

**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 advanced concepts of Physics and ability to apply this knowledge in various fields of academics, research and industry. They may pursue their future career in the field of academics, research and industry.

<b>PO1</b>	Competence in the methods and techniques of calculations using Mathematical Physics, Classical Mechanics, Quantum Mechanics and Communication Electronics. It will develop 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
<b>PO2</b>	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)					
<b>Programme: DISCIPLINE SPECIFIC COURSE</b>				<b>Year: IV</b>	<b>Semester: VII</b>
<b>Subject: Physics</b>					
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
<b>Course Outcomes</b>					
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
<b>UNIT I</b>	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.				<b>10</b>
<b>UNIT II</b>	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).				<b>10</b>

<b>UNIT III</b>	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.	<b>10</b>
<b>UNIT IV</b>	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.	<b>15</b>

**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](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

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		
<b>DSE A6: Classical Mechanics</b>	3	3	0	B.Sc. with Physics	B.Sc. with Physics
<b>Course Outcomes:</b> 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
<b>UNIT I</b>	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.				<b>10</b>
<b>UNIT II</b>	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.				<b>15</b>
<b>UNIT III</b>	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.				<b>10</b>
<b>UNIT IV</b>	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				<b>10</b>

**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 : Classical Mechanics, 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](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		
<b>DSE A7: Quantum Mechanics</b>	3	3	0	B.Sc. with Physics	B.Sc. with Physics
<p><b>Course Outcomes:</b>            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 formulations of 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.</p>					
UNIT	TOPIC				No. of Lectures
<b>UNIT I</b>	<b>Non-Relativistic Quantum Mechanics and Schrödinger Equation</b> 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 its wave functions, Hydrogen atom.				<b>15</b>
<b>UNIT II</b>	<b>Operator Formulation of Quantum Mechanics</b> 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				<b>10</b>
<b>UNIT III</b>	<b>Theory of Angular Momentum</b> Orbital Angular momentum operator, its eigen value and eigen functions, space quantization, spin angular momentum, Pauli's theory of spin, Addition of angular momentum, ClebschGordan coefficients				<b>10</b>
<b>UNIT IV</b>	<b>Approximation Methods and Time independent Perturbation Theory</b> Stationary Perturbation, first and second order corrections, WKB approximation methods, connection formula and boundary				<b>10</b>

	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.	
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### Suggested Readings

1. B. S. Rajput: Advanced Quantum Mechanics Schiff: 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](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		
<b>DSE A8: Communication Electronics</b>	3	3	0	B.Sc. with Physics	B.Sc. with Physics
<b>Course Outcomes</b> 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	TOPI C				No. of Lectures
<b>UNIT I</b>	Modulation AM and FM (Transmission and reception): Modulation, AM generation, over 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				<b>10</b>

<b>UNIT II</b>	Propagation of Radio Waves Ground wave, sky wave and space wave propagation. Ionosphere (Ecclr- larmer theory, magneto ionic theory.	<b>10</b>
<b>UNIT III</b>	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.	<b>10</b>
<b>UNIT IV</b>	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, TE <sub>10</sub> mode and cut off wavelength, cavity resonator, light propagation in cylindrical wave guide, step index and graded index fibers, attenuation and dispersion in fibers	<b>15</b>

**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](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		
<b>GE P7: Renewable Sources of Energy</b>	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
<b>Unit I</b>	Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in wind Energy.	<b>15</b>
<b>Unit II</b>	Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.	<b>15</b>
<b>Unit III</b>	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.	<b>15</b>
<b>Unit IV</b>	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	<b>15</b>

**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., 2<sup>nd</sup> 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		
<b>GE P8: Radiation Physics</b>	3	3	1	B.Sc. with Physics	B.Sc. with Physics
<b>Course Outcomes:</b> 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
<b>Unit I</b>	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.				<b>15</b>
<b>Unit II</b>	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.				<b>15</b>
<b>Unit III</b>	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.				<b>15</b>
<b>Unit IV</b>	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.				<b>15</b>

