimensional quantum system Oscillator, Time independent and time dependent one dimensional Schrödinger equation, Steady state solutions, Physical interpretation of wave functions, probability current density, Ehrenfest's theorem, Particle in a box, Idea of Tunneling	**15**

Suggested Reading

1. L.I. Schiff, "Quantum Mechanics" (McGraw Hill Book Co.)
2. Chris J. Isham, "Lectures on Quantum Theory" (Allied Publisher)
3. B.S. Rajput , "Advanced Quantum Mechanics" (Pragati Prakashan)
4. Ghatak and Lokanathan , "Quantum Mechanics" (Macmillan Pub.)
5. Mathew and Venkatesan , "Quantum Mechanics"(Tata McGraw-Hill)

Practical Component

1. Determination of Rydberg's constant.
2. Determination of 'h' Planck's constant by Photoelectric effect.
3. 'e/m' by Thomson method.
4. 'e/m' Magnetron method.
5. 'e/m' Helical method
6. To determine the Planck's constant using LEDs of at least 4 different colours.

Suggested Readings:

1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd.,London, 1962.
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd.,2015.
3. Indu Prakash: Practical Physics
4. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014.

Suggestive Digital Platforms / Web Links:

1. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=74
2. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists byindividual Universities

GENERAL ELECTIVE (GE P5)						
Programme: **General Elective**					**Year: III**	**Semester: V**
Course Title & Code	**Credits**	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
GE P5: Basics of Heat Transfer	4	3	1	0	As per University Ordinance	As per University Ordinance

Course Outcome:

1. To understand the of Heat Transfer processes.
2. Thermal radiation, Kirchoff's Laws, Derivation of Stefan Boltzmann law, and Wein's displacement law.
3. To understand the black body radiation and related laws.

Unit	**Topic**	**No. of Lectures**
Unit I	**Conduction :** Modes of heat transfer via Conduction: Fourier's law, One dimensional steady state conduction, Heat conduction through plane and composite walls, Cylinders and spheres, Electrical analogy, Thermal conductivity and its experimental detection.	**10**
Unit II	**Convection**: Modes of heat transfer via Convection : Newton's law of cooling Dimensional analysis applied to forced and free convection, Dimensionless numbers and their physical significance.	**10**
Unit III	**Thermal Radiation**: Physical quantities associated with Radiation, Black body, Radiation from non-black-bodies, Thermodynamics of radiations inside a hollow enclosure, Kirchoff's Laws, Derivation of Stefan Boltzmann Law, Wein's displacement law.	**15**
Unit IV	**Black Body Radiation:** Black body spectrum formula- early attempts, Raleigh Jean's Law, Quantum theory of Radiation, Planck's formula for black body spectrum, Wien's law, Radiation as a photon gas.	**10**

Suggested Reading:

1. S. Loknathan, “Thermodynamics, Heat and Statistical Physics” (Prentice Hall India)
2. Sharma and K.K. Sarkar “Thermodynamics, and Statistical Physics” (Himalaya Pub.)
3. Brijlal and Subrahmanyam, “Heat and Thermodynamics”(S Chand)
4. Saha and Srivastav “Treatise on heats”, (The Indian Press Publications)

Suggested Online Link:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

SKILL ENHANCEMENT COURSE (SEC P5)						
Programme: **Skill Enhancement Course**				**Year: III**	**Semester: V**	
Course Title & Code	**Credits**	**Credit distribution of the course**			**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture/Theory	**Tutorial**	**Hands-on Training**		
SEC P5: Advanced Instrumentation and Measurement Techniques -I	2	1	0	2	As per University Ordinance	As per University Ordinance

Course Outcome:

1. To understand the Impedance Bridges.
2. To understand the Principle and uses of electronic voltmeter.

Unit	Topic (Theory and hands on practice)	No. of Lectures
Unit I	**Multimeter:** Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. Advantage over conventional multimeter for voltage measurement with respectto input impedance and sensitivity.	**15**
Unit II	**Digital Multimeter:** Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/frequency counter, time-base stability, accuracy and resolution.	**15**

Suggested Reading

1. B L Theraja : A text book in Electrical Technology
2. M G Say : Performance and design of AC machines
3. S. Salivahanan& N. S.Kumar : Electronic Devices and Circuits, , 3rd Edn
4. Shashi Bhushan Sinha, Handbook of Repair and Maintenance of Domestic Electronics Appliances hand book.
5. M. Lotia, Modern Basic Electrical & House Wiring Servicing

OR

SKILL ENHANCEMENT COURSE (SEC P5)						
Programme: **Skill Enhancement Course**				**Year: III**	**Semester: V**	
Course Title & Code	**Credits**	**Credit distribution of the course**			**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture/Theory	**Tutorial**	**Hands-on Training**		
SEC P5 Electrical circuit network Skills - I	2	1	0	2	As per University Ordinance	As per University Ordinance

Course Outcome:

1. To understand the Impedance Bridges.
2. To understand the Principle and uses of electronic voltmeter.

Unit	Topic (Theory and hands on practice)	No. of Lectures
Unit I	**Electrical Circuit Fundamentals and Series Circuits:** Zero Reference level, Chassis Ground, Ohm's Law, Graphical representation of Ohm's Law, Linear and Non-linear resistor, Cells in series in electrical circuits, Resistances in series circuit, Characteristics, Case of zero IR drop, Polarity of IR drops, Total Power, Series Aiding and series opposing voltages, Proportional voltage formula in series circuits, Series Voltage dividers, opens and Shorts in a series circuit.	**15**
Unit II	**Parallel Electrical circuits:** Cells in parallel in electrical circuits, Parallel resistive circuits, Laws of parallel circuits, Special case of equal resistances in all branches and only two branches, Any branch resistance, Proportional current formula, opens and shorts in a parallel circuit.	15

Suggested Reading

1. B L Theraja : A text book in Electrical Technology
2. B L Theraja : A text book in Basic Electronics
3. M G Say : Performance and design of AC machines
4. S. Salivahanan& N. S.Kumar : Electronic Devices and Circuits, , 3rd Edn
5. Shashi Bhushan Sinha, Handbook of Repair and Maintenance of Domestic Electronics Appliances hand book.
6. M. Lotia, Modern Basic Electrical & House Wiring Servicing

SEMESTER VI

BACHELOR IN SCIENCE

DISCIPLINE SPECIFIC COURSE (DSC A6)		
Programme: DISCIPLINE SPECIFIC COURSE	**Year: III**	**Semester: VI**
Subject: Physics		

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
DSC A6: Electronics	4	3	0	1	As per the university ordinance	As per the university ordinance

Course Outcomes:

1. Study of different Network Theorems for simplifying complicated electronics circuits.
2. Study of Regulated Power Supply. Understand different types of Rectifiers, Filters and Voltage Regulator.
3. Study of different types of special diodes and their applications
4. Study of Bipolar Junction Transistors.
5. Study of Field Effect Transistor

Theory Component

Unit	Topic	No. of Lectures
Unit I	**Network Theorems and Power Supplies:** Superposition Theorem, Thevenin's Theorem, Norton‟s Theorem, Maximum power transfer theorem, Semiconductor diode: P-N Junction diode, Diode as a: Half and Full wave rectifiers, Bridge rectifiers, Efficiency, Ripple factor, Filters: Low pass and High pass filters, Band pass and Band stop filters, L and π – filters, Zener diode, its characteristics,Voltage regulation	**10**
Unit II	**Solid State Devices :** Tunnel diode, Varactor diode, V-I characteristic of these diodes, Optoelectronic devices: Light emitting diode, Photodiode, Bipolar junction transistor, Transistor operation and its Biasing rule, Transistor currents, Transistor circuit configuration (CB, CE, and CC configuration), Transistor characteristics in different configuration, cut-off and saturation points, Active region, Relation between transistor current in various configuration, General idea of FETs	**10**
Unit III	**Amplifiers :** Single-stage transistor amplifiers, Common base (CB) amplifier, Common emitter (CE) amplifier, Common collector (CC) amplifier, Amplifier based on biasing condition, Power amplifiers, Noise and Distortion in amplifiers, RC- coupled two stage amplifier and its frequency response, Feedback amplifiers, positive and negative feedback, Advantage of negative feedback.	**10**
Unit IV	**Oscillators :** Classification of oscillators, Frequency of oscillating current, Frequency stability of an oscillator, Essential of a feedback LC oscillator, Tuned base oscillator, Tuned collector oscillator, Hartley oscillator, Colpitt oscillator, Clapp oscillator, Tunnel diode oscillator, Crystal oscillator, Phase shift oscillator, Wien Bridge oscillator, Relaxation oscillator, Multivibrators (Astable, monostable and bistable).	**08**

Unit V	**Digital Electronics:** Number systems, Decimal, Binary, Octal and Hexadecimal number systems, Binary to decimal conversion, Boolean algebra, Laws of Boolean algebra, De Morgan's theorems, Logic gates, OR gate, Exclusive OR gates, AND gate, NOT gate, NOR gate, NAND gate, NAND and NOR as universal gates, XNOR gate, Half Adder, Full adder, Half subtractor and Full subtractor.	**07**

Suggested Reading

1. M.K. Baagde, S.P. Singh and Kamal Singh : Elements of Electronics
2. B.L. Theraja : Basic Electronics
3. V.K. Mehta : Elements of Electronics
4. J.D. Ryder : Networks, Lines and Fields
5. J.D. Ryder : Electronic Fundamentals and Applications.
6. Millman and Halkias : Integrated Electronics

Suggested Online Link:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

Practical Component

1. To study the characteristics of integrating and differentiating circuit.
2. To draw the characteristics of P-N junction diode.
3. To draw the characteristics of PNP and NPN junction transistor.
4. Measurements of h-parameters of a transistor.
5. Study of different types of Rectifiers and Filters.
6. Verification of Network theorems.
7. Child Langmuir law.
8. Triode/ Tetrode/ Pentode characteristics and constants.
9. Study of power supply (Ripple factor).
10. Study of Zener diode and regulation (taking different source voltage andloads).
11. To study the Characteristics of a Photo-diode.

Suggested Readings:

1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd.,London, 1962.
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd.,2015.
3. Indu Prakash: Practical Physics
4. S.L. Gupta, V. Kumar, "Practical Physics", Pragati Prakashan, Meerut, 2014.

Suggestive Digital Platforms / Web Links:

1. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=74
2. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by

individual Universities

DISCIPLINE SPECIFIC ELECTIVE (DSE A4)						
Programme: Discipline Specific Elective				**Year: III**	**Semester: VI**	
Subject: Physics						
Course Title & Code	**Credits**	**Credit distribution of the course**			**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**	**Practical**		
DSE A4: Special Theory of Relativity	4	3	0	1	As per the university ordinance	As per the university ordinance

Course Outcome:

1. To understand the special theory of relativity
2. Lorentz Transformations and its Consequences
3. To understand the Maxwell's equations and their physical significance
4. To understand about the four vector and four vector formulation of current and continuity equation

Theory Component

Unit	Topic	No. of Lectures
Unit I	**Foundation of Special theory of Relativity :** Frames of reference, Galilean transformations, Ether hypothesis, Failure of Michelson-Morley experiment, Postulates of Special theory of relativity, Lorentz transformations.	**10**
Unit II	**Consequences of Lorentz Transformations :** Length contraction, Time dilation, Velocity transformations and Law of velocity addition, Variation of mass with velocity, Relativistic energy and mass energy equivalence, Concept of four vector, Examples of position and momentum four vectors.	**10**
Unit III	**Electromagnetic waves :** Maxwell's equations in differential and integral forms, Electromagnetic energy and Poynting theorem , Wave equations, Plane electromagnetic waves in free space, Maxwell's equations for isotropic, nonisotropic and dielectric medium, Plane Electromagnetic wave in Conducting and non-conducting (dielectric) medium.	**15**
Unit IV	**Relativity of Electromagnetism :** Notations for Four- vectors, space and light like separations, Energy-Momentum Four Vector, Four vector potential, electromagnetic field tensor, Lorentz invariance, Lorentz force, covariant form of Maxwell's equations, four vector formulation of current and continuity equation.	**10**

Suggested Reading

1. H.S. Mani and Mehta, Introduction to Modern Physics , (Allied East West Press)
2. A. Beiser , Perspective of Modern Physics, , (Tata McGraw Hill)
3. Ahmad and Lal, Modern Physics (S. Chand and Co.)
4. B.V.N. Rao, Modern Physics (New Age International)
5. B.B.Laud Electromagnetics (Wiley Eastern limited)
6. Berkely Physics course, Vol II "Electricity and Magnetism" (McGraw Hill.)
7. A. S. Mahajan and A. Rangwala "Electricity and Magnetism" (Tata McGraw Hill.)

Practical Component

1. Speed of light in air.
2. To verify the Cauchy's dispersion formula.
3. Determination of wavelength using grating and spectrometer.
4. Measurement of wavelength difference of Na using Michelson Interferometer.
5. Measurement of thickness of mica sheet using Michelson Interferometer.
6. To demonstrate interference & Doppler effect in waves.

Suggested Reading:

1. Worsnop, B. L., Flint, H. T., "Advanced Practical Physics for Students", Methuen & Co., Ltd.,London
2. Panigrahi, S., Mallick, B. "Engineering Practical Physics", Cengage Learning India Pvt. Ltd.,
3. Gupta and Kumar, Practical Physics, Pragati Prakashan
4. Srivastava, Anchal , and Shukla, R. K., New Age International (P) Ltd

DISCIPLINE SPECIFIC ELECTIVE (DSE A5)						
Programme: Discipline Specific Elective				**Year: III**	**Semester: VI**	
Subject: Physics						
Course Title & Code	**Credits**	**Credit distribution of the course**			**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**	**Practical**		
DSE A5: Research Methodology in Physics	4	3	0	1	As per the university ordinance	As per the university ordinance

Course Outcome:

1. Analyze uncertainties in measurements, probability distributions and error analysis Lorentz Transformations and its Consequences
2. Determine the appropriate research theory for problem
3. Evaluate data collection from proper method
4. Examine data by statistical approach
5. Justify the hypothesis and conclude the limitation of it

Theory Component

Unit	Topic	No. of Lectures
Unit I	**UNCERTAINTIES IN MEASUREMENTS, PROBABILITY DISTRIBUTIONS, ERROR ANALYSIS:** Uncertainties in Measurements: Measuring Errors, accuracy and Precision, systematic errors, Random errors, Significant figures and Round off, Uncertainties, Parent and Sample Distributions, Mean, median and mode, Standard Deviation of Distributions. Probability Distributions: Binomial Distributions, Poisson distribution, Gaussian or Normal Error Distribution,. Selected problems and examples. Error Analysis: Instrumental and Statistical Uncertainties, Propagation of Errors, Specific Error Formulas with examples, Application of Error Equations. Numerical Errors, Conditioning and Stability, Convergence of Iterative Processes.	**10**
Unit II	**DATA ANALYSIS:** Processing and Analysis of Data: Processing Operations, Some Problems in Processing. Elements/Types of Analysis: Statistics in Research, Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry (Skewness), Simple Regression Analysis, Multiple Correlation and Regression, Partial Correlation, Association in Case of Attributes.	**10**

Unit III	**HYPOTHESES:** Testing of Hypotheses-I (Parametric or Standard Tests of Hypotheses): Basic Concepts Concerning Hypothesis and Testing of Hypotheses, Procedure for Hypothesis Testing, Flow Diagram for Hypothesis Testing, Measuring the Power of a Hypothesis Test, Tests of Hypotheses. Important Parametric Tests, Hypothesis Testing of Means, Hypothesis Testing for Differences between Means, Hypothesis Testing for Comparing Two Related Samples. Hypothesis Testing of Correlation Coefficients, Limitations of the Tests of Hypotheses.	**15**
Unit IV	**Instrumentation in Physics:** Analog and Digital CRO, Function Generator, Spectrophotometer, LASER, FTIR, Gamma Ray Spectrometer, GM Counter, Scanning Electron Microscope, Transmission Electron Microscope, Raman Spectrometer, X-Ray Diffractometer, Vibrating Sample Magnetometer. Telescopes: Astronomical Telescopes, Charge Coupled Devices (CCD).	**10**

Practical Component

1. To count radiations by GM counter.
2. Study of anlog CRO.
3. Study of digital storage oscilloscope (DSO).
4. To measure the absorption spectra using spectrophotometer.
5. To measure the distribution of gamma radiation by Gamma Ray Spectrometer.
6. To measure the wavelength of He-Ne LASER.
7. To measure the emission/excitation spectra using spectrfluorometer.
8. X-ray diffraction analysis of some selected samples.