#### 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
<b>Course Outcomes:</b> Student would gain practical knowledge by performing various experiments of Electronics and Optics.					
	List of Experiments				No. of Lectures
	1. Study of RC circuit with an AC source using phase diagrams. 2. Absorption Spectrum of KMnO <sub>4</sub> 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. Lecher Wire				<b>60</b>

**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		
<b>DSC A8: Electrodynamics</b>	3	3	0	According to University Ordinance	According to University Ordinance
<p><b>Course Outcomes:</b></p> <p>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</p>					
UNIT	TOPIC				No. of Lectures
<b>UNIT I</b>	<b>Electromagnetism:</b> 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.				<b>10</b>
<b>UNIT II</b>	<b>Maxwell's Equations:</b> 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				<b>10</b>
<b>UNIT III</b>	<b>Four Vector Formalism of Maxwell's Equations:</b> 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				<b>15</b>
<b>UNIT IV</b>	<b>Electromagnetic Radiation:</b> 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 of the emitted radiation, special cases of acceleration parallel and perpendicular (circular orbit) to velocity; Larmor's formula and its relativistic Generalization; Bremsstrahlung Cerenkov radiation				<b>10</b>

### 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](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		
<b>DSE A9:</b> Atomic and Molecular Spectra	3	3	0	According to University Ordinance	According to University Ordinance
<p><b>Course Outcomes</b></p> <p>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 &amp; D opportunities in various areas of science and technology such as biomedical, industrial and environmental fields.</p>					
UNIT	TOPIC				No. of Lectures
<b>UNIT I</b>	Fine structure of hydrogen spectrum, L-S and J-J coupling, Spectroscopic terms, Hund's rule and time reversal, Pauli's exclusion principle.				<b>10</b>
<b>UNIT II</b>	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).				<b>10</b>

<b>UNIT III</b>	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.	<b>10</b>
<b>UNIT IV</b>	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	<b>15</b>

### 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](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		
<b>DSE A10:</b> Nuclear Physics	3	3	0	According to University Ordinance	According to University Ordinance
<p><b>Course Outcomes:</b> 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.</p>					
UNIT	TOPIC				No. of Lectures
<b>UNIT I</b>	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.				<b>10</b>
<b>UNIT II</b>	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.				<b>10</b>
<b>UNIT III</b>	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.				<b>15</b>

<b>UNIT IV</b>	Nuclear Decays Basic understanding of $\alpha$ and $\beta$ decay, Fermi theory of beta decay, selection rules in $\gamma$ decay, Neutrino hypothesis, Parity violation in beta decay, K capture and internal conversion.	<b>10</b>
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### **Suggested Readings**

1. E. Burcham: Nuclear Physics Ervin Kaplan: Nuclear Physics Roy & Nigam: Nuclear Physics
2. S. N. Ghoshal: Atomic and Nuclear Physics A. 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](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		
<b>DSE A11:</b> 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
<b>UNIT I</b>	<b>Elementary Particles and Conservation Laws:</b> 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.				<b>10</b>
<b>UNIT II</b>	<b>Particle Models:</b> 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.				<b>10</b>
<b>UNIT III</b>	<b>Unitary Symmetries and Young Tableaux:</b> 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				<b>15</b>

	of the tableaux representing different Special Unitary Groups, Dimensionality of the representations of SU(N), Simple product representation using Young Tableaux technique	
<b>UNIT IV</b>	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	<b>10</b>

**Suggested Readings:**

1. D. H. Perkins: Introduction to High Energy Physics, Cambridge University Press, 2000
2. S. N. Ghoshal: Atomic and Nuclear Physics, S. Chand and Company Ltd, 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 Physics FE 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](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

GENERAL ELECTIVE (GE P9)					
Programme: General Elective				Year: IV	Semester: VIII
Course Title & Code	Credits	Credit distribution of the course		Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial		
<b>GE P9:</b> Physics of Weather and Climate	3	3	1	According to University Ordinance	According to University Ordinance
<b>Course Outcomes:</b> 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
<b>Unit I</b>	<b>Elementary idea of atmosphere:</b> 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;				<b>15</b>
<b>Unit II</b>	<b>Atmospheric pressure:</b> 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				<b>15</b>
<b>Unit III</b>	<b>Radiation:</b> 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.				<b>15</b>
<b>Unit IV</b>	<b>Climate and its classification:</b> Causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate.				<b>15</b>

**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: VIII
Course Title & Code	Credits	Credit distribution of the course		Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial		
<b>GE P10 : Digital Electronics and computer architecture</b>	3	3	1	According to University Ordinance	According to University Ordinance
<p>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.</p>					
Unit	Topic				No. of Lectures
Unit I	<b>Elementary idea of combinational and sequential circuits :</b> 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	<b>Computer Organization and Architecture:</b> 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	<b>Application of microprocessor:</b> 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	<b>Data Communication:</b> 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](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
<b>Course Outcomes</b>					
<p>The student will have adequate knowledge to perform the experiments of different fields of physics with clear understanding of the theory behind the experiment.</p> <p>Student will know about various electronic components and learn to design some basic electronic circuits and study their applications.</p>					
UNIT	List of Experiments				No. of Lectures
	<ol style="list-style-type: none"> <li>1. Study of the Phase measurement by superposition of voltages with LCR Circuits.</li> <li>2. Study of different oscillators (Hartely, colpit, Weinbridge oscillators etc.).</li> <li>3. Study of an electronically regulated power supply.</li> <li>4. Study of negative Feed- back Amplifier.</li> <li>5. Determination of wavelength (<math>\lambda</math>) and wavelength difference (<math>\Delta\lambda</math>) by Michelson Interferometer.</li> <li>6. Study of different type of Resistances and Diodes.</li> <li>7. Study of Photo Voltaic Cell.</li> <li>8. Stefan's Constant</li> <li>9. FET characteristics</li> <li>10. Fresnel's Law</li> <li>11. Cauchy Formula</li> <li>12. Lattice Dynamic Kit</li> <li>13. Study of Logic gates</li> <li>14. Detection Efficiency of Diode</li> <li>15. Fabry – Perot Interferometer</li> <li>16. Four Probe method</li> </ol>				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		
<b>DSC A9: Advanced Quantum Mechanics</b>	3	3	0	According to University Ordinance	According to University Ordinance
<b>Course Outcomes:</b> 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
<b>UNIT I</b>	<b>Free particle Dirac equation</b> 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				<b>10</b>

<b>UNIT II</b>	<b>Dirac particle in Electromagnetic Fields</b> 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.	<b>10</b>
<b>UNIT III</b>	<b>Quantum Theory of Scattering</b> 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	<b>15</b>
<b>UNIT IV</b>	<b>Time Dependent Perturbation Theory</b> 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	<b>10</b>

**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. Thankappan V.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](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

<b>DISCIPLINE SPECIFIC ELECTIVE (DSE A12)</b>					
<b>Programme: Discipline Specific Elective</b>				<b>Year: V</b>	<b>Semester: IX</b>
<b>Course Title &amp; Code</b>	<b>Credits</b>	<b>Credit distribution of the course</b>		<b>Eligibility Criteria</b>	<b>Pre-requisite of the course</b>
		<b>Lecture</b>	<b>Tutorial</b>		
<b>DSE A12:</b> Plasma Physics	3	3	0	According to University Ordinance	According to University Ordinance
<b>Course Outcomes:</b> 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.					
<b>UNIT</b>	<b>TOPIC</b>				<b>No. of Lectures</b>
<b>UNIT I</b>	<b>Introduction to Plasma</b> Elementary concept of plasma: Debye Shielding, Plasma parameters, Drift of guiding center, Gradient drift, Curvature drift, Magnetic mirror, Plasma Confinement				<b>10</b>
<b>UNIT II</b>	<b>Magneto-Hydrodynamics and Fluid Plasma</b> Plasma Oscillation, Fluid equations for a plasma, Continuity equation, Wave Propagation in unmagnetized plasma, Magneto Hydrodynamics , Hydrodynamical description of Plasma: fundamental equation, Concept of convective derivative, hydromagnetic waves, magneto- sonic and Alfven waves.				<b>10</b>
<b>UNIT III</b>	<b>Magneto Plasma</b> 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,.				<b>10</b>
<b>UNIT IV</b>	<b>Electromagnetic Wave Propagation in Plasma</b> 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				<b>15</b>