BOOKS RECOMMENDED:

1. Research Methods the Basics by Nicholas Walliaman, Taylor and Francis London& New York 2011.
2. Research Methodology- Methods and Techniques 2nd edition. By C R Kothari, New Age Int. Publ. 2004.
3. Data Reduction and Error Analysis for the Physical Sciences 3rd Ed by Philip R Bevington & D Keith Robinson, McGraw – Hill (2003)
4. Numerical Methods by Balagurusamy, Tata McGraw – Hill (2000)
5. Numerical Analysis, 2nd Ed. by Francis Scheid, McGraw-Hill (2009)
6. Numerical mathematical Analysis, James B Scarboroughs
7. Numerical Methods for Scientists and Engineers, K Sankara Rao, 3rd Ed. PHI

GENERAL ELECTIVE (GE P6)						
Programme: **General Elective**					**Year: III**	**Semester: VI**
Course Title & Code	**Credits**	**Credit distribution of the course**			**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**	**Practical**		
GE P6: Basics of Digital electronics	4	3	1	0	As per University Ordinance	As per University Ordinance

Course outcome:

1. To understand the different number systems
2. To understand the concept of Boolean algebra
3. Different type of Logic gates
4. To understand the different combination circuits

Unit	Topic	No. of Lectures
Unit I	**Number System**: Number systems, Decimal, Binary, Octal and Hexadecimal number systems, Binary to decimal conversion, Double-Dadd method, Binary operations, Binary addition, Binary subtravtion, Complement of a number (1"s complement and 2"s complement), Binary divison, Representation of a Binary number as electrical signals, Conversion of Binary to octal, Binary to hexadecimal and vice-versa (Inter-conversion).	**15**
Unit II	**Boolean Algebra:** BCD, GREY, EXCESS-3 codes, Boolean algebra, Features of Boolean algebra, Laws of Boolean algebra, Equivalent switching circuit, De Morgan's theorems and Duals.	**10**
Unit III	**Logic Gates :** Positive and Negative logic, Two input OR gate, Diode OR gate and transistor OR gate, Three input OR gate and its truth table, Exclusive OR gates, The AND gate, Diode AND gate and transistor AND gate, The NOT gate, Bubbled gates, The NOR gate, The NAND gate, NAND and NOR as universal gates, The XNOR gate,	**10**
Unit IV	**Combinational Circuits:** Adders and subtractors, Half Adders, Full adders, Parallel binary adder, Half subtractor and Full subtractor.	**10**

Suggested Reading

1. M.K. Baagde, S.P.Singh and Kamal Singh ,Elements of Electronics ,(S. Chand and Co.)
2. B.L.Thereza, Basic Electronics, (S. Chand and Co.)
3. V.K.Mehta, Elements of Electronics, (S. Chand and Co.)
4. Brophy, Communication Electronics (McGraw-Hill Education)
5. R Boylested , Electronic Devices & Circuit theory (PHI)

Suggested Online Link:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

3. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

SKILL ENHANCEMENT COURSE (SEC P6)						
Programme: **Skill Enhancement Course**				**Year: III**	**Semester: VI**	
Course Title & Code	**Credits**	**Credit distribution of the course**			**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture/Theory	**Tutorial**	**Hands-on training**		
SEC P6 Advanced Instrumentation and Measurement Techniques-II	2	1	0	2	As per University Ordinance	As per University Ordinance

Course Outcomes:

To understand the function of analog and digital Multimeter.

Unit	Topic	No. of Lectures
Unit I	**Cathode Ray Oscilloscope:** Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only–no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance. Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.	**15**
Unit II	**Signal and pulse Generators** Block diagram, explanation and specifications of low frequency signal generator and pulse generator. Brief idea for testing, specifications. Distortion factor meter,wave analysis.	**15**

Suggested Reading

1. B L Theraja : A text book in Electrical Technology
2. M G Say : Performance and design of AC machines
3. S. Salivahanan& N. S.Kumar : Electronic Devices and Circuits, , 3rd Edn
4. Shashi Bhushan Sinha, Handbook of Repair and Maintenance of Domestic Electronics Appliances hand book.
5. M. Lotia, Modern Basic Electrical & House Wiring Servicing

OR

SKILL ENHANCEMENT COURSE (SEC P6)						
Programme: **Skill Enhancement Course**				**Year: III**	**Semester: VI**	
Course Title & Code	**Credits**	**Credit distribution of the course**			**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture/Theory	**Tutorial**	**Hands-on training**		
SEC P6: Electrical circuit network Skills - II	2	1	0	2	As per University Ordinance	As per University Ordinance

Course Outcomes:

To understand the types of electrical circuits and method of making different types of electrical circuits.

Unit	Topic	No. of Lectures
Unit I	**Series-Parallel electrical circuits and Kirchhoff's:** Series –parallel circuits, Analysing series-parallel circuits, Opens and Shorts in series-parallel circuits, Voltage division in a complex Series-Parallel circuits. Kirchhoff's laws: Kirchhoff's current law, Kirchhoff's voltage law, Determination of Algebraic sign, Assumed direction of current flow, Solving circuit problems using Kirchhoff's laws.	**`15**
Unit II	**Network Theorems:** Concept of electrical Network, Different types of Network Theorems: Superposition Theorem, Application of superposition theorem for solving electrical network problems, Thevenin's Theorem, Procedure for Thevenizing an electrical circuit, Application of Thevenin's theorem, Norton's Theorem, Procedure to Nortonise an electrical circuit, Application of Norton's theorem, Maximum Power Transfer Theorem.	**15**

Suggested Reading

1. B L Theraja : A text book in Electrical Technology
2. B L Theraja : A text book in Basic Electronics
3. M G Say : Performance and design of AC machines
4. S. Salivahanan& N. S.Kumar : Electronic Devices and Circuits, , 3rd Edn
5. Shashi Bhushan Sinha, Handbook of Repair and Maintenance of Domestic Electronics Appliances hand book.
6. M. Lotia, Modern Basic Electrical & House Wiring Servicing

MASTER OF SCIENCE IN PHYSICS

M. Sc. (Physics)

SYLLABUS FRAMED AS PER THE

NATIONAL EDUCATION POLICY-2024

Programme Outcomes (POs):

Students having Degree in Master of Science should have knowledge of advancedconcepts of Physics and ability to apply this knowledge in various fields of academics, researchand industry. They may pursue their future career in the field of academics, research and industry.

PO1	Competence in the methods and techniques of calculations using Mathematical Physics, Classical Mechanics, Quantum Mechanics and Communication Electronics. It will develope an analytical skill on an advanced level and will enable the student to have mathematical tools to solve complex problems of Physics. The Programme will motivate the student to know more about the matter, the universe and the recent developments in the field of science. The student will have adequate knowledge to work for the industry,, consultancy, education, and research
PO2	The students would gain substantial knowledge in various branches of physics. The programme will enable the student to explore more in the field of his/her choice like Advanced Electronics, Spectroscopy, Astrophysics and High energy Physics. The student will be well equipped with the knowledge required for different organizations, industry, R& D sector.

Programme specific outcomes (PSOs)

PG I YEAR/ Major in Physics

Major in Physics 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 organisation.

Programme specific outcomes (PSOs):

PG II YEAR/ Master in Physics

- The Master of Science 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.
- This course would enable the student to acquire scientific skills and the practical knowledge by performing experiments in general physics and electronics.
- The student would also get some research oriented experience by doing theoretical and experimental projects in the last semester under the supervision of faculty.
- The course as a whole opens up several career doors for the students interested in various areas of science and technology in private, public and government sectors. Students may get job opportunities in higher education, research organizations, physics consultancy and many others. Some of the institutions where physics students can start their career are: BARC, DRDO, NPTC, IISc, ISRO, ONGC, BHEL, PRL, NPL, SINP, VECC, IITs, NITs, IIPR etc.

DETAILED SYLLABUS FOR

MAJOR IN PHYSICS
P.G. FIRST YEAR

Semester: VII
MAJOR IN PHYSICS

DISCIPLINE SPECIFIC COURSE (DSC A7)					
Programme: DISCIPLINE SPECIFIC COURSE			**Year: IV**	**Semester: VII**	
Subject: Physics					
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSC A7: Mathematical Physics	3	3	0	B.Sc. with Physics	B.Sc. with Physics

Course Outcomes

Students would be able to understand the mathematical methods essential for solving the advanced problems in physics. It would be helpful in the development of the ability to apply the mathematical concepts and techniques to solve the problems in theoretical and experimental physics. The knowledge of mathematical physics would be beneficial in further research and development as it serves as a tool in almost every branch of science and engineering Course.

UNIT	TOPIC	No. of Lectures
UNIT I	Special Functions Series solution of differential equations, Legendre, Bessel, Hermite, and Laguerre differential equation and related polynomial, physical integral form of polynomials and their orthogonality relations. Generating Function and recurrence relation.	**10**
UNIT II	Curvilinear Coordinates and Tensors Curvilinear Coordinates and various operators in circular, cylindrical and spherical coordinate systems, classification of Tensors, Rank of a Tensor, covariant and contra-variant tensors, symmetric and anti-symmetric Tensors, Kronecker delta symbol. Contraction of Tensor, metric Tensor and Tensor densities, covariant differentiation and Geodesic equation (variational Method).	**10**

UNIT III	Complex Variables Function of complex variable, Cauchy's Riemann differential equation, Cauchy's integral theorem, residues and Cauchy's residues theorem, singularities, evolution of residues and definite integral.	**10**
UNIT IV	Integral Transforms Fourier integral and Fourier Transform, Fourier integral theorem, finite and infinite integral, Laplace transform of elementary function (Dirac delta & Green's function), Solution of simple differential equations.	**15**

Suggested Readings:

1. B. S. Rajput: Mathematical Physics (Pragati Prakashan, Meerut)
2. L. I.Pipes: Mathematical Physics (McGraw Hill)
3. P. K. Chattopadhyay: Mathematical Physics (Wiley Eastern, NewDelhi)
4. Afriken.: Mathematical methods for Physics
5. Harper Charlie: Introduction to Mathematical Physics
6. Mathews and Walker: Mathematical Methods of Physics (Benjaminpress)
7. Horse and Feshbach : Methods of Theoretical Physics (McGraw Hill)

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A5)

Programme: Discipline Specific Elective	**Year: IV**	**Semester: VII**
Subject: Physics		

Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A5: Research Methodology in Physics	3	3	0	B.Sc. with Physics	B.Sc. with Physics

Course Outcome:

6. Analyze uncertainties in measurements, probability distributions and error analysis Lorentz Transformations and its Consequences
7. Determine the appropriate research theory for problem
8. Evaluate data collection from proper method
9. Examine data by statistical approach
10. Justify the hypothesis and conclude the limitation of it

Theory Component

Unit	**Topic**	**No. of Lectures**
Unit I	**UNCERTAINTIES IN MEASUREMENTS, PROBABILITY DISTRIBUTIONS, ERROR ANALYSIS:** Uncertainties in Measurements: Measuring Errors, accuracy and Precision, systematic errors, Random errors, Significant figures and Round off, Uncertainties, Parent and Sample Distributions, Mean, median and mode, Standard Deviation of Distributions. Probability Distributions: Binomial Distributions, Poisson distribution, Gaussian or Normal Error Distribution,. Selected problems and examples. Error Analysis: Instrumental and Statistical Uncertainties, Propagation of Errors, Specific Error Formulas with examples, Application of Error Equations. Numerical Errors, Conditioning and Stability, Convergence of Iterative Processes.	**10**
Unit II	**DATA ANALYSIS:** Processing and Analysis of Data: Processing Operations, Some Problems in Processing. Elements/Types of Analysis: Statistics in Research, Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry (Skewness), Simple Regression Analysis, Multiple Correlation and Regression, Partial Correlation, Association in Case of Attributes.	**10**

Unit III	**HYPOTHESES:** Testing of Hypotheses-I (Parametric or Standard Tests of Hypotheses): Basic Concepts Concerning Hypothesis and Testing of Hypotheses, Procedure for Hypothesis Testing, Flow Diagram for Hypothesis Testing, Measuring the Power of a Hypothesis Test, Tests of Hypotheses. Important Parametric Tests, Hypothesis Testing of Means, Hypothesis Testing for Differences between Means, Hypothesis Testing for Comparing Two Related Samples. Hypothesis Testing of Correlation Coefficients, Limitations of the Tests of Hypotheses.	**15**
Unit IV	**Instrumentation in Physics:** Analog and Digital CRO, Function Generator, Spectrophotometer, LASER, FTIR, Gamma Ray Spectrometer, GM Counter, Scanning Electron Microscope, Transmission Electron Microscope, Raman Spectrometer, X-Ray Diffractometer, Vibrating Sample Magnetometer. Telescopes: Astronomical Telescopes, Charge Coupled Devices (CCD).	**10**

BOOKS RECOMMENDED:

8. Research Methods the Basics by Nicholas Walliaman, Taylor and Francis London& New York 2011.
9. Research Methodology- Methods and Techniques 2nd edition. By C R Kothari, New Age Int. Publ. 2004.
10. Data Reduction and Error Analysis for the Physical Sciences 3rd Ed by Philip R Bevington & D Keith Robinson, McGraw – Hill (2003)
11. Numerical Methods by Balagurusamy, Tata McGraw – Hill (2000)
12. Numerical Analysis, 2nd Ed. by Francis Scheid, McGraw-Hill (2009)
13. Numerical mathematical Analysis, James B Scarboroughs
14. Numerical Methods for Scientists and Engineers, K Sankara Rao, 3rd Ed. PHI

DISCIPLINE SPECIFIC ELECTIVE (DSE A6)					
Programme: Discipline Specific Elective			**Year: IV**	**Semester: VII**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A6: Classical Mechanics	3	3	0	B.Sc. with Physics	B.Sc. with Physics

Course Outcomes:

In this course students would learn to apply the Newtonian laws using various mathematical formulations to describe the motions of macroscopic objects using generalized coordinates, momentum, forces and energy. The classical mechanics would
be helpful in understanding of advanced branches of modern physics.

UNIT	TOPIC	No. of Lectures
UNIT I	Mechanics of a System of Particles Constraints and generalized coordinates, D Alembert's principle, Lagrange equations for holonomic and non holonomic systems and their applications, conservation laws of linear momentum, energy and angular momentum.	**10**
UNIT II	Hamiltonian Formulation and Hamilton Jacobi Theory Hamiltonian equations of motion and their physical significance, Hamilton's principle, principle of least action, canonical transformations Hamilton-Jacobi theory, Poisson brackets, properties of Poisson bracket, Poisson's Theorem, Lagrange bracket.	**15**
UNIT III	Dynamics of a Rigid Bodies Motion of a rigid body, body and space Reference system, angular momentum and Inertia tensor, Principle axes- Principle moments of Inertia, spinning tops, Euler angles, Infinitesimal rotations.	**10**
UNIT IV	Central Force Problem Action and angle variables, phase integral, small oscillations, Kepler's laws of Planetary motion and their deduction, scattering in a Central field, Rutherford scattering cross section	**10**

Suggested Readings:

7. H. Goldstein : Classical Mechanics
8. N.C. Rana & P. S. Jog : Classical Mechanics
9. Landau and Lifshitz : Mechanics, Pergamon Sommerfeld : Mechanics,Academic Press
10. Whittaker : Analytical Dynamics of Particles and Rigid Bodies -Cambridge
11. Raychaudhuri : Classical Mechanics, Oxford Bhatia : ClassicalMechanics, Narosa.
12. H.M. Agrawal: Classical Mechanics, New Age International

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL),

https://www.youtube.com/user/nptelhrd

3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A7)					
Programme: Discipline Specific Elective			**Year: IV**	**Semester: VII**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A7: Quantum Mechanics	3	3	0	B.Sc. with Physics	B.Sc. with Physics

Course Outcomes:

The course provides an understanding of the behaviour of the systems at microscopic (atomic and nuclear) scale and even smaller. Students would learn basic postulates and formulationsof quantum Mechanics. The course, in fact, plays an important role in explaining the behaviour of all physical systems in the universe. The course includes the study of a brief review of foundations of quantum mechanics, matrix formulation of quantum mechanics, symmetry in quantum mechanics and approximation methods for bound states.