**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](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

<b>DISCIPLINE SPECIFIC ELECTIVE (DSE A13(a1))</b>					
<b>Programme: Discipline Specific Elective</b>				<b>Year: V</b>	<b>Semester: IX</b>
<b>Course Title &amp; Code</b>	<b>Credits</b>	<b>Credit distribution of the course</b>		<b>Eligibility Criteria</b>	<b>Pre-requisite of the course</b>
		<b>Lecture</b>	<b>Tutorial</b>		
<b>DSE A13 (a1): Advanced Electronics- I</b>	3	3	0	According to University Ordinance	According to University Ordinance
<b>Course Outcomes:</b>					
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.					
<b>UNIT</b>	<b>TOPIC</b>				<b>No. of Lectures</b>
<b>UNIT I</b>	<b>Integrated Circuit Technology</b> 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.				<b>10</b>
<b>UNIT II</b>	<b>Operational Amplifier(OP-AMP)</b> Basic OP-AMP, Ideal OP-AMP, Inverting & Non inverting OP – AMP, OP-AMP internal circuit, Differential amplifier, The emmitter 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.				<b>10</b>
<b>UNIT III</b>	<b>Operational Amplifier Applications</b> 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.				<b>10</b>

<b>UNIT IV</b>	<b>Comparator and Waveform Generators</b> 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, Linear ramp generator, Frequency divider, FSK generator, Pulse-Position modulator, Schmitt Trigger.	<b>15</b>
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**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](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

<b>DISCIPLINE SPECIFIC ELECTIVE (DSE A13(b1))</b>					
<b>Programme: Discipline Specific Elective</b>				<b>Year: V</b>	<b>Semester: IX</b>
<b>Course Title &amp; Code</b>	<b>Credits</b>	<b>Credit distribution of the course</b>		<b>Eligibility Criteria</b>	<b>Pre-requisite of the course</b>
		<b>Lecture</b>	<b>Tutorial</b>		
<b>DSE A13 (b1) Astrophysics- I</b>	3	3	0	According to University Ordinance	According to University Ordinance
<p><b>Course Outcomes:</b>            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 spread in use of R&amp; D sector.</p>					
<b>UNIT</b>	<b>TOPIC</b>				<b>No. of Lectures</b>
<b>UNIT I</b>	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. Units of astronomical distance (Astronomical Unit, parsec, lightyear), Distance measurements: distance measurement by geometric means (parallax, distances to open clusters)				10
<b>UNIT II</b>	Structure and components of the solar-system, Origin and evolution, Classification of planets, Earth- Moon system (Phases, eclipses, tides), Asteroids and dwarf planets, Meteoroids.				10
<b>UNIT III</b>	Basic optics for astronomy, Types of telescopes (refracting and reflecting), Different types of telescope focus, Telescope mounting system, Optical and non- optical telescopes (infrared, ultraviolet, x-ray, gamma-ray), Sky charts and their importance				10

<b>UNIT IV</b>	Types of detectors (Photographic plates, Photomultiplier tubes, CCDs), Working principles of CCDs, Application of CCDs in photometry, Detector characteristics (quantum efficiency, noise, dynamic range, linearity), Image Calibration techniques (bias, dark, flat correction). Signal to noise ratio, Astronomical filters and Sources, Space based astronomy and it' s advantages.	15
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**Suggested Readings:**

1. Abhyankar K.D. : Astrophysics, Galaxies and Stars Vaidyanth Basu : An Introduction to Astrophysics Motz : Astrophysics
2. K S Krishnaswamy : Astrophysics: A Modern Perspective
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](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