UNIT	TOPIC	No. of Lectures
UNIT I	**Non-Relativistic Quantum Mechanics and Schrödinger Equation** Schrödinger's equation, Probability and current densities, continuity equation, physical interpretation of wave function, orthogonality of eigen functions, Principle of superposition, wave packet, normalization, Schrödinger's equation in three dimensions, centrally symmetric square well and harmonic potentials, harmonic oscillator and itswave functions, Hydrogen atom.	**15**
UNIT II	**Operator Formulation of Quantum Mechanics** State vectors and operators in Hilbert Space, Eigen values and Eigen vectors of an operator, Hermitian ,Unitary and Projection operators, commuting operators, BRA and KET Notations, Postulates of Quantum Mechanics, co-ordinate Momentum and Energy representations, dynamical behavior, Heisenberg, Schrödinger and interaction Pictures	**10**
UNIT III	**Theory of Angular Momentum** Orbital Angular momentum operator, its eigen value andeigen functions, space quantization, spin angular momentum, Pauli's theory of spin, Addition of angular momentum, ClebschGordan coefficients	**10**
UNIT IV	**Approximation Methods and Time independent Perturbation Theory** Stationary Perturbation, first and second order corrections, WKB approximation methods, connection formula and boundary	**10**

	conditions, Bohr Sommerfield quantization rule, Penetration of Potential Barrier, Time independent perturbation theory and anomalous Zeeman Effect, Variation Method and its application to the ground state of Helium atom and harmonic oscillator.	

Suggested Readings

1. B. S. Rajput: Advanced Quantum MechanicsSchiff: Quantum Mechanic
2. Thankppan: Quantum Mechanics
3. Loknathan and Ghatak Quantum Mechanics

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A8)						
Programme: Discipline Specific Elective			**Year: IV**	**Semester: VII**		
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**	
		Lecture	**Tutorial**			
DSE A8: Communication Electronics	3	3	0	B.Sc. with Physics	B.Sc. with Physics	

Course Outcomes

This course helps the student to gain basic ideas of the fundamentals of communication systems. The course includes Modulation AM and FM (Transmission and reception), SSB transmission, AM detection, AGC, Radio receiver characteristics, FM transmitter, Propagation of Radio Waves, Antenna, Fundamentals of image transmission,TV transmitter,Transmission Lines etc.The course may provide the opportunity to work in any organization related to communication.

UNIT	**TOPIC**	**No. of Lectures**
UNIT I	Modulation AM and FM (Transmission and reception): Modulation, AM generation, ower consideration, Balanced modulator, SSB transmission, AM detection, AGC, Radio receiver characteristics, signal to noise ratio, FM analysis, noise considerations, generation, direct method and reactance tubemethod, FM transmitter, AFC, FM Propagation, phase discriminator	**10**

UNIT II	Propagation of Radio Waves Ground wave, sky wave and space wave propagation. Ionosphere (Ecclr- larmer theory, magneto ionic theory.	**10**
UNIT III	Antenna and TV Antenna, HF antenna, Yagi antenna, loop antenna, Satellite communication, parabolic reflector, dish antenna, Fundamentals of image transmission, vestigial transmission, TV camera tubes, image orthicon, vidicon, TV transmitter, TV receiver and picture tubes.	**10**
UNIT IV	Transmission Lines Voltage and current relations on transmission line, propagation constant, characteristic impedance, impedance matching, quarter wave T/L as impedance transformer, attenuation along coaxial cable, cables of low attenuation, propagation of radio waves between two parallel lines, wave guide modes, TE10 mode and cut off wavelength, cavity resonator, light propagationin cylindrical wave guide, step index and graded index fibers, attenuation and dispersion in fibers	**15**

Suggested Readings:

1. George Kennedy & Davis: Electronics Communication Systems
2. Millar & Beasley: Modern Electronics Communication
3. R.R Gulani: Monochrome and colour television (Wiley Eastern Limited)
4. Taub and Schilling: Principle of Communication Systems (TMH)
5. Simon Gaykuti: Communication Systems (John Wiley & Sons Inc. 1994

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

GENERAL ELECTIVE (GE P7)					
Programme: General Elective			**Year: IV**	**Semester: VII**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
GE P7: Renewable Sources of Energy	3	3	1	B.Sc. with Physics	B.Sc. with Physics

Course Outcomes:

This course helps the student to gain basic ideas of the Renewable Sources of Energy. The course includes Fossil fuels and nuclear energy, Tidal Energy, Solar energy and its importance. The course may provide the opportunity to work in any organization related Renewable Sources of Energy.

Unit	**Topic**	**No. of Lectures**
Unit I	Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in wind Energy.	**15**
Unit II	Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.	**15**
Unit III	Solar energy and its importance, storage of solar energy, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems.	**15**
Unit IV	Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. Tide characteristics and Statistics: Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass	**15**

Suggested Reading

1. Non-conventional energy sources, B.H. Khan, McGraw Hill
2. Solar energy, Suhas P Sukhative, Tata McGraw - Hill Publishing Company Ltd.
3. RenewableEnergy,Powerforasustainablefuture,GodfreyBoyle,3rd Edn., 2012.
4. Renewable Energy Sources and Emerging Technologies, Kothari et.al., 2nd Edition, PHI Learning.
5. Solar Energy: Resource Assesment Handbook, P Jayakumar, 2009

GENERAL ELECTIVE (GE P8)					
Programme: General Elective			**Year: IV**	**Semester: VII**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
GE P8: Radiation Physics	3	3	1	B.Sc. with Physics	B.Sc. with Physics

Course Outcomes:

This course helps the student to gain basic ideas of the Radiation Physics. The course includes Interactions of electrons with matter, fission and fusion. The course may provide the opportunity to work in any organization related Radiation Physics.

Unit	Topic	No. of Lectures
Unit I	Interactions of electrons with matter - Specific energy loss, radiative mode of energy loss, electron range and transmission curves. Interaction of gamma rays with matter - Elastic scattering, photoelectric effect, Compton scattering.	**15**
Unit II	Klein-Nishina formula (qualitative) and pair production processes, cross section, gamma ray attenuation, linear and mass absorption coefficients. Radiation quantities and units - radiation exposure, absorbed dose, equivalent dose and effective dose.	**15**
Unit III	Sources of ionising radiations in the environment – terrestrial radiation sources and radionuclides, cosmic radiations and cosmogenic radionuclides. Technologically enhanced radiation sources. Artificial radiation sources artificial radionuclides. Production of radioisotopes using reactors. Application of radioisotopes in medicine, agriculture and industry.	` **15**
Unit IV	Fission chain reaction. Slowing down of neutrons - moderators. Conditions for controlled chain reactions in bare homogeneous thermal reactor, Effect of reflectors. Brief introduction of nuclear fuel cycle.	**15**

Suggested Reading:

1. Patel S B, „Nuclear Physics - An Introduction‟ (Wiley Eastern, 1991)
2. Krane K S, „Introductory Nuclear Physics‟ (John Wiley, 1988)
3. Roy R K and Nigam P P, „Nuclear Physics - Theory and Experiment‟ (Wiley Eastern Ltd., 1993)
4. Singru R M, „Experimental Nuclear Physics‟ (Wiley Eastern, 1972)
5. Zweifel P F, „Reactor Physics‟, International Student Edn. (McGraw Hill, 1973)
6. Kapoor S S and Ramamurthy V S, „Radiation Detectors‟ (Wiley Eastern, 1986)
7. Henry Semat& John R AlBright, „Introduction to Atomic and Nuclear Physics‟ V Edn. (Chapman & Hall, 1972).

PRACTICALS					
Programme: PRACTICALS			**Year: IV**	**Semester: VII**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Practicals	**Tutorial**		
Practicals	4	4		B.Sc. with Physics	B.Sc. with Physics

Course Outcomes:
Student would gain practical knowledge by performing various experiments of Electronicsand Optics.

	List of Experiments	**No. of Lectures**
	1. Study of RC circuit with an AC source using phase diagrams. 2. Absorption Spectrum of KMnO4 using Hilger-Nutting Photometer. 3. Young's modulus by Interference method. 4. NPN and PNP Transistor Characteristics with (a) Common base (b) 5. Common emitter configurations/ h – parameter. 6. Study of RC- coupled/ Transformer Coupled Amplifier. Study of B-H curve. 7. Study of Amplitude Modulation /Demodulation. Verification of the 8. Hartmann's Formula. 9. Frank-Hertz experiment.e/m by Zeeman effect. 10. Determination of susceptibility.Study of CRO. 11. Velocity of Ultrasonic waves.Linear Air track. 12. Leacher Wire **Practical Component of Research Methodology Lab** 13. To count radiations by GM counter. 14. Study of anlog CRO. 15. Study of digital storage oscilloscope (DSO). 16. To measure the absorption spectra using spectrophotometer. 17. To measure the distribution of gamma radiation by Gamma Ray Spectrometer. 18. To measure the wavelength of He-Ne LASER. 19. To measure the emission/excitation spectra using spectrfluorometer. 20. X-ray diffraction analysis of some selected samples.	**60**

Suggested Equivalent Online Courses:

Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=74

Semester: VIII
MAJOR IN PHYSICS

DISCIPLINE SPECIFIC COURSE (DSCA8)					
Programme: DISCIPLINE SPECIFIC COURSE			**Year: IV**	**Semester: VIII**	
Subject: Physics					
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSC A8: Electrodynamics	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

The study of electrodynamics provides basic foundation for the student to understand advance courses of physics. The course includes Basic equations of Electromagnetism, Electrostatics; Magnetostatics; Maxwell's equation, Four Vector Formalism of Maxwell's Equations Four vector potential, electromagnetic field tensor and Quantization of electromagnetic energy

UNIT	TOPIC	No. of Lectures
UNIT I	**Electromagnetism:** Basic equations; Electrostatics; Magnetostatics; Different Systems of Units, Preliminary notations, four- vectors,Lorentz transformations, time, space and light like separations, Lorentz invariants, Energy and Momentum.	**10**
UNIT II	**Maxwell's Equations:** Maxwell's equation, Displacement current, electromagnetic waves in conducting and nonconducting medium, Poynting theorem, boundary condition at the interface of conducting and non conducting media, propagation between parallel conducting plates. Electromagnetic wave equations	**10**
UNIT III	**Four Vector Formalism of Maxwell's Equations:** Four vector potential, electromagnetic field tensor, Lorentz invariance, Lorentz force, covariant form of Maxwell's equations, four vector current, continuity equation, Gauge invariance of Maxwell equation, electromagnetic energy- momentum tensor, Motion of charge particle in electromagnetic field, Lorentz force	**15**
UNIT IV	**Electromagnetic Radiation:** Lienard-Witchert potential, conventional potential, Quantization of electromagnetic energy (virtual photon), Radiation from an Accelerated Charge, Fields of an accelerated charge; angular and frequency distributions ofthe emitted radiation, special cases of acceleration parallel and perpendicular (circular orbit) to velocity; Larmor's formula and its relativistic Generalization; Bremstrahlung Cerenkov radiation	**10**

Suggested Readings

1. Jackson: Classical electrodynamics; Wiley Eastern, New Delhi
2. Landau and Lifshitz: Classical theory of fields; Pergameon Press
3. Thide : Electromagnetic field Theory
4. Panofsky and Phillips: Classical Electricity and Magnetism
5. Landau &Lifshitz : Electrodynamics of Continuous Medi

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A9)					
Programme: Discipline Specific Elective			**Year: IV**	**Semester: VIII**	
Course Title & Code	**Credits**	Credit distribution of the course		Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial		
DSE A9: Atomic and Molecular Spectra	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes

The course structure includes atomic and molecular spectroscopy. As per the course structure, the students learn basics concepts of spectroscopic principles and rules. Students would learn technique in spectroscopy and know about their applications. The course is helpful for the students to explore R & D opportunities in various areas of science and technology such as biomedical, industrial and environmental fields.

UNIT	**TOPIC**	**No. of Lectures**
UNIT I	Fine structure of hydrogen spectrum, L-S and J-J coupling, Spectroscopic terms, Hund's rule and time reversal, Pauli'sexclusion principle.	**10**
UNIT II	Alkali spectra, spin-orbit interaction and fine structure in alkali Spectra, Equivalent and non-equivalent electrons, Normal and anomalous Zeeman effect, Paschen Back effect, Stark effect, Hyperfine structure (qualitative).	**10**

UNIT III	Molecular spectra of diatomic molecules, Born Oppenheimer approximation, elementary idea of quantization of rotational and vibrational energy, rotational spectra for rigid and non rigid rotations, vibrational spectra (harmonic and an-harmonic), intensity and selection rules and molecular constants.	**10**
UNIT IV	Atomic Polarizability, Raman spectra, Quantum theory of Raman spectra, Determination of molecular structure, Electronic spectra, band system, Progression and sequences, band head formation, Condon parabola, Franck Condon Principle dissociation energy and its determination	**15**

Suggested Readings

1. C. B. Banwell: Fundamentals of Molecular Spectroscopy Walker and Stranghen: Spectroscopy Vol. I, II, III G.M.
2. Barrow: Introduction to Molecular Spectroscopy Herzberg: Spectra of diatomic molecules
3. Jeanne L Mchale: Molecular Spectroscopy
4. J. M. Brown: Molecular Spectroscopy
5. P. F. Bemath: Spectra of atoms and molecules
6. J. M. Holias: Modern Spectroscopy
7. K. Thyagrajan and A.K. Ghatak: Lasers: Theory and applicationsA Yariv: Quantum Electronic
8. M. D. Levenson: Intoduction to non-linear laser spectroscopy

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A10)					
Programme: Discipline Specific Elective			**Year: IV**	**Semester: VIII**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A10: Nuclear Physics	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

In this course students would know about the general properties of nuclei, nuclear forces and detectors, radioactive decay and nuclear reactions. The course builds a foundation for the students to carry out research in the field of nuclear physics, high energy physics, nuclear astrophysics, nuclear reactions and applied nuclear physics.

UNIT	TOPIC	No. of Lectures
UNIT I	Nuclear Properties and Nuclear Models Concepts of Atomic Nuclear-Size, Shape, charge distribution, spin & parity, magnetic moment; electric quadrupole moment; binding energy; semi-empirical mass formula, mirror nuclei, Liquid drop model, Experimental evidence for shell effects, Shell model, Magic numbers, Spin orbit coupling, Single particle shell model-its validity and limitations; collective model.	**10**
UNIT II	Nuclear Forces and Nuclear Interactions Theory of Deuteron and nuclear level properties, nucleon - nucleon interactions, low & high energy nucleon-nucleon scattering, Yukawa's Meson theory of nuclear forces, Spin dependence and charge independence of nuclear forces.	**10**
UNIT III	Nuclear Reactions Kinds of nuclear reactions; Conservation laws; Nuclear reaction Kinematics; charge particle reaction spectroscopy; neutron spectroscopy; nuclear cross-section; compound nucleus; Nuclear transmutations, continuum theory of nuclear reaction, Nuclear fission, Chain reactions, Nuclear fusion, Thermonuclear reactions.	**15**

UNIT IV	Nuclear Decays Basic understanding of α and β decay, Fermi theory of beta decay, selection rules in γ decay, Neutrino hypothesis, Parity violation in beta decay, K capture and internal conversion.	**10**

Suggested Readings

1. E. Burcham: Nuclear Physics Ervin Kapalan: Nuclear PhysicsRoy & Nigam: Nuclear Physics
2. S. N. Ghoshal: Atomic and Nuclear PhysicsA.Enge: Nuclear Physics
3. D. Evans: Nuclear Physics
4. E. Segre: Nuclei and Particles
5. H.M. Agrawal: Nuclear Physics, PHI Learning

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A11)					
Programme: Discipline Specific Elective			**Year: IV**	**Semester: VIII**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A11: Elementary Particle Physics	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes

The course is important for students to learn about the most fundamental building blocks of matter and radiation, the interaction among elementary particles, and hence, to understand their behaviour. It also provides a platform for students seeking research opportunities in high-energy physics.

UNIT	TOPIC	No. of Lectures
UNIT I	**Elementary Particles and Conservation Laws:** History of elementary particles, neutrinos:prediction, properties and role in particle physics, meson-muon riddle , classification schemes of elementary particles, Fundamental interactions among elementary particles: special emphasis on Strong and weak interactions, Strange particles, Resonances, Symmetries and conservation laws, Lepton and Baryon number., Isospin , Strangeness, Hypercharge, Gell - Mann Nishijima relation, Parity, Time reversal and charge conjugation, Parity violation, CP violation in K mesons, CPT invariance.	**10**
UNIT II	**Particle Models:** Fermi Yang model, Sakata model, shortcomings of these models, eight fold way scheme of hadrons: baryons and mesons multiplets, positive and negative aspects of eight fold way scheme, Necessity of Quark model, Gell - Mann Zweig Quark model and Quark structure of Hadrons, Positive facets of quark model, Elementary idea of charm, bottom and top quarks, Quantum number of quarks, Experimental evidence for the existence of quarks.	**10**
UNIT III	**Unitary Symmetries and Young Tableaux:** Symmetry , symmetry transformation and groups, basics of unitary groups, Special Unitary Groups, fundamental representation of SU(2) and SU(3), diagonal generators and weights, generators of SU(2), U(2), SU(3) and U(3), weight diagram of the fundamental representation of SU(2) and its physical interpretation, Weights of SU(3) and their physical interpretation, Weight diagrams of the fundamental and Conjugate representations of SU(3), I, U, V spins, Young Tableaux and unitary symmetry, standard arrangements of young tableaux, integer- notation	**15**

	of the tableaux representing different Special Unitary Groups, Dimensionality of the representations of SU(N), Simple product representation using Young Tableaux technique	
UNIT IV	Nuclear and Particle Detectors Basic principle of particle detectors, Ionization chamber, Proportional counter, Geiger- Muller Counter, Scintillation counters and-ray spectrometer, semiconductor detector, Nuclear emulsion technique, Cloud, chamber, Bubble chamber	**10**

Suggested Readings:

1. D. H. Perkins: Introduction to High Energy Physics, CambridgeUniversity Press, 2000
2. S. N. Ghoshal: Atomic and Nuclear Physics, S. Chand and CompanyLtd, 1994
3. D. Griffiths : Introduction of Elementary Particles
4. DB Lichtenberg: Unitary Symmetry and Elementary Particles,Academic Press, 1978
Hughes: Elementary Particles
5. Blatt and Weiskopff : Theoretical Nuclear PhysicsFE Close: Quarks and Patrons
6. P.P.Cheng and G.LF Li : Gauge Field Theory:
7. W. E. Burcham : Nuclear Physics
8. R. M. Singru: Introduction to experimental nuclear physics
9. E. Segre: Experimental nuclear physics

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

GENERAL ELECTIVE (GE P9)					
Programme: General Elective			**Year: IV**	**Semester: VII**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
GE P9: Physics of Weather and Climate	3	3	1	According to University Ordinance	According to University Ordinance

Course Outcomes:
The course is important for the students to learn about the Elementary idea of atmosphere. The course provides a platform for the students who have interest in atmospheric Physics.

Unit	Topic	No. of Lectures
Unit I	**Elementary idea of atmosphere:** physical structure and composition; compositional layering of the atmosphere; variation of pressure and temperature with height; air temperature, requirements to measure air temperature; temperature sensors: types;	**15**
Unit II	**Atmospheric pressure:** its measurement; cyclones and anticyclones: its characteristics.Wind; forces acting to produce wind; wind speed direction: units, its direction; measuring wind speed and direction; humidity, clouds and rainfall	**15**
Unit III	**Radiation:** absorption, emission and scattering in atmosphere; radiation laws. Global wind systems; air masses and fronts: classifications; jet streams; local thunderstorms; tropical cyclones: classification; tornadoes; hurricanes.	**15**
Unit IV	**Climate and its classification:** Causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate.	` **15**

Reference books:

1. Aviation Meteorology, I.C. Joshi, 3rd edition 2014, Himalayan Books
2. The weather Observers Hand book, Stephen Burt, 2012, Cambridge University Press.
3. Meteorology, S.R. Ghadekar, 2001, Agromet Publishers, Nagpur.
4. Text Book of Agro meteorology, S.R. Ghadekar, 2005, Agromet Publishers, Nagpur .
5. Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, htt

GENERAL ELECTIVE (GE P10)					
Programme: General Elective				**Year: IV**	**Semester: VII**
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
GE P10 : Digital Electronics and computer architecture	3	3	1	According to University Ordinance	According to University Ordinance

Course Outcomes:
This course helps the students to learn about foundation of Digital electronics and computer architecture. Students will have the idea about the different types of sequential and combinational circuits, memory devices and concept of microprocessor.

Unit	Topic	No. of Lectures
Unit I	**Elementary idea of combinational and sequential circuits** : Overview of Microcomputer organization. Microprocessor evolution(8085/8086), Architecture and its operations, Basic idea of logic devices for interfacing 8085/8086. Tri state devices, unidirectional and bidirectional buffers. Computer memory(semiconductor, magnetic and optical) cache memory, real and virtual memory	15
Unit II	**Computer Organization and Architecture:** Central Processing Unit, computer operating systems. Instruction formats and instructions classification, addressing modes, Timing diagram, op code and operand. Memory mapped input/output and peripheral mapped inputs/outputs. Interrupt structures, Multi-programming. Introduction to microcontroller, RISC and CISC processors.	15
Unit III	**Application of microprocessor**: assembly language programming for Addition, subtraction, multiplication, up counter, down counter, delay, stack, subroutines, nesting and time delays. Program execution and debugging. Microprocessor based traffic light controller. Digital to analog and analog to digital convertor.	15
Unit IV	**Data Communication**: Need for communication networks, Internet and World Wide Web, communication protocols, Local Area Networks, Interconnecting networks. Computer Network Characteristics of communication channels, Allocation of Channels, Physical Communication media, Public Switched Telephone Network, Cellular Communication Network, ATM networks, Future of Network Technology.	

Suggested Readings:

1. Mchilling and Belove: Electronic circuits Discrete and Integrated,Mcgraw Hill
2. Millman and Halkias: Electronic Fundamentals & Applications, TataMcgraw
3. K.R. Botkar: Integrated Circuits, Khanna Publishers
4. G.K. Mithal and Ravi Mittal: Electronic Devices & Circuits, KhannaPublishers
5. Malmstadt and Enke: Electronics for scientists
6. Taub and Schilling: Principal of communication systems
7. Simon Gayukti: Communication Systems
8. Martin S. Roden: Analog & Digital Communication Systems
9. V. K. Sarkar and D. C. Sarkar: Optoelectronics and Fibre OpticCommunication.

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL) https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

PRACTICALS					
Programme: PRACTICALS			**Year: IV**	**Semester: VIII**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Practical's	**Tutorial**		
Practicals	4	4		According to University Ordinance	According to University Ordinance

Course Outcomes

The student will have adequate knowledge to perform the experiments of different fields ofphysics with clear understanding of the theory behind the experiment.
Student will know about various electronic components and learn to design some basicelectronic circuits and study their applications.

UNIT	List of Experiments	No. of Lectures
	1. Study of the Phase measurement by superposition ofvoltages with LCR Circuits. 2. Study of different oscillators (Hartely, colpit, Weinbridgeoscillators etc.). 3. Study of an electronically regulated power supply. 4. Study of negative Feed- back Amplifier. 5. Determination of wavelength (λ) and wavelengthdifference (Δλ) by Michelson Interferometer. 6. Study of different type of Resistances and Diodes. 7. Study of Photo Voltaic Cell. 8. Stefan's Constant 9. FET characteristics 10. Fresnel's Law 11. Cauchy Formula 12. Lattice Dynamic Kit 13. Study of Logic gates 14. Detection Efficiency of Diode 15. Fabry – Perot Interferometer 16. Four Probe method	**60**

Suggested Equivalent Online Courses:

1. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=74
2. Digital Platforms /Web Links of other virtual labs may be suggested /added to this lists by individual Universities

DETAILED SYLLABUS FOR

MASTER IN PHYSICS
P.G. SECOND YEAR

Semester: IX
MASTER IN PHYSICS

DISCIPLINE SPECIFIC COURSE (DSC A9)					
Programme: Discipline Specific Course			**Year: V**	**Semester: IX**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSC A9: Advanced Quantum Mechanics	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

The course includes the study of scattering theory, identical particles, relativistic wave equations and quantization of wave fields. The course would describe the nature and behaviour of matter and energy at subatomic level. In particular, theory of scattering gives an understanding collision between a quantum mechanical particle and target. The study of relativistic quantum mechanics enables the students to understand the behaviour of objects moving with speeds comparable to that of light. The knowledge of this field forms the foundation for pursuing research in Quantum Field Theory and High Energy physics.

UNIT	TOPIC	No. of Lectures
UNIT I	**Free particle Dirac equation** Discrepancies faced by Schrödinger equations, Klein- Gordon equation and its drawbacks, Dirac's equation for a free particle, Dirac matrices, covariant form of Dirac equation, Probability and current densities, Free particle solutions of Dirac equation, Non conservation of Orbital Angular momentum and idea of spin, Interpretation of negative energy and hole theory	**10**

UNIT II	**Dirac particle in Electromagnetic Fields** Dirac equation in electromagnetic fields, Magnetic moment of charged particle, Gauge invariance of Dirac equation in electromagnetic fields, Non- relativistic correspondence of Dirac equation; Pauli equation, Adjoint spinors,Symmetries of Dirac Equation: Parity, Time reversal and Charge Conjugation; Lorentz covariance of Dirac Equation.	**10**
UNIT III	**Quantum Theory of Scattering** Scattering Theory, Scattering cross section, method of partial wave analysis, phase shift, Optical theorem, scattering length, effective range theory; low energy scattering, scattering from a square potential well and a rigid sphere, Born approximation, Validity of Born approximation, Born approximation through time dependent perturbation, its application to square well potential	**15**
UNIT IV	**Time Dependent Perturbation Theory** Time dependent perturbation theory, constant perturbation, Fermi Golden rule, Coulomb excitation, sudden and adiabatic approximation, harmonic perturbation, radiative transition in atoms. Einstein's A and B coefficients and spontaneous emission of radiation	**10**

Suggested Readings:

1. Davydov : Quantum Theory Messiah : Quantum Mechanics Vols. I& I
2. Rajput B. S. : Advanced Quantum Mechanics
3. Ropman P. : Advanced Quantum Mechanics Trigg : QuantumMechanics
4. ThankappanV.K. : Quantum Mechanics Sakurai J.J. : QuantumMechanics

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A12)					
Programme: Discipline Specific Elective			**Year: V**	**Semester: IX**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A12: Plasma Physics	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

The course includes Magneto Hydrodynamics , Plasma Propagation and other topics related to plasma. Plasma physicists study plasmas, which are considered a distinct state of matter and occur naturally in stars and interplanetary space .The knowledge acquired by the student can be used in various field of Physics and thus career prospects are bright in the field of research.

UNIT	TOPIC	No. of Lectures
UNIT I	**Introduction to Plasma** Elementary concept of plasma: Debye Shielding, Plasma parameters, Drift of guiding center, Gradient drift, Curvature drift, Magnetic mirror, Plasma Confinement	**10**
UNIT II	**Magneto-Hydrodynamics and Fluid Plasma** Plasma Oscillation, Fluid equations for a plasma, Continuity equation, Wave Propogation in unmagnetized plasma, Magneto Hydrodynamics , Hydrodynamical description of Plasma: fundamental equation, Concept of convective derivative, hydromagnetic waves, magneto- sonic and Alfven waves.	**10**
UNIT III	**Magneto Plasma** Wave phenomena in Magneto plasma: Polarization, Phase velocity, group velocity, cutoff, resonance for electromagnetic wave propagating parallel and perpendicular to the magnetic field Helicon, Faraday rotation,.	**10**
UNIT IV	**Electromagnetic Wave Propagation in Plasma** Propagation at finite angle and CMA diagram, Propagation through ionosphere and magnetosphere Derivation of moment Equation from Boltzmann Equation, Momentum balance equation, Equations of state, Two-fluid equations, Plasma resistivity	**15**

Suggested Readings:

1. Jackson: Classical Electrodynamics; Wiley Estern, New Delhi

2. Bittencourt: Plasma Physics Chen: Plasma Physics
3. Robert J Goldston and Paul H. Rutherford: Introduction to PlasmaPhysics

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A13(a1))					
Programme: Discipline Specific Elective			**Year: V**	**Semester: IX**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A13 (a1): Advanced Electronics- I	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

This course helps the students to gain basic ideas of the construction and working of electronic devices and circuits. The course includes the study of IC technology, Operational amplifier as linear Analog systems and non-linear analog systems. The course is of much practical purpose for the students to learn basics of integrated circuit technology which has wide applications in computing, process control, signal processing, communication systems, digital instruments etc.

UNIT	TOPIC	No. of Lectures
UNIT I	**Integrated Circuit Technology** Advantages & limitations of integrated circuits. Classification of IC's, Fabrication of IC's & components, Basic monolithic Integrated Circuit technology, processes used in monolithic technology, fabrication of monolithic diodes, integrated resistors, integrated capacitors, metal semiconductor contact, The Schottky transistor, thick & thin film IC's, hybrid IC's.	**10**
UNIT II	**Operational Amplifier(OP-AMP)** Basic OP-AMP, Ideal OP-AMP, Inverting & Non inverting OP – AMP, OP-AMP internal circuit, Differential amplifier, The emmiter coupled differential amplifier, Common Mode Rejection Ratio (CMRR), Operational Amplifier characteristics, DC characteristics- Offset error voltages and currents, Temperature drift of input offset voltage and current. AC characteristics- Frequency response and stability, Frequency compensation, slew rate, Measurement of OP-AMP parameters.	**10**
UNIT III	**Operational Amplifier Applications** Circuit type of OP – AMP 741, Scale changer, Summing Amplifier-Inverting summing amplifier, non-inverting summing amplifier, subtractor, adder subtractor, voltage follower, current to voltage converter, voltage to current converter, OP-AMP circuits using diodes-Half wave rectifier, Full wave rectifier, Peak value detector, Clipper and Clamper, Sample and hold circuits, Logarithmic Amplifier, Antilogarithmic Amplifier, Integrator, Differentiator.	**10**

UNIT IV	**Comparator and Waveform Generators** Comparators, Applications of comparator- Zero crossing detector. Regenerative comparator (Schmitt trigger), Square and triangular, waveform generators, Discriminators, OP-AMP as astable and monostable multivibrator, IC 555 timer-Functional diagram, Monostable operation, Astable operation. Applications in monostable and astable mode-Missing pulse detector, Liner ramp generator, Frequency divider, FSK generator, Pulse-Position modulator, Schmitt Trigger.	**15**

Suggested Readings:

1. Coughlin: Operational Amplifiers and Linear Integrated Circuits.
2. Schilling and Belove: Electronic circuits Discrete and Integrated, Mcgraw Hill
3. Millman and Halkias: Electronic Fundamentals & Applications, TataMcgraw Hill
4. Millman and Halkias: Integrated Electronics K.R. Botkar: IntegratedCircuits, Khanna Publishers G.K.
5. Mithal and Ravi Mittal: Electronic Devices & Circuits, KhannaPublishers
6. Roychaudhary and Jain: Operational Amplifier & Linear Integrated Circuits
7. V.K. Mehta: Electronics for Scientists & Engineers

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,https://openlearning.mit.edu
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A13(b1))					
Programme: Discipline Specific Elective			**Year: V**	**Semester: IX**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A13 (b1) Astrophysics- I	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

The course would be important to understand the spherical astronomy, distance measurement in astrophysics, and physics of solar system and extra solar planets. The course provides an opportunity to understand the optics of the different astronomical instruments such as: telescopes, CCD camera etc. It has wide spared in use of R& D sector.

UNIT	TOPIC	No. of Lectures
UNIT I	Spherical Astronomy Celestial sphere, Celestial coordinate system (equatorial and alt-azimuth): altitude and azimuth, right ascension and declination, hour angle, sidereal time, mean solar time, summer and winter solstice, seasons. Distance measurements: AU, parsec, standard candles, distance measurement by geometric means (parallax, distances to open clusters).	10
UNIT II	Solar System Idea of solar system, Study of planets and their satellites, Earth-Moon system, tidal forces, asteroids, meteors, comets and their origin, composition and dynamical evolution.	10
UNIT III	Telescopes: Basic Optics, Types of telescopes. Telescope mounting systems. Optical telescopes, Infrared, Ultraviolet, X-ray and Gamma-ray telescopes. Schmidt telescopes. Solar telescopes. Design and construction of a simple optical telescopes. Active and adoptive optics in astronomical study. Sky charts and their importance.	10

UNIT IV	Classification of detectors, characteristics of detectors. Detectors for optical and infrared wavelength regions. Working of Charge Coupled Device (CCD). sensitivity, noise, quantum efficiency, spectral response, Johnson noise, signal to noise ratio, Application of CCD for stellar imaging, photometry and spectroscopy. Importance of space based astronomy. Observational techniques of astronomical sources from space in infrared, EUV, X-ray and Gamma ray regions of the electromagnetic spectrum.	15

Suggested Readings:

1. Abhyankar K.D. : Astrophysics, Galaxies and StarsVaidyanthBasu : An Introduction to Astrophysics Motz : Astrophysics
2. K S Krishnaswamy : Astrophysics: A Modern Perspectiv
3. W. M Smart: Spherical Astronomy
4. Mark A. Garlick: The Story of the Solar System

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A13(c1))					
Programme: Discipline Specific Elective			**Year: V**	**Semester: IX**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A13 (c1): High Energy Physics- I	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

Students would be able understand the complex properties and behaviour of high energy particles at the microscopic level. This course would encourage students to peruse higher study and research in particle and high energy Physics.