<b>DISCIPLINE SPECIFIC ELECTIVE (DSE A13(c1))</b>					
<b>Programme: Discipline Specific Elective</b>				<b>Year: V</b>	<b>Semester: IX</b>
<b>Course Title &amp; Code</b>	<b>Credits</b>	<b>Credit distribution of the course</b>		<b>Eligibility Criteria</b>	<b>Pre-requisite of the course</b>
		<b>Lecture</b>	<b>Tutorial</b>		
<b>DSE A13 (c1): High Energy Physics- I</b>	3	3	0	According to University Ordinance	According to University Ordinance
<b>Course Outcomes:</b> 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.					
<b>UNIT</b>	<b>TOPIC</b>				<b>No. of Lectures</b>
<b>UNIT I</b>	<b>Concepts of Quantum Field Theory</b> 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				<b>10</b>
<b>UNIT II</b>	<b>Quantization of Scalar Fields</b> 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				<b>15</b>
<b>UNIT III</b>	<b>Quantization of Spinor Field</b> 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				<b>10</b>
<b>UNIT IV</b>	<b>Quantization of Electromagnetic Field</b> 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.				<b>10</b>

**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](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
<p><b>Course Outcomes:</b></p> <p>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&amp;D sector.</p>					
UNIT	TOPIC				No. of Lectures
UNIT I	<p><b>Rotational spectra:</b> 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.</p>				10
UNIT II	<p><b>Vibrational Spectra:</b> 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 H<sub>2</sub>O and CO<sub>2</sub> molecules, anharmonicity, degenerate and non-degenerate vibrations, inversion doubling, Quantized Vibrational motion of polyatomic molecules.</p>				15
UNIT III	<p><b>Electronic Spectra:</b> Spectroscopy of Diatomic and Polyatomic Molecules: Coupling of Electronic and Rotational motion in Diatomic Molecules and Rotational structure of <math>1\pi - 1\Sigma</math> and <math>1\Sigma</math> - <math>1\Sigma</math> 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</p>				10

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

**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](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

<b>DISCIPLINE SPECIFIC ELECTIVE (DSE A13(e1))</b>					
<b>Programme: Discipline Specific Elective</b>				<b>Year: V</b>	<b>Semester: IX</b>
<b>Course Title &amp; Code</b>	<b>Credits</b>	<b>Credit distribution of the course</b>		<b>Eligibility Criteria</b>	<b>Pre-requisite of the course</b>
		<b>Lecture</b>	<b>Tutorial</b>		
<b>DSE A13 (e1): Condensed Matter Physics-I</b>	3	3	0	According to University Ordinance	According to University Ordinance
<b>Course Outcomes:</b> 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.					
<b>UNIT</b>	<b>TOPIC</b>				<b>No. of Lectures</b>
<b>UNIT I</b>	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.				<b>10</b>
<b>UNIT II</b>	Crystal Structure determination: Introduction and different methods of x-ray diffraction. Structure factor determination of the crystal (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.				<b>15</b>
<b>UNIT III</b>	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.				<b>10</b>
<b>UNIT IV</b>	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 Waller factor. Hyperfine interactions (isomer shift, quadrupole splitting and magnetic splitting), Mössbauer effect and its applications. quantum size effect, special carbon solids, carbon nano tubes and				<b>10</b>

	Fullerene.Ion irradiation properties of crystal.	
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**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](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		
<b>DSE A14 (a2): Advanced Electronics- II</b>	3	3	0	According to University Ordinance	According to University Ordinance
<b>Course Outcomes:</b> 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
<b>UNIT I</b>	<b>Digital Communication:</b> 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.				<b>10</b>

<b>UNIT II</b>	<b>Optical communication:</b> 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.	<b>15</b>
<b>UNIT III</b>	<b>Optical Communication Transmitters, Repeaters and Receivers:</b> 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.	<b>10</b>
<b>UNIT IV</b>	<b>Memory and Optoelectronic devices:</b> 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.	<b>10</b>

### **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](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
<b>Course Outcomes:</b>					
The Course will provide the deeper understanding of the radiative transfer and the interaction of 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 and black 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, Polytropic indices, Lane – Emden equation LTE, Radiative equilibrium, stability condition 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 for Physicists
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](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		
<b>DSE A14 (c2):</b> 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 complex properties. 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
<b>UNIT I</b>	<b>Lie Groups and Lie Algebra:</b> 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,				<b>10</b>
<b>UNIT II</b>	<b>Special Unitary Groups and hadrons :</b> 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.				<b>10</b>
<b>UNIT III</b>	<b>Gauge Symmetry:</b> 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				<b>15</b>