UNIT	TOPIC	No. of Lectures
UNIT I	**Concepts of Quantum Field Theory** Classical Fields, Schwinger's action principle, Lagrangian and Hamiltonian densities, Field equation, quantum structure of free fields and the particle concept, Quantization relations, Quantization of non -relativistic Schrödinger matter field, System of identical bosons and fermions, Commutation and anti-commutation relations, Occupation number representation, creation and annihilation operators	**10**
UNIT II	**Quantization of Scalar Fields** Covariant formulation of field theory, Scalar field quantization, Lagrangian Formulation, Field Hamiltonian and field momentum densities, Neutral and Charged scalar fields and their quantization, Momentum representation and frequency splitting, Identification of various particle operators, Charge operator	**15**
UNIT III	**Quantization of Spinor Field** Lagrangian formulation for Spinor field, Evaluation of conjugate momenta, Field Hamiltonian and field momentum densities, Quantization of Spinor Field, Momentum representation and frequency splitting, Identification of various particle operators, Charge operator for Spinor field, Algebra of spinor field operator	**10**
UNIT IV	**Quantization of Electromagnetic Field** EM field as a vector field, Classical electromagnetic field theory and its gauge formulation, Covariant Lagrangian formulation for EM field, Quantization of EM field, Momentum representation and frequency splitting, Identification of various particle operators, concept of longitudinal, temporal and transverse photons and complete quantized expression of EM field in terms of its various polarization states.	**10**

Suggested Readings:

1. L. Ryder : Quantum Field Theory
2. B.K. Agarwal : Quantum Mechanics and Field Theory
3. F Mandel and Shaw: Quantum Field Theory
4. P. Roman: Quantum Field Theory
5. A. Das: Quantum Field theory
6. M. E. Peskin, D.V. Schroeder : An Introduction to Quantum FieldTheory
7. B.S.Rajput : Advanced Quantum mechanics

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A13(d1))					
Programme: Discipline Specific Elective				**Year: V**	**Semester: IX**
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A13 (d1): Spectroscopy-I	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

Topics covered here deals with the observation and interpretation of radiation absorbed or emitted by molecules. This information can lead into the knowledge of structure and properties of the molecules. The course will enable the student to get an understanding on the Molecular spectra (rotational, vibrational and electronic spectra), NMR and ESR spectroscopy, and their applications. Knowledge acquired by the course will be of much use for various industries and R&D sector.

UNIT	TOPIC	No. of Lectures
UNIT I	**Rotational spectra:** rotational energy level populations, linear, symmetric, spherical and asymmetric top molecules, rotational selection rules for linear molecules, Stark effect in molecular rotation spectra, Molecular rotation-nuclear spin coupling, Positive and negative character of the wave functions of linear molecules, Symmetric-antisymmetric character and statistical weight of homo-nuclear linear molecule.	**10**
UNIT II	**Vibrational Spectra:** Vibration spectra of polyatomic molecule, coupling of rotation and vibration, perpendicular and parallel bands, Normal modes of vibration and their analysis in Cartesian coordinates, normal coordinates and their internal coordinates, calculation of vibrational frequencies and force field of H2O and CO2 molecules, anharmonicity, degenerate and non-degenerate vibrations, inversion doubling, Quantized Vibrational motion of polyatomic molecules.	**15**
UNIT III	**Electronic Spectra:** Spectroscopy of Diatomic and Polyatomic Molecules: Coupling of Electronic and Rotational motion in Diatomic Molecules and Rotational structure of 1π - 1Σ and 1Σ - 1Σ transitions, Vibronic interaction and Herzberg Teller theory for absorption spectrum of benzene vapour, Single vibronic level spectroscopy and lifetime of vibronic levels in benzene, Photoelectron spectroscopy, Quantum yield and the concept of nonradiative transitions in molecules, Electronic transitions, Basics of Absorption, Fluorescence	**10**

	and Phosphorescence.	
UNIT IV	**NMR and ESR Spectroscopy (Resonance Spectroscopy):** NMR spectroscopy, Bloch Equation, Principle and working of NMR Spectrometer, Basic Principle & Theory of ESR spectroscopy, Resonance conditions, ESR spectrometer, Applications of resonance spectroscopy.	**10**

Suggested Readings:

1. C.N. Banwell: Fundamentals of Molecular Spectroscopy
2. Walker and Stranghen: Spectroscopy Vol. I, II, & III
3. Herzberg: Spectra of diatomic molecules
4. Jeanne L. Mchale: Molecular Spectroscopy
5. P.F. Bemath: Spectra of atoms and molecules
6. J.M Holias: Modern Spectroscopy
7. K. Thyagrajan and A.K. Ghatak: Lasers: Theory and applications
8. AYariv: Quantum Electronics

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A13(e1))					
Programme: Discipline Specific Elective			**Year: V**	**Semester: IX**	
Course Title & Code	**Credits**	Credit distribution of the course		Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial		
DSE A13 (e1): Condensed Matter Physics-I	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

Topics covered in this paper deals about the Crystal Symmetry, Crystal structure, and idea of nano-materials. This course would encourage students to peruse higher study and research in Condensed Matter Physics.

UNIT	TOPIC	No. of Lectures
UNIT I	Crystal Symmetry: Point group and space group. External symmetry elements (translational, rotational, reflection and inversion) and internal symmetry elements (screw axis and glide plane) of the crystal.Notation of symmetry elements of the crystals, structure of diamond.Non existence of fivefold symmetry in crystals.	**10**
UNIT II	Crystal Structure determination: Introduction and different methods of x-ray diffraction. Structure factor determination of thecrystal (SC, BCC, Base centered, FCC and diamond) and its importance in crystallography. Interpretation of diffraction pattern for determining the structure of the unknown material.Particle size and strain calculation by Williamson-Hall plot method.	**15**
UNIT III	Band theory of solids: Energy bands in solid, distinction between conductor, semi conductor and insulator. Carrier concentration in intrinsic semiconductor. Energy band diagram and Fermi level. Bloch theorem, Kroning-Penny model, concept of hole. Effective mass and its physical interpretation. Tight binding approximation, motion of electrons in one dimensional and three-dimensional lattices. Brillouin zones, density of states.	**10**
UNIT IV	Modification Methods : Basic idea about nanomaterials and nanotechnology.fabrication of nanomaterials (top down approach, bottom up approach). Modification of crystal properties in nanodimension.Neutron scattering and its applications. Debye Wallerfactor. Hyperfine interactions (isomer shift, quadrupole splitting and magnetic splitting),Mössbauer effect and its applications.quantum size effect,special carbon solids, carbon nano tubes and	**10**

	Fullerene.Ion irradiation properties of crystal.	

Suggested Readings:

1. J. Dekker: Solid State Physics
2. S.O. Pillai : Solid State Physics
3. Kittle : Introduction to Solid State Physics
4. Verma &Srivastava : Crystallography for Solid State Physics
5. D. Cullity: Elements of X-ray diffraction

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A14(a2))					
Programme: Discipline Specific Elective			**Year: V**	**Semester: IX**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A14 (a2): Advanced Electronics- II	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

This course helps the students to gain basic ideas of the digital communication, optical communication, memory and optoelectronic devices. The course is of much practical purpose for the students to learn advanced concepts of digital communication systems.

UNIT	**TOPIC**	**No. of Lectures**
UNIT I	**Digital Communication:** Digital signal processing, Image processing (Basic ideas only), Pulse Modulation systems, Pulse Amplitude Modulation, Pulse Width Modulation, Pulse position modulation, Pulse code modulation, Delta modulation, Frequency division multiplexing (FDM), Basic idea of digital telemetry.	**10**

UNIT II	**Optical communication:** Principle of optical communication, Light propagation through cylindrical wave guide, Ray paths of planar optical waveguide, Different modes of propagation of E. M. Wave through optical fiber, TE and TM modes, Power associated with a mode, Radiation modes, Excitation of guided modes, Advantages of multimode fibers and cladding, Optical Fiber connectors, Advantages of optical communication.	**15**
UNIT III	**Optical Communication Transmitters, Repeaters and Receivers:** Optical Fiber communication transmitters; Semiconductor lasers, Laser diodes and LEDs, Optical gain in a semiconductor, Receivers; Principle of optical detection, PIN photodetector and Avalanche photodiodes, Optical Fiber amplifiers; Optical amplification, Energy levels of erbium ions, Gaussian envelope approximation, Noise in EDFA, EDFAs for WDM transmission.	**10**
UNIT IV	**Memory and Optoelectronic devices:** Bulk and thin films, Photoconductive devices (LDR), charge coupled devices (CCDs), LCDS, Memory devices, static and dynamic random access memories SRAM and DRAM, CMOS and NMOS, nonvolatile- NMOS, magnetic, optical and ferromagnetic memories.	**10**

Suggested Readings

1. Coughlin: Operational Amplifiers and Linear Integrated Circuits.
2. Mchilling and Belove: Electronic circuits Discrete and Integrated,Mcgraw Hill
3. Millman and Halkias: Electronic Fundamentals & Applications, TataMcgraw
4. Millman and Halkias: Integrated Electronics
5. K.R. Botkar: Integrated Circuits, Khanna Publishers
6. G.K. Mithal and Ravi Mittal: Electronic Devices & Circuits, KhannaPublishers
7. Malmstadt and Enke: Electronics for scientists
8. Taub and Schilling: Principal of communication systemsSimon Gayukti: Communication Systems
9. Martin S. Roden: Analog & Digital Communication Systems
10. V. K. Sarkar and D. C. Sarkar: Optoelectronics and Fibre OpticCommunication.

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A14(b2))					
Programme: Discipline Specific Elective			**Year: V**	**Semester: IX**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A14 (b2) Astrophysics–II	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

The Course will provide the deeper understanding of the radiative transfer and the interactionof radiation with matter. It would be important to understand the physics of the death of stars. This study is crucial for the deeper knowledge of the neutron stars, white dwarfs andblack holes. Their study provides the insight for the gravitational waves.

UNIT	TOPIC	No. of Lectures
UNIT I	Radiation transfer: Definitions of specific intensity, mean intensity, flux and energy density; Equation of radiation transfer; solutions in some specific cases, optical depth; Thermal emission; Blackbody spectrum and its characteristics; Kirchoff's law; Einstein coefficients.	**10**
UNIT II	Interior Properties of Stars Hydrostatic equilibrium, Virial theorem, Polytrophic indices, Lane – Emden equation LTE, Radiative equilibrium, stabilitycondition of convective and radiative equilibrium, Continuous spectra of stars, Stellar opacity, limb darkening, line blanketing, theory of Fraunhofer lines, curve of growth and line broadening.	**15**
UNIT III	Elementary theory of white dwarfs, Chandrashekhar's limit for white dwarf stars, neutron stars their birth and properties, Pulsars, black holes, low medium mass star and high mass stars, death of high mass stars, supernova remnants..	**10**
UNIT IV	AGNs and Quasi-stellar Objects Theory of AGNs, Syferts, quasars and their energy generation and redshift anomaly. Different AGN models, radio lobes and jets, Gamma ray bursts.	**10**

Suggested Readings:

1. Abhyankar K.D.: Astrophysics, Galaxies and Stars
2. Vaidyanth Basu: An Introduction to Astrophysics
3. Motz: Astrophysics A. R. Choudhuri : Astrophysics forPhysicists
4. B. D. Abhyankar : An Introduction to Astrophysics
5. T. Padmanabhan : Astrophysical Processes

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A14(c2))					
Programme: Discipline Specific Elective			**Year: V**	**Semester: IX**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A14 (c2): High Energy Physics-II	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

The course would provide the knowledge of basic building blocks of matter and its complexproperties.The students will also be able to know the complicated theory of Higgs mechanism which led to the detection of God particle in LHC experiment in the year 2012.It would open doors for the students who want to work in the field of HEP.

UNIT	TOPIC	No. of Lectures
UNIT I	**Lie Groups and Lie Algebra**: Symmetries in Physics and conservation Laws, Definition and Examples of Groups Continuous vs Discrete Groups ,Groups and conservation laws, Definition of Lie groups with examples U(N), SU(N) groups as Lie Groups , Concept of Generators and Parameters of the groups, Lie Algebra and Structure Constants, Commutation Relations and Algebra of Generators, Different dimensions and parameter groups-their generators and algebra, Simple and semi-simple Lie groups, .	**10**
UNIT II	**Special Unitary Groups and hadrons** : SU(3) shift operators, I, U, V spin subgroups of SU(2) in SU(3) multiplets, commutation relations of shift operators, irreducible representations of SU(3) , application of shift operators for fundamental triplet of SU(3) and for baryon octet , decuplet etc, application of Young tableaux for finding out weight diagram for the (1 0), (0 1), (3, 0), (1 1) and (2 1) representations of SU(3) , physical interpretation of these weight diagrams and identification of the particles of the weight diagram, SU(4) group and its generators, physical meaning of the weights of SU(4), reduction of the Kronecker product of two representations of special symmetry groups by Young tableaux, Kronecker product of three particle state vectors.	**10**
UNIT III	**Gauge Symmetry:** Concept of gauge fields and Gauge connections: coupling of physical space with internal symmetry space, principle of Gauge invariance, Global and local gauge invariance, Global U(1) Gauge Invariance, U(1) Local gauge symmetry of QED , Non –Abelian Gauge theory, Global SU(2) gauge symmetry, conserved isospin current for isospin group SU(2), Noether's Theorem, SU(2) Local Gauge symmetry, Yang Mill's Field and its properties	**15**

UNIT IV	**Spontaneous Symmetry Breaking** (SSB): Concept of Spontaneous Symmetry Breaking, Mass generation through SSB, SSB of Global Gauge Symmetry, Goldstone Bosons, SSB of Abelian local Gauge Symmetry and mass generation of Gauge fields, Elimination of Goldstone Bosons, Higgs Mechanism with physical examples and mass generation for gauge fields, Higgs bosons : its detection and its properties.	**10**

Suggested Readings:

1. E. Close : Quarks and Patrons
2. D.C. Cheng and O Neil : Elementary Particle PhysicsP.Cheng and G.LF Li : Gauge Field Theory
3. I.J. Aitchison and A.J. Hey : Gauge theories in Particle Physics
4. H. Georgi : Lie Algebras in particle Physics
5. D. B. Lichtenberg : Unitary Symmetry and Elementary Particles,Academic Press, 1978

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/

2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A14(d2))					
Programme: Discipline Specific Elective			**Year: V**	**Semester: IX**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A14 (d2): Spectroscopy -II	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

Laser, the light extraordinary, has so many applications in various field even having further potential and hence it has vital need to familiarize lasers & their technical advances to the students so that students be ready to apply coherent light to solve various problems in areas such as scientific, industrial, healthcare etc. Through this course students will learn about light matter interaction, basic principles of stimulated emission, fundamentals of lasers, types of laser, and applications of lasers in various fields including scientific research to common use. Also, it provides a good understanding of the critical laser parameters important for their use in various real-world applications such as: quantum optics, quantum technologies, telecommunications, and industrial material processing, sensing, bio-medicine, imaging, ranging and automobile industry.

UNIT	TOPIC	No. of Lectures
UNIT I	**Radiation and Matter:** Interaction of radiation with matter, Einstein quantum theory of radiation, Einstein's coefficients, Momentum Transfer, Lifetime, Theory of optical frequencies, Coherence Spatial and temporal and Monochromaticity, kinetics of optical absorption, line width, line broadening mechanisms.	**10**
UNIT II	**Basic Elements of Lasers:** Laser fundamentals and fabrication – active medium, pumping source and the optical resonator, phenomenon of population Inversion, characteristic of laser light, Spontaneous emission, Stimulated emission, Possibility of amplification, laser pumping and population inversion in three and four level laser, rate equations, Threshold condition, Active resonators & laser modes, gain saturation, Saturable absorption.	**15**
UNIT III	**Type of Lasers:** Different types of lasers, Principle and working of gas lasers, He-Ne laser, N_2 & CO_2 lasers, dye lasers, solid state lasers, Nd-YAG, semiconductor lasers, Excimer laser, Tunability of lasers	**10**
UNIT IV	**Applications of Lasers:** Basic application of laser spectroscopy, laser cooling and trapping of atoms, Isotope separation, Plasma, Laser Induced Breakdown Spectroscopy (LIBS), Lasers in material processing, laser barcode scanner, Pattern formation by laser etching, LIDAR, lasers in Holography, Interferometry and Microscopy, Communication by Laser, Lasers in Astronomy, Biology, Chemistry, Medicines, Atmospheric optics, optical tweezers	**10**

Suggested Readings:

1. K. Thyagarajan and A.K. Ghatak: Lasers: Theory and applications
2. B.B. Laud: Lasers and Non-linear optics
3. Orazio Svelto: Principles of Lasers
4. Wolfgang Demtröder: Laser Spectroscopy
5. M Hollas: Modern Spectroscopy

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL) https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A14(e2))					
Programme: Discipline Specific Elective			**Year: V**	**Semester: IX**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A14 (e2): Condensed Matter Physics –II	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:
Topics covered in this paper deals about thermal, magnetic, and optical properties of solids. Crystal Symmetry, Crystal structure, and idea of nano-materials. This course would encourage students to peruse higher study and research in Condensed Matter Physics.

Unit	Topic	No. of Lectures
Unit I	**Thermal Properties of solids:** Thermal expansion and thermal conductivity in metals, anharmonicity interaction of electrons andphonons with photons (direct and indirect transitions). Theory of specific heat of solids: classical theory (Dulong and Petit law), Einstein's theory of specific heat and Debye's theory of specific heat.	**10**
Unit II	**Magnetic Properties of Matter:** Detailed study of magnetism (diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, ferrimagnetism) and measurements of magnetic parameters (Gauss meter and Vibrating Sample Magnetometer). Structure of ferrites., superexchange interaction, Introductoryidea of magneto resistance (GMR & CMR). Hall Effect (integer and fractional) and its applications.	**15**
Unit III	**Optical properties of solids:** Luminescence (chemical luminescence, thermoluminescence, electroluminescence), Franck-Condon principle, luminescence efficiency. UV- VIS spectroscopy, energy band gap determination, Raman spectroscopy and its applications. FTIR spectroscopy and determination of mode of vibrations.	**10**
Unit IV	**Superconductivity:** Introduction of superconductivity, phenomenological, semi phenomenological andmicroscopic theories of superconductors. Meissner effect, Type-I and type-IIsuperconductors, London equation, Penetration depth, coherence length, Josephson effect, Isotope effect. Heat capacity, energy gap. Flux quantization in a superconducting ring. Elementary idea of high temperature superconductors.	**10**

Suggested Readings:

1. A. J. Dekker: Solid State Physics
2. S.O. Pillai : Solid State Physics
3. C. Kittle : Introduction to Solid State Physics
4. B. D. Cullity: Introduction to Magnetic Materials.

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

GENERAL ELECTIVE (GE P11(a))					
Programme: General Elective			**Year: V**	**Semester: IX**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
GE P11: Bio-Physics	4	3	1	According to University Ordinance	According to University Ordinance

Course Outcomes:

The course is important for the students to learn about the Basic Concepts in Biophysics. The course provides a platform for the students who have interest in Biophysics.

Unit	**Topic**	**No. of Lectures**
Unit I	Basic Concepts in Biophysics, Elementary ideas about the DNA structure, Forces stabilizing DNA and protein structure, sugar-phosphate backbone, nucleosides and nucleotides, three-dimensional DNA structure, RNA. Proteins: primary, secondary, tertiary and quaternary structures.	**15**
Unit II	Application of experimental techniques of light scattering (tomography), FTIR and Raman spectroscopy, absorption and fluorescence spectroscopy/ microscopy, anisotropy, optical activity, circular dichroism, electrophoresis,.	**15**
Unit III	Photobiology: interaction of light with cell and tissues, Photosynthesis, human eye and vision optical biopsy, optical biosensors, Laser tweezers and Laser scissors Photo-dimerization, Photodynamic therapy	**15**
Unit IV	High doses received in a short time, Low-level doses limits, direct ionization of DNA, radiation damage to DNA, Biological effects (Genetic, Somatic, Cancer and sterlity). Bioimaging: Ultrasound, MRI imaging, confocal fluorescence imaging and X-ray.	` **15**

Suggested Readings:

1. Essentials of Biophysics: P. Narayanan.
2. Basic Molecular Biology: Price.
3. Quantum Mechanics of Molecular Conformations: Pullman (Ed.).
4. Non-linear Physics of DNA: Yakushevich.
5. Biological Physics: Nelson.
6. Spectroscopy of biological systems Modern Spectroscopy: J.M. Hollas.
7. Transmission Electron Microscopy of Metals: Gareth Thomas
8. Elements of X-ray Diffraction: Bernard Dennis Cullity.
9. Atomic Force Microscopy/Scanning Tunneling Microscopy: M.T. Bray, Samuel H. Cohen and Marcia L

OR

GENERAL ELECTIVE (GE P11(b1))					
Programme: General Elective				**Year: V**	**Semester: IX**
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	Tutorial		
(GE P11(b1)): PHOTONICS - I	4	3	1	According to University Ordinance	According to University Ordinance

Course Outcomes:

1. To Understand the concept of superposition of waves
2. To Explain the concept of coherence
3. To Classify interference phenomenon based on division of amplitude and division of wavefront
4. To Differentiate between Fresnel and Fraunhofer diffraction
5. To Summarize the idea of polarized light, its generation and detection
6. To study randomness in optical waves
7. To explain the concept of holography

Unit	**Topic**	**No. of Lectures**
Unit I	**Wave Optics:** Interference by division of wavefront and division of amplitude; Phase change on reflection, Stoke's relations; Reflecting and non reflecting films; Colors of thin films. Michelson interferometer; Fabry-Perot interferometer, Fresnel and Fraunhofer diffraction. Single slit, Double slit, Diffraction grating, Resolving power. Fresnel half-period zones and the zone plate. Diffraction of a Gaussian beam.	**15**
Unit II	**Crystal Optics:** Review of Maxwell's equations and propagation of waves, Plane polarized light. Reflection and refraction of e. m. wave, Brewster angle; total internal reflection and evanescent waves. Reflection by a conducting medium. Anisotropic Media: Plane waves in anisotropic media,	**15**

	Birefringence, Uniaxial crystals; Analysis of polarized light; some polarization devices.	
Unit III	**Statistical Optics:** Introduction to Probability theory, random variables and probability distribution, Gaussian probability distribution, Wiener–Khinchin theorem, Second order coherence theory of scalar fields, Complex degree of coherence, cross spectral density, Spectral degree of coherence, Wigner function	**15**
Unit IV	**Fourier Optics:** Fourier transform operation spatial frequency and transmittance function, spatial-frequency filtering, Phase contrast microscope. Holography: Principle of holography, On-axis and Off-axis hologram recording and reconstruction, types of hologram and some applications.	**15**

Suggested Reading

1. Optics, Ajoy Ghatak, 6th edition, Tata McGraw Hill, (2017)
2. Optics, Eugene Hecht and A R Ganesan , 4th Edition, Pearson Education (2008) (Text)
3. Basics of Interferometry - P Hariharan, Academic Press(2006)(Text)
4. Fundamentals of Optics, Jenkins and White, McGraw Hill Education, 4th edition (2017)
5. Introduction to optics and optical imaging - C.Scott, Wiley-IEEE Press (1998)
6. Optical Electronics - Thyagarajan and Ghatak, Cambridge University Press (1997)
7. Polarization of light - S. Huard, John Wiley and Sons (1997)
8. Fundamentals of photonics : Bahaa E.A. Saleh and Malvin Carl Teich, New York: John Wiley, (2007)
9. Introduction to Fourier Optics : Joseph W. Goodman
10. The Fourier Transform And its Applications to Optics-P M Duffieux, John Wiley Sons 2nd Ed, (1983)

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

GENERAL ELECTIVE (GE P 12)					
Programme: GENERAL ELECTIVE			**Year: V**	**Semester: IX**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
GE P 12: Nanoscience and Nanotechnology	4	3	1	According to University Ordinance	According to University Ordinance

Course Outcomes:

The course is important for the students to learn about the Nanoscience and Nanotechnology. The course provides a platform for the students who have interest in Nanotechnology.

Unit	Topic	No. of Lectures
Unit I	Emergence of Nanotechnology – Challenges in Nanotechnology, Carbon age–New form of carbon (From Graphene sheet to CNT), Introduction to nanomaterials, evolution of nanoscience, general properties of nanomaterials, role of size in nanomaterials, semiconducting nanoparticles,	15
Unit II	One-, two- and three-Dimensional nanostructured materials. Influence of Nano size on mechanical, optical, electronic, magnetic and chemical properties of quantum dots and quantum wires, electronic transport in quantum wires and carbon nano tubes (CNT), types of CNT, magnetic behavior of nano particles	15
Unit III	Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, HRTEM, Atomic Force Microscopy, Scanning Tunneling Microscopy, Optical Absorption and Emission Spectroscopy, X Ray Diffraction, Raman and FTIR Spectroscopy.	15
Unit IV	Molecular electronics and nanoelectronics, Quantum electronic devices, Carbon Nano Tube based transistor and Field Emission Display, Biological applications, Biochemical sensor, medical applications and Membrane based water purification	` 15

Suggested Readings:

1. C. Kittle: Introduction to Solid State Physics (John Wiley)
2. C.Poole and F.J.Owens: Introduction to Nanotechnology (John Wiley)
3. T.Varghese and K.M.Balakrishna: Nanotechnolgy: An Introduction to Synthesis, properties and Application of Nanomaterials. (Atlantic)
4. G. Schmidt: Nanoparticles: From theory to applications (Wiley Weinheim)

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,https://openlearning.mit.edu/

2. National Programme on Technology Enhanced Learning (NPTEL) https://www.youtube.com/user/nptelhrd

3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

PRACTICALS					
Programme: PRACTICALS				**Year: V**	**Semester: IX**
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Practicals	**Tutorial**		
Practicals	4	4	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

The student will have adequate knowledge to perform the experiments of different fields of physics with clear understanding of the theory behind the experiment. Student will know about various electronics experiments and some advanced experiments inPhysics

Unit	List of Experiments	No. of Lectures
	1. Verification of Richardson's law. 2. Study of ESR spectra of a given sample. 3. Hall Effect 4. RCS Spectrometer 5. gamma ray spectrometer 6. Radio Receiver 7. e by Millikan's oil drop method. 8. Temperature dependence of diode characteristics. 9. Elastic constants of a cubic crystal by ultrasonicwaves. 10. Study of Multivibrators . 11. Study of transistor amplifier cum feedbackamplifiers. 12. Study of absorption of KMnO4 Spectrophotometer 13. Study of different FETs and MOSFETs. 14. Study of Thermo luminance. 15. Study of VTVM.	**60**

Suggested Equivalent Online Courses:

1. Virtual Labs at AmritaVishwa Vidyapeetham https://vlab.amrita.edu/?sub=1&brch=74
2. Digital Platforms /Web Links of other virtual labs may be suggested/added to this lists by individual Universities

Semester: X
MASTER IN PHYSICS

DISCIPLINE SPECIFIC COURSE (DSC A10)					
Programme: Discipline Specific Course			**Year: V**	**Semester: X**	
Subject: Physics					
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	Tutorial		
DSC A10: Solid State Physics	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

The students will be able to develop an understanding of the lattice, different types of crystal structures, symmetries. The student would gain insight about the interior of the substances using X-ray diffraction in crystals. This course also includes elastic waves, phonons, and lattice vibrational properties and also superconductivity. The course forms a theoretical basis of experimental material science and technology.

Unit	Topic	No. of Lectures
Unit I	**Crystal Structure:** Crystalline and non-crystalline solids. Lattice, basis, unit cell, co-ordination number, lattice planes and Miller indices. Interplanner spacing, seven crystal system. Interaction of radiation with matter (for elastic and inelastic scatterings of x- ray). X ray diffraction, Bragg's law. Diffraction conditions, Fourier analysis. Concept of reciprocal lattice point, calculation of reciprocal lattice point of SC, BCC. and FCC lattices, Application of reciprocal lattice point in diffraction technique. Neutron scattering and its applications.	**15**
Unit II	**Bonding in Solids** : Different types of bonding in solids, covalent, metallic, Vander Waal, hydrogen bonding & ionic bonding, Calculation of Madelung constant of ionic crystals, Determination of cohesive energy. Born-Haber cycle of NaCl molecule. Properties of covalent compounds and hybridization. Dispersion and dipole bonds. Thermal expansion and thermal conductivity, anharmonicity interaction of electrons and phonons with photons (direct and indirect transitions).	**10**
Unit III	**Lattice Vibrations:** Vibrations of crystals with monoatomic and diatomic basis. Concept of dispersion relation, optical and acoustical branches. Quantization of lattice vibrations (Phonons), normal modes & normal coordinates, longitudinal and transverse modes of vibration, modes of vibration of monatomic and diatomic lattices. Density of states, Phonon momentum, Inelastic scattering by phonons. Theory of specific heat of solids : classical theory , Einstein theory and Debye theory .Theory of metals : Classical theory , free electron theory and F-D distribution function , Hall effect and its applications.	**10**

Unit IV	**Crystal Defects:** Lattice vacancies, Fick's law, color centers and its production method in crystal, Point defects (Schottky & Frankel Defects) Imperfections, Line defects (Edge& Screw dislocations), slip, Burger vector & Burger Circuit, Role of dislocation in plastic deformation and crystal growth. Strength of alloys. Elementary idea of superconductivity, Meissner effect, Type-I and type-II superconductors, BCS theory. Theory of ferrimagnetism, ferromagnetism and antiferromagnetism.	**10**

Suggested Readings:

1. A. J. Dekker: Solid State Physics
2. S.O. Pillai : Solid State Physics
3. C. Kittle : Introduction to Solid State Physic
4. Verma &Srivastava : Crystallography for Solid State Physics

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A15)					
Programme: Discipline Specific Elective			**Year: V**	**Semester: X**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A15: Statistical Physics	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

This course helps the students to learn about foundation of statistical mechanics, statistical properties and different statistical models. Students will have the idea about the different types of ensembles and different statistics namely M-B, B-E and F-D statistics.

Unit	**Topic**	**No. of Lectures**
Unit I	**Foundation of Statistical Mechanics** Microscopic and macroscopic states, density of states, micro-canonical, canonical and grand canonical ensembles, canonical ensemble and Gibb's distribution, Boltzmann–Planck method, partition function and statistical definition of thermodynamic quantities, computation of partition functions of some standard systems.	**10**
Unit II	**Statistical Properties** System of linear harmonic oscillators in the canonical ensemble; grand canonical ensemble and its partition function;	

	chemical potential; Partition function and distribution for perfect gas; Gibb's paradox; Free energy, entropy, equation of state and specific heat determination of perfect gas.	**15**
Unit III	**Statistical Models** Theory of phase transitions, First order phase transition, Second order phase transitions and higher order phase transitions (elementary discussion), Ising model, one dimensional (with exact solution), Two dimensional (with exact solution) & three dimensional model (elementary idea), Landau theory of phase transition, Weiss theory of Ferro-magnetism, Heisenberg model. Virial equation of states.	**10**
Unit IV	**Quantum Statistics** Bose-Einstein and Fermi- Dirac distributions, degeneracy, gas degeneration, degenerate Bose gas, Bose Einstein condensation, highly degenerate B-E and F-D gases; examples of Molecular Hydrogen, liquid helium and electron gas in metals.	10

Suggested Readings:

1. A.S. Davidov: Quantum Mechanics
2. Paul Roman: Quantum Mechanics
3. Glastohn Theoretical Chemistry
4. Landau and Lifshitz: Statistical Mechanics
5. Pathira: Statistical Mechanics
6. Huang: Statistical Mechanics

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A16 (a3))					
Programme: Discipline Specific Elective			**Year: V**	**Semester: X**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A16 (a3): Advanced Electronics- III	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

This course helps the students to gain advanced concepts of power supply regulation, microwave production and microwave generation which has wide applications in modern Industry and Research.