<b>UNIT IV</b>	<b>Spontaneous Symmetry Breaking (SSB):</b> 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.	<b>10</b>
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**Suggested Readings:**

1. E. Close : Quarks and Patrons
2. D.C. Cheng and O Neil : Elementary Particle Physics P.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](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		
<b>DSE A14 (d2): Spectroscopy -II</b>	3	3	0	According to University Ordinance	According to University Ordinance
<p><b>Course Outcomes:</b>            Laser, the light extraordinary, has so many applications in various field even having further potential and hence it has vital need to familiarize lasers &amp; 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.</p>					
UNIT	TOPIC				No. of Lectures
<b>UNIT I</b>	<b>Radiation and Matter:</b> 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.				<b>10</b>
<b>UNIT II</b>	<b>Basic Elements of Lasers:</b> 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.				<b>15</b>
<b>UNIT III</b>	<b>Type of Lasers:</b> Different types of lasers, Principle and working of gas lasers, He-Ne laser, N <sub>2</sub> & CO <sub>2</sub> lasers, dye lasers, solid state lasers, Nd-YAG, semiconductor lasers, Excimer laser, Tunability of lasers				<b>10</b>
<b>UNIT IV</b>	<b>Applications of Lasers:</b> 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				<b>10</b>

**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](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		
<b>DSE A14 (e2): Condensed Matter Physics –II</b>	3	3	0	According to University Ordinance	According to University Ordinance
<p><b>Course Outcomes:</b>            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.</p>					
Unit	Topic				No. of Lectures
<b>Unit I</b>	<b>Thermal Properties of solids:</b> Thermal expansion and thermal conductivity in metals, anharmonicity interaction of electrons and phonons 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.				<b>10</b>
<b>Unit II</b>	<b>Magnetic Properties of Matter:</b> 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, Introductory idea of magneto resistance (GMR & CMR). Hall Effect (integer and fractional) and its applications.				<b>15</b>
<b>Unit III</b>	<b>Optical properties of solids:</b> 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.				<b>10</b>
<b>Unit IV</b>	<b>Superconductivity:</b> Introduction of superconductivity, phenomenological, semi phenomenological and microscopic theories of superconductors. Meissner effect, Type-I and type-II superconductors, 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.				<b>10</b>

**Suggested Readings:**

1. A. J. Dekker: Solid State Physics
2. S.O. Pillai : Solid State Physics
3. C. Kittel : 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](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		
<b>GE P11: Bio-Physics</b>	4	3	1	According to University Ordinance	According to University Ordinance
<b>Course Outcomes:</b>					
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			
<b>Unit I</b>	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			
<b>Unit II</b>	Application of experimental techniques of light scattering (tomography), FTIR and Raman spectroscopy, absorption and fluorescence spectroscopy/ microscopy, anisotropy, optical activity, circular dichroism, electrophoresis,.	15			
<b>Unit III</b>	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			
<b>Unit IV</b>	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 sterility). 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
<p><b>Course Outcomes:</b></p> <ol style="list-style-type: none"> <li>1. To Understand the concept of superposition of waves</li> <li>2. To Explain the concept of coherence</li> <li>3. To Classify interference phenomenon based on division of amplitude and division of wavefront</li> <li>4. To Differentiate between Fresnel and Fraunhofer diffraction</li> <li>5. To Summarize the idea of polarized light, its generation and detection</li> <li>6. To study randomness in optical waves</li> <li>7. To explain the concept of holography</li> </ol>					
Unit	Topic				No. of Lectures
Unit I	<p><b>Wave Optics:</b> 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.</p>				15
Unit II	<p><b>Crystal Optics:</b> 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,</p>				15

	Birefringence, Uniaxial crystals; Analysis of polarized light; some polarization devices.	
<b>Unit III</b>	<b>Statistical Optics:</b> 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	<b>15</b>
<b>Unit IV</b>	<b>Fourier Optics:</b> 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.	<b>15</b>

### Suggested Reading

1. Optics, Ajoy Ghatak, 6<sup>th</sup> edition, Tata McGraw Hill, (2017)
2. Optics, Eugene Hecht and A R Ganesan , 4<sup>th</sup> 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, 4<sup>th</sup> 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](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		
<b>GE P 12: Nanoscience and Nanotechnology</b>	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. Kittel: 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: Nanotechnology: 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](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
<b>Course Outcomes:</b> 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 in Physics					
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 ultrasonic waves. 10. Study of Multivibrators . 11. Study of transistor amplifier cum feedback amplifiers. 12. Study of absorption of KMnO <sub>4</sub> Spectrophotometer 13. Study of different FETs and MOSFETs. 14. Study of Thermo luminance. 15. Study of VTVM.				<b>60</b>

**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

**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		
<b>DSC A10: Solid State Physics</b>	3	3	0	According to University Ordinance	According to University Ordinance
<b>Course Outcomes:</b>					
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
<b>Unit I</b>	<b>Crystal Structure:</b> Crystalline and non-crystalline solids. Lattice, basis, unit cell, co-ordination number, lattice planes and Miller indices. Interplaner 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.				<b>15</b>
<b>Unit II</b>	<b>Bonding in Solids :</b> 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).				<b>10</b>
<b>Unit III</b>	<b>Lattice Vibrations:</b> 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.				<b>10</b>

<b>Unit IV</b>	<b>Crystal Defects:</b> 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.	<b>10</b>
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**Suggested Readings:**

1. A. J. Dekker: Solid State Physics
2. S.O. Pillai : Solid State Physics
3. C. Kittel : Introduction to Solid State Physics
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](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

<b>DISCIPLINE SPECIFIC ELECTIVE (DSE A15)</b>					
<b>Programme: Discipline Specific Elective</b>			<b>Year: V</b>	<b>Semester: X</b>	
<b>Course Title &amp; Code</b>	<b>Credits</b>	<b>Credit distribution of the course</b>		<b>Eligibility Criteria</b>	<b>Pre-requisite of the course</b>
		<b>Lecture</b>	<b>Tutorial</b>		
<b>DSE A15:</b> Statistical Physics	3	3	0	According to University Ordinance	According to University Ordinance
<b>Course Outcomes:</b> 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.					
<b>Unit</b>	<b>Topic</b>				<b>No. of Lectures</b>
<b>Unit I</b>	<b>Foundation of Statistical Mechanics</b> 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.				<b>10</b>
<b>Unit II</b>	<b>Statistical Properties</b> 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.	<b>15</b>
<b>Unit III</b>	<b>Statistical Models</b> 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 Ferromagnetism, Heisenberg model. Virial equation of states.	<b>10</b>
<b>Unit IV</b>	<b>Quantum Statistics</b> 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](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		
<b>DSE A16 (a3): Advanced Electronics- III</b>	3	3	0	According to University Ordinance	According to University Ordinance
<b>Course Outcomes:</b> 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
<b>Unit I</b>	<b>Power Supply regulation with Series Regulators:</b> 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.				<b>10</b>
<b>Unit II</b>	<b>Switching Regulators and Active Filters:</b> 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).				<b>15</b>
<b>Unit III</b>	<b>Microwave Production:</b> 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.				<b>10</b>
<b>Unit IV</b>	<b>Microwave Communication:</b> Advantages and Disadvantages of Microwave transmission, loss in free space, propagation of microwaves, atmospheric effects on propagation, Fresnel zone problem, ground reflection, Fading, Antenna action, Antennas used in microwave communication system; Antennas with parabolic reflectors, Horn antennas, Lens antennas.				<b>10</b>

**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](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
<b>Course Outcomes:</b>					
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
<b>UNIT I</b>	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
<b>UNIT II</b>	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 Helioseismology, Astroseismology, Description about p-mode and g-mode oscillations, Introduction to variable stars and their locations in H-R diagram.				15
<b>UNIT III</b>	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 curve, dark matter.				10
<b>UNIT IV</b>	Principle of equivalence and principle of general covariance, Principle 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 (Schwarzschild 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](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			
<b>DSE A16 (c3): High Energy Physics-III</b>	3	3	0	According to University Ordinance	According to University Ordinance	
<b>Course Outcomes:</b>						
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 the field of HEP.						
UNIT