Unit	Topic	No. of Lectures
Unit I	**Power Supply regulation with Series Regulators:** Voltage Regulators: Regulation using Operational Amplifier, Zener reference source, The 723 regulator, current regulator, short circuit and over load protection, Current Foldback, Current Boosting, Precision rectifier, Three terminal voltage regulations (78 XX and 79 XX series regulators (Basic ideas only)), Dual polarity regulated power supplies.	**10**
Unit II	**Switching Regulators and Active Filters:** Switched mode power supply (SMPS), Active filters; advantages and limitations of Active filters, RC Active filters, First order, second order and higher order Low pass and High pass active filters, Voltage transfer function, frequency response and Gain roll-off, Narrow and wide band pass Active filters, Notch and wide band reject Active filters, PLL; Lock-in range, Capture range, Pull-in time, Phase detectors, Error amplifier, Voltage controlled oscillator (VCO).	**15**
Unit III	**Microwave Production:** Limitation of convectional electronics devices at UHF, Microwave frequencies, Principle of velocity modulation and current modulation, Multicavity Klystron, Reflex klystron, Theory and uses of cavity magnetron, Strapping, Phase focusing effect, frequency pulling and pushing, Travelling-Wave tube (TWT), Semiconductor microwave devices; PIN & GUNN Diode, Detection of microwave.	**10**
Unit IV	**Microwave Communication:** Advantages and Disadvantages of Microwave transmission, loss in free space, propagation of microwaves, atmospheric effects on prorogation , Fresnel zone problem, ground reflection, Fading, Antenna action, Antennas used in microwave communication system; Antennas with parabolic reflectors, Horn antennas, Lens antennas.	**10**

Suggested Readings:

1. Coughlin: Operational Amplifiers and Linear Integrated Circuits.
2. Schilling & Belove: Electronic circuits Discrete and Integrated, Mcgraw Hill
3. Millman &Halkias: Electronic Fundamentals & Applications, Tata Mcgraw Hill
4. Millman &Halkias: Integrated Electronics
5. R. Botkar: Integrated Circuits, Khanna Publishers
6. V.K. Mithal& Ravi Mittal: Electronic Devices & Circuits, Khanna Publishers
7. Malmstadt &Enke: Electronics for scientists
8. Taub & Schilling: Principal of communication systems
9. Simon Gayukti: Communication Systems
10. Martin S. Roden: Analog & Digital Communication Systems
11. Terman: Electronic & Radio Engineering

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL) https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A16 (b3))					
Programme: Discipline Specific Elective			**Year: V**		**Semester: X**
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
Astrophysics-III DSE A16 (b3)	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

This course provides the basic physical mechanisms about the solar activities, which will help to probe the Sun- Earth connection. This study provides the knowledge of Astroseismology, classification of stars and the distribution in Galaxies.

UNIT	TOPIC	No. of Lectures
UNIT I	Sun as a star: Solar spectrum, effective temperature, luminosity, photospheric absorption lines, limb darkening; energy source: Kelvin time scale, nuclear fusion; energy transport in the sun, Thomson scattering, mean free path, photon diffusion inside the Sun; photosphere, chromosphere, transition region, corona.	10
UNIT II	Quiet and Active Sun, Sunspots, their formation and magnetic field, Solar flares, Solar filaments/prominences, Coronal mass ejections (CMEs), Solar wind, Different type of solar eruptions models, Coronal heating, Solar Cycle, General idea of Heliosesmology, Astroseismology, Description about p-mode and g-mode oscillations, Introduction to variable stars and their locations in H-R diagram.	15
UNIT III	The Milky way and Other Galaxies Distributions of stars in the Milky way, Morphology, Kinematics, Interstellar medium, Galactic center. External galaxies, Types of galaxies: spirals, ellipticals and irregulars, Hubble classification for galaxies, 21cm line, rotation cure, dark matter.	10
UNIT IV	Principle of equivalence and principle of general covariance, Principal of general gravitational field, Metric tensor and gravity, Geodesics, Christoffel symbols, Space- time curvature and curvature tensor, Riemann curvature tensor, Bianchi identity, Ricci tensor, Einstein's field equations , Centrally Symmetric Fields, Metric in spherically symmetric space-time (Schwarzchild metric).	10

Suggested Readings:

1. Stix: The Sun: An Introduction
2. K. D. Abhyankar : Astrophysics: Stars and Galaxies
3. T. Padmanabhan : Galaxies and Cosmology Motz : Astrophysics
4. I. Zhelyazkov and R. Chandra : Kelvin_Helmholtz Instability In Solar Atmosphere Jets, Word Scientific
5. R. K. Pathria, The Theory of Relativity, Hindustan Publishing Corpn, (India

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A16 (c3))					
Programme: Discipline Specific Elective			**Year: V**		**Semester: X**
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A16 (c3): High Energy Physics-III	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

The course would provide the knowledge of advanced concepts of HEP. The students will be able to know the complicated theory of Relativistic propagators, S matrix expansion and S matrix formulation of QED. It would open doors for the students who want to work in thefield of HEP.

UNIT	**TOPIC**	**No. of Lectures**
UNIT I	**Relativistic Propagators I** Relativistic propagators using quantized formulation of free fields, Properties of quantized scalar fields (Real and complex cases), Algebra of field operators, covariant form of the field operators algebras, (Covariant commutation relations), Meson propagator and its characteristics,	**10**
UNIT II	**Relativistic Propagators II** Properties of quantized spinor fields, Algebras of spinor field operator, Covariant form of anti-commutation relations, Fermion propagator and its characteristics, properties of quantized EM field, Covariant commutation relations of EM field operators, Photon propagator and its characteristics, EM interaction in terms of radiation field and instantaneous coulomb fields.	**10**
UNIT III	**Operator Products, Feynman Propagators and S-matrix Expansion** Various type of operator products (Normal, Dyson products and Chronological T-products), Wick's theorem, Feynman propagators	**10**

	and its physical interpretation, Interacting fields, S-Matrix formulation as a perturbative series solution of collision processes, Dyson expansion of S-matrix.	
UNIT IV	**S-matrix Formulation of QED** Interaction Hamiltonian in QED, Reduction of S-matrix for the case of QED, Representation and description of various first and second order processes in QED using S-matrix expansion Compton scattering, Moller scattering, Bhabha scattering, Electron self energy, Photon self-energy, vacuum configuration in QED, Feynman diagrams and Feynman Rules in QED.	**15**

Suggested Readings:

1. Ryder : Quantum Field Theory
2. B.K. Agarwal: Quantum Mechanics and Field Theory
3. F Mandel and G. Shaw: Quantum Field Theory
4. Roman: Quantum Field Theory
5. A. Das: Quantum Field theory
6. M. E. Peskin, D.V. Schroeder: An Introduction to Quantum FieldTheory

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A16 (d3))					
Programme: Discipline Specific Elective				**Year: V**	**Semester: X**
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A16 (d3): Spectroscopy-III	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

Through this coursework students will get a deep knowledge about the molecular symmetries and group theory, mechanism behind the absorption and emission of photon and related phenomena. Also, after attending the course a student will be acquainted with fluorescence measurement techniques and recent advances in fluorescence spectroscopy.

Knowledge acquired by the course will be of much use for various industries and R&D sector

UNIT	TOPIC	No. of Lectures
UNIT I	**Molecular Symmetries and Group Theory:** Symmetry Properties of molecule: symmetry element, symmetry operation and point group, character table, Group theory: representation of a group, reducible and irreducible representations, LCAO coefficient of a polyatomic molecule, Huckel approximation, overlap and resonance integrals.	**10**
UNIT II	**Mechanism of Absorption and Fluorescence:** Theory of absorption spectroscopy, differential absorption spectroscopy(circular Dichroism), Mechanism of fluorescence emission and decay, radiative & nonradiative processes, Jablonski diagram, Kasha rule, Mirror image rule, Oscillator strength, Stoke's shift, Fluorescence lifetime and quantum yield, Environmental effects on absorption and fluorescence spectra, Time scale of molecular processes in solution, Fluorescence sensing and quenching, Fluorescence polarisation and Anisotropy.	**15**
UNIT III	**Instrumentation for Absorption and Fluorescence Spectroscopy:** Absorption, Excitation and Emission spectra, UV – Vis spectrophotometer, Basic instrumentation of steady state and time resolved fluorometer, An ideal spectrofluorometer, Principle of Time Correlated Single Photon Counting (TCSPC), Light sources, Monochromator, Optical filters, Photomultiplier tubes, Distribution in Excitation & Emission spectra, Photon counting versus Analog detection of Fluorescence Corrected Fluorescence spectra, Circular Dichroism, Applications of steady state and time resolved measurements,.	**10**
UNIT IV	**Advances in Fluorescence Spectroscopy:** Concept of fluorescence lifetime imaging, Theory and principle of Fluorescence Correlation Spectroscopy and Single molecule fluorescence spectroscopy, Applications of fluorescence spectroscopy.	**10**

Suggested Readings:

1. Barrow G.M: Introduction to Molecular spectroscopy; McgrawHill
2. Herzberg G: Infrared and Raman Spectra of Polyatomic Molecules;
3. Von Nostrand Herzberg G: Spectra of Polyatomic Molecules;
4. J. R. Lackowicz: Principle of Fluorescence
5. Bernard Valeur and Mário Nuno Berberan-Santos: Molecular fluorescence (Principles and Applications)
6. King G.W: Spectroscopy and Molecular Structure

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A16(e3))					
Programme: Discipline Specific Elective			**Year: V**	**Semester: IX**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A16(e3): Condensed Matter Physics – III	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

Topics covered in this paper deals about dielectric properties of matter, Crystallography, and Microscopy & Surface Topography. This course would encourage students to peruse higher study and research in Condensed Matter Physics.

UNIT	**TOPIC**	**No. of Lectures**
UNIT I	**Dielectric properties of matter:** Polarization (ionic, electronic, orientation) Dielectric and ferroelectric properties of matter, polarizability, Clauses-Mossotti relation. Temperature dependence and frequency dependence of dielectric constant, dielectric loss and dielectric strength, Piezoelectricity. Langevin's theory of polarization.	**15**

UNIT II	**Advance Methods of Crystallography**: Different sources of error in Powder method of X-ray photography, Determination of errorfunction for powder method, Accurate determination of lattice parameter, Applications ofpowder method, Moving film methods and advance methods of crystallography	**10**
UNIT III	**Methods of Microscopy and Surface Topography:** Observation of surface imperfections using X-ray, Electron microscopy: Transmission Electron Microscopy, Surface Scanning Electron Microscopy and Scanning-TunnelingElectron Microscopy, Atomic force microscopy (AFM).	**10**
UNIT IV	**Discarded Systems:** Concept of order, long range and short-range order, Concept of impurity states in condensed matter system, Shallow impurity states in semi conductor, deep traps in condense matter systems, colourcentre of an ionic crystal system, Disorder in condensed Matter system: substitutional positional and topological disorders.	**10**

Suggested Readings:

1. C. S. Kittel: Introduction to solid state Physics.
2. C. S. Kittel: Quantum theory of Solids.
3. Verma and Srivastava: Crystallography for solid state Physicists.
4. Madelung: Solid State Physics.

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A17 (a4)					
Programme: Discipline Specific Elective			**Year: V**	**Semester: X**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A17 (a4): Advanced Electronics-IV	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

This course helps the students to gain basic ideas of the construction and working of electronic devices and circuits. The course includes the study of combinational circuits, sequential circuits and analog computation. The course is of much practical purpose for the students to learn the basics of digital electronics. The digital electronics have wide applications in computing, process control, signal processing, communication systems, digital instruments etc.

UNIT	TOPIC	No. of Lectures
UNIT I	**Analog Computation** Solution of ordinary linear differential equations with constant coefficients, Operation modes of analog computers, repetitive operation of computers, Time scaling, amplitude scaling, Combined time and amplitude scaling, Generation of functions, Simulation of time varying systems.	**10**
UNIT II	**Logic Circuits and Logic Families** Canonical and standard forms of Boolean functions, Algebraic simplification of Boolean equations. Karnaugh maps, Construction of K-maps from truth tables, don't care conditions, NAND and NOR implementations. The Tabulation method, Determination and selection of prime implicants, Classification of Digital logic families. Digital to Analog and Analog to Digital converters.	**15**
UNIT III	**Combinational Circuits** Adders & Subtractors, Magnitude comparators, Code converters; Parallel adders, Encoders, Decoders, Multiplexers, Demultiplexers, Parity bit generator and checker, read-only memory (PROM, EPROM), ROM applications, Programmable Logical Array (PLA).	**10**
UNIT IV	**Sequential Circuits** Sequential logic- Memory element, RS, JK, JKMS, T type and Edge triggered Flip flop; Registers; Shift register; Counters—synchronous and Asynchronous; The memory unit; Semiconductor Random Access Memory; Inter-register transfer; Arithmetic; Logic and Shift Micro-operation; Fixed point and floating point data.	**10**

Suggested Readings:

1. Morris Mano: Digital Logic & Computer Design
2. Rajaraman: Introduction to Digital Computer design
3. Malvino& Leech Sloan: Computer Hardware & Organization
4. V. Rajaraman: Analog Computation & Simulation Integrated Circuits.
5. Schilling & Belove: Electronic circuits Discrete and Integrated,Mcgraw Hill
6. Millman &Halkias: Electronic Fundamentals & Applications, TataMcgraw Hill

7. Millman &Halkias: Integrated Electronics
8. K.R. Botkar: Integrated Circuits, Khanna Publisher
9. G.K. Mithal& Ravi Mittal: Electronic Devices & Circuits, KhannaPublisher

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE DSE A17 (b4)					
Programme: Discipline Specific Elective			**Year: V**	**Semester: X**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A17 (b4): Astrophysics-IV	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

This course will provide the basic properties of stars, birth and the evolution of stars. In addition of this, it provides the deep understanding about the star clusters and their properties, e.g. luminosity and mass function, mass-luminosity relations etc.

UNIT	**TOPIC**	**No. of Lectures**
UNIT I	Basic Properties of Stars: Mass, radius, distance, luminosity, temperature, magnitude system, Wien-displacement colour indices, filters, H-R diagram, classification of stellar spectra, luminosity classification, stellar motion, stellar populations	**10**
UNIT II	Star Formation and Stellar Evolution: Birth of stars, protostar, Pre-main sequence evolution: Jeans instability, star formation, Hayashi track, Zero age main sequence (ZAMS), Post-main sequence evolution: Core He burning, shell burning, red giant phase, planetary nebulae, white dwarf physics, electron degeneracy pressure, energy generation in stars – gravitational contraction, pp chain, CNO cycle and triple alpha process, stellar life, cycles-Premain sequence, main sequence, giants.	**15**
UNIT III	Star Cluster and their Properties : Open clusters, globular clusters and the galaxy itself are examples of 'stellar systems'; crossing time; mean potential and total potential energy in a constant density sphere; equation of motion of N-body stellar system; total momentum, angular momentum and energy as constants of motion, stellar	**10**

	population, population I and II type objects, inter-stellar extension, reddening determination from color color diagram, age and distance determination of star clusters, luminosity function, mass function, mass segregation, mass-luminosity relation.	
UNIT IV	Cosmological Models: Universe at large scales – Homogeneity and isotropy – distance ladder – Newtonian cosmology - expansion and redshift - Cosmological Principle - Hubble's law - Robertson-Walker metric - Observable quantities – luminosity and angular diameter distances - Horizon distance- Dynamics of Friedman- Robertson-Walker models: Friedmann equations, Weyl's postulate, Big-bang and steady state models of the universe.	**10**

Suggested Readings:

1. Abhyankar K.D. : Astrophysics, Galaxies and Stars
2. Vaidyanth Basu : An Introduction to Astrophysics
3. Motz : Astrophysics
4. T. Padmanabhan : Stars and Stellar Systems
5. L Kutner: Astronomy: A Physical Perspective

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A17 (c4))					
Programme: Discipline Specific Elective			**Year: V**	**Semester: X**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A17 (c4): High Energy Physics-IV	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

The course would provide the knowledge of some more advanced concepts of HEP. Thestudents will also be able to learn the detailed theory of weak interactions, electromagnetic interactions and strong interactions.

UNIT	TOPIC	No. of Lectures
UNIT I	**Quarks and Gluons:** Quark-Lepton Symmetry, Theoretical and experimental need of charm quark, J/ψ and Charm, Three generations of quark and leptons: from bottom to Top quark, Positive facets of quark model , Paradoxes of the Naive Quark Model, Need of color quantum number for Quarks, Gluons, Standard Model and Fundamental Particles , Symmetry and Quark model, Color octet and singlet of Gluons, diquark and exotic hadrons, Color SU(3), SU(3) color ladder operators, concept of colorless hadrons .	**10**
UNIT II	**Strong Interaction :** The basic difference between QED and QCD, QCD Lagrangian, SU(3) global color gauge invariance and concept of 8 conserved currents, SU(3) local color gauge symmetry and QCD ,basic idea of Asymptotic freedom and Perturbative QCD, Experimental indication for quarks and gluons, String model of hadrons and concept of confinement of Quarks, Classification of Hadrons and Regge Trajectories.	**10**
UNIT III	**Weak Interaction:** Classification of weak interaction in terms of Leptonic, Semi-leptonic and non-leptonic weak Decays, Fermi Non relativistic theory of beta decay, Fermi &Gammow Teller transitions and their selection rules, Parity violation in weak interaction, Helicity of particle, Helicity operator, Two component theory of Neutrinos, Fermi's relativistic theory of beta decay, concept of weak hadron current and lepton current, Current-Current Interaction and V-A theory.	**15**
UNIT IV	**Weak Gauge Bosons & Weak currents:** Universality of weak interactions, Intermediate Vector Boson (IVB) concept, Cabibbo theory, Cabibbo angle, Consequences of Cabibbo theory, Quark lepton Universality, Weak Isospin and weak hypercharge, W and Z bosons as weak gauge bosons, Charged and neutral weak currents, Conservation of Vector Current (CVC) Hypothesis, Elementary Idea of Unification of Fundamental Interactions with reference to standard model of electro weak unification	**10**

Suggested Readings:

1. E Close : Quarks and Patrons
2. I.J. Aitchison and A.J. Hey : Gaugetheories in Particle Physics

3. F. Haltzin& A.D. Martin : Quarks andLeptons
4. D.H. Perkins : Introduction of High Energy Physics, CambridgeUniversity Press 2000
5. P.Cheng and G.LF Li : Gauge Field TheoryED Commins : Weak Interactions
6. D.C. Cheng and O Neil : Elementary Particle Physics

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE DSE A17 (d4)					
Programme: Discipline Specific Elective			**Year: V**	**Semester: X**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A17 (d4): Spectroscopy-IV	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

The course content covers the propagation of electromagnetic waves in nonlinear media. The course provides students with knowledge of laser physics and introduces them to nonlinear optics and spectroscopy applications. Students will be learning different nonlinear processes as an outcome under light matter interaction in nonlinear media. In addition, they will also have knowledge about holography, multiphoton processes, Raman scattering, Raman spectroscopy etc. Knowledge acquired by the course will be of much use for various industries and R&D sector.

UNIT	TOPIC	No. of Lectures
UNIT I	**Ultrashort Pulses and Dynamics of Laser Processes**: Production of giant pulse, Q-switching by different types of shutters, giant pulse dynamics, laser amplifiers, mode locking, mode pulling, ultra shot pulses, hole burning, Principle and theory of Holography, Characteristics of Holograms, Applications and advances in Holography.	**15**
UNIT II	**Non-Linear Optics:** Harmonic generation, phase matching, second harmonic generation, third harmonic generation, optical mixing, parametric generation of light, Self focusing of light.	**10**
UNIT III	**Multi Photon Processes:** Multi quantum photoelectric effect, two photon processes, experiments in two photon processes, parametric light oscillator, frequency up-conversion, phase conjugate optics, Femtosecond laser.	**10**
UNIT IV	Rayleigh and Raman scattering, Stimulated Raman effect, coherent stokes & anti-stokes, Raman scattering, Resonance Raman spectroscopy, surface enhanced Raman Spectroscopy, Hyper Raman effect, Photo acoustic Raman Spectroscopy, Spin – flip laser, Free electron laser, Laser stark spectroscopy	**10**

Suggested Readings:

1. Marc D. Levenson: Introduction to non-linear laser spectroscopy
2. B.B. Laud: Lasers and Non-linear optics
3. Orazio Svelto: Principles of Lasers
4. Wolfgang Demtröder: Laser Spectroscopy

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/

2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

DISCIPLINE SPECIFIC ELECTIVE (DSE A17(e4))					
Programme: Discipline Specific Elective			**Year: V**	**Semester: X**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
DSE A17 (e4): Advanced Condensed Matter Physics – IV	3	3	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

Topics covered in this paper deals about exotic solids, soft matter, and Thin film and Surface States. This course would encourage students to pursue higher study and research in Condensed Matter Physics.

UNIT	**TOPIC**	**No. of Lectures**
UNIT I	**Exotic solids:** Structure and symmetry of liquids, Amorphous solids, Quasicrystals,Glass transition temperature. Alloys, solid solutions, substitutional solid solutions, Kondo effect, order disorder trandformation, theory of order eutectic phase diagrams. Transition metal alloys. Heat capacity and thermal conductivity of amorphous solids.	**15**
UNIT II	**Soft Matter**: Definition of Soft matters, Properties, phases and applications of liquid crystals, Polymer, Polymer systems and its Physical aspects, Universal Properties of a single polymer chain, Bio-polymers and applications of Polymer systems.	**10**
UNIT III	**Thin film and Surface States:** Definition and proprieties of thin films, Difference in the properties of a thin film from it'scorresponding bulk material, Boltzmann Transport equation for diffused Scattering ofelectron in the thin film, surface states, and surface reconstruction, metallic surface.	**10**
UNIT IV	**Relaxation and resonance phenomena:** Principle of electron spin resonance, Zeeman Splitting, ESR spectrometer, relaxation, hyperfine structure, resonance. Principle of Nuclear magnetic resonance and its applications. Magnetic resonance imaging, principle and image processing.	**10**

Suggested Readings:

1. C. S. Kittel: Introduction to solid state Physics.
2. C. S. Kittel: Quantum theory of Solids.

3. Poole: Nanotechnology
4. K. L. Chopra: Thin Film
5. Steinhardt and Ostulund: The Physics of Quasicrystals
6. Chandrasekhar: Liquid-Crystal

Suggested Equivalent Online Courses

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/currenthe/8

GENERAL ELECTIVE (GE P 13(a))					
Programme: GENERAL ELECTIVE			**Year: V**	**Semester: X**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
(GE P13 (a)): Medical Physics	4	3	1	According to University Ordinance	According to University Ordinance

Course Outcomes

The course content covers the concepts of Medical Physics. The course provides students with knowledge of Medical physics and introduces them Mechanics of Human Body, Physics of Respiratory and Cardiovascular System, Diagnostic X-Rays and Nuclear Medicine Production. Knowledge acquired by the course will be of much use in Medical field and R&D sector.

Unit	Topic	No. of Lectures
Unit I	Mechanics of Human Body Static , Dynamic and Frictional forces in the Body, Composition, properties and functions of Bone, Heat and Temperature, Temperature scales, Clinical thermometer, Thermography, Heat therapy, Cryogenics in medicine, Heat losses from Body, Pressure in the Body, Pressure in skull, Eye and Urinary Bladder.	15
Unit II	Physics of Respiratory and Cardiovascular System, Body as a machine, Airways, Blood and Lungs interactions, Measurement of Lung volume, Structure and Physics of Alveoli, Breathing mechanism, Airway resistance, Components and functions of Cardiovascular systems, work done by Heart, Components and flow of Blood, Laminar and Turbulent flow, blood Pressure, direct and indirect method of measuring, Heart sounds.	15
Unit III	Electricity in the Body and Sound/Light In Medicine, Nervous system and Neuron ,Electrical potentials of Nerves, Electric signals from Muscles, Eye and Heart, Block diagram and working to record EMG, Normal ECG wave form, Electrodes for ECG, Amplifier and Recording device, Block diagram and working to record ECG, Patient monitoring, Pace maker.	15
Unit IV	Diagnostic X-Rays and Nuclear Medicine Production and properties of X-	`

	rays, Basic Diagnostic X-ray Machine, X-ray image, Live X- ray image, X-ray computed Tomography, Characteristics of Radio activity, Radioisotopes and Radio nuclides, Radioactivity sources for Nuclear medicine.	15

Suggested Readings

1. Medical Physics by Department of Physics, St. Joseph's College,Trichy-
2. Medical Physics by John R. Cameron and James G. Skofronick, John Wiley & Sons.
3. Hand book of Biomedical Instrumentation : R.S.Khandpur, Tata McGraw Hill Publication Co., Delhi, 1987.

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

OR

GENERAL ELECTIVE (GE P 13(b2))					
Programme: GENERAL ELECTIVE		**Year: V**		**Semester: X**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
(GE P13 (a)): Photonics-II	4	3	1	According to University Ordinance	According to University Ordinance

Course Outcomes:

1. To Gain sufficient knowledge in the area of laser technology
2. To Classify optical fibers based on their refractive index profiles
3. To Examine the loss mechanisms in optical fibers and to compute various losses
4. To Understand the non-linear coefficient and conversion efficiency for various non-linear phenomena
5. To Understand and visualise the different quantum states of light for their applications in the field of quantum technology

Unit	**Topic (Theory / Experiments/hands on training)**	**No. of Lectures**
Unit I	**Lasers:** interaction of radiation and matter, Einstein coefficients, condition for amplification. Optical resonators, Condition for laser oscillation. Longitudinal and transverse modes of a laser. Some Laser	**12**

	Systems.	
Unit II	**Fiber Optics:** Light propagation in optical fibers, Attenuation and dispersion; Single-mode fibers, material dispersion. Optical fiber communication, Fiber amplifiers and lasers. Optical fibers in sensing.	**12**
Unit III	**Electro-Optic (E.O) Effect:** Phase-and amplitude modulators. E.O. effect in liquid crystals; LCDs and SLMs. Magneto-optic effect: Faraday rotation. Acousto-Optic (A.O.) Effect: Raman-Nath and Bragg diffraction; A.O. modulators and deflectors.	**12**
Unit IV	**Nonlinear Optics:** Second order and third order effects, Phase-matching schemes. Self-phase modulation and optical solitons; Cross phase modulation and four wave mixing. Stimulated Raman scattering (SRS) and stimulated Brillouin scattering (SBS)	**12**
Unit V	**Quantum Optics:** Quantum states of light and their properties, Generation and detection of quantum light Entanglement and its applications: quantum computing, cryptography and teleportation.	**12**

Suggested Reading

1. Optics, Ajoy Ghatak, 6th edition, Tata McGraw Hill, (2017)
2. Optics, Eugene Hecht and A R Ganesan , 4th Edition, Pearson Education (2008) (Text)
3. An introduction to Fiber Optics, Ghatak and Thyagarajan, Cambridge University Press, 1998.
4. Fundamentals of Fibre Optic Telecommunication -B. P. Pal., Wiley Eastern (1994)
5. Fibre optic sensors - principles and applications - B.D.Gupta, New India Publishing, (2006).
6. Lasers: Fundamentals and Applications, K. Thyagarajan and Ajoy Ghatak, Springer, 2nd edition (2011)
7. Nonlinear optics- Robert W Boyd, Academic Press, Elsevier, Inc (Third Edition) (2008),
8. Physics of nonlinear optics-Guang S He and Song H Lie, world scientific , London (1999)
9. Quantum Optics an Introduction - Mark Fox Oxford University press Press (2004)
10. Optical Coherence and quantum optics, Leonard Mandel, Emil Wolf, Cambridge University Press, 2nd Edition (2013)

GENERAL ELECTIVE (GE P 14)					
Programme: GENERAL ELECTIVE			**Year: V**	**Semester: X**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Lecture	**Tutorial**		
GE P 14: Basics of Astrophysics	4	3	1	According to University Ordinance	According to University Ordinance

Course Outcomes:
This course will provide the basic properties of stars. In addition of this, it provides the understanding about the sun and solar system and their properties.

Unit	Topic	No. of Lectures
Unit I	**Introduction to Astronomy:** History of astronomy, Overview of the night sky, basic concepts of positional astronomy: celestial sphere, astronomical coordinate systems, circumpolar stars; sidereal and solar day, Size and time scales in astronomy, Stars physical parameters: Temperature, distance, luminosity, mass and size. Basic idea of HR diagram.	**15**
Unit II	**The Sun:** Solar parameters, Sun's internal structure: Core, Radiative, and converctive zone, Sun's outer structure: photosphere, chromosphere, and corona, Quiet Sun: granulations, supergranulations, plages, faculae, Active Sun: Sunspots, filaments/prominences, solar flares and coronal mass ejections.	**15**
Unit III	**Our Solar System:** Overview of Solar system, Solar system planets, Formation of Solar System, Planetary Atmospheres: Structure, Composition, planet atmospheres, extrasolar planets, Earth-Moon System, Comets, Meteorites, Interplanetary dust	**15**
Unit IV	**Telescopes and instrumentation :** Telescope mounting, plate scale, resolving power, and diffraction limits of telescopes. Optical telescopes: Galilean, Newtonian, Cassegranian, Hubble space telescope, Photo-multiplier tube, charge-coupled devices (CCDs).	**15**

Suggested readings

1. Fundamental Astronomy, H. Karttunen et al., Springer Berlin, Heidelberg
2. Modern Astrophysics, B. W. Carroll and D. A. Ostlie, Addison-Wesley Publishing Co.
3. Introductory Astronomy and Astrophysics, M. Zeilik and S. A. Gregory, Saunders
4. College Publishing.
5. Astronomy in India: A Historical Perspective, T. Padmanabhan, Springer

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. SwayamPrabha - DTH Channel,
4. https://www.swayamprabha.gov.in/index.php/program/current_he/8

PRACTICALS					
Programme: PRACTICALS			**Year: V**	**Semester: X**	
Course Title & Code	**Credits**	**Credit distribution of the course**		**Eligibility Criteria**	**Pre-requisite of the course**
		Practicals	**Tutorial**		
Practicals	4	4	0	According to University Ordinance	According to University Ordinance

Course Outcomes:

The student will have adequate knowledge to perform the experiments of different fields of physics with clear understanding of the theory behind the experiment. Student will know about advanced experiments based on their specialization paper.

UNIT	TOPIC	No. of Lectures
	List of Experiments: (a) Advanced Electronics 1. Study of regulated power supply (723). 2. Study of operational amplifier (741). 3. Study of Timer (555). 4. A to D and D to A converter 5. 1 of 16 Decoder/Encoder 6. Study of Multiplexer/Demultiplexer 7. Study of Logic gates (Different types) 8. Study of Comparator and Decoder 9. Study of amplitude and frequency modulations anddemodulations. 10. Study of different flip- flop circuits (RS, JK, Dk type, T-type, Master slave). 11. Study of Digital combinational and sequential circuits 12. Study of Microprocessor (8085) 13. Study of SCR, DIAC,TRIAC 14. Study of IC- Based Power supply 15. Microwave experiment. 16. Shift Registers 17. Fiber Optics communication	60
	List of Experiments: (b) Astrophysics 1. Study of Hubble's law and age of Universe (from given data) 2. Study of constant density neutron star 3. Study of the static parameters of a Neutron Star model withinverse square density distribution 4. Study of star cluster from a given data 5. Study of Extinction coefficients 6. Study of variability of stars 7. Study of solar limb Darkening 8. Study of solar differential rotation. 9. Measuring extension of the atmosphere in B, V and R bands	60

10. Measuring the colour of star using differential photometer data
11. Determination of age star cluster
12. Determination of reddening in a star cluster.

List of Experiments: (c) High Energy Physics

1. Characteristic curve of a GM Detector and verification ofinverse square law .
2. Characteristic curve of a GM Detector and Absorptioncoefficient of a using aluminum GM Detector.
3. Energy spectrum of gamma rays using gamma rayspectrometer.
4. Absorption coefficient of aluminum using gama-rayspectrometer.
5. Characteristics of Scintillation Detector.
6. Study of gama-gama unperturbed angular correlations.
7. Study of particle tracks using a Nuclear Emulsion Detector.
8. Classification of tracks in interaction with Nuclear Emulsion and determination of excitation energy.

List of Experiments: (d) Spectroscopy

1. Study of the vibrational levels of Iodine.
2. Evaluation of wavelength of He- Ne laser (green/ red) by constructing diffraction pattern with the help of (a) diffraction grating and (b)vernier callipers.
3. Measurement of absorptivity coefficient oscillator strength of a known sample using UV-Visible spectrum.
4. Determination of the non-radiative decay rates and intrinsic life-time of a given fluorescent molecule.
5. Determination of Stoke shift and change in dipole moment using Solvatochromic shift method.
6. Determination of the quantum yield of known samples using Steady state measurements.
7. To determine the slit width with the help of double slit experiment.

List of Experiments: (e) Condensed Matter Physics

1. Determination of elastic constant of crystals by optical methods.
2. Study of fluorescence spectra of a given compound.
3. Study of colour centers.
4. Determination of lattice parameters using powder method.
5. Determination of hall coefficient using Hall effect.
6. Determination of Energy gap of a semiconductor by four probe method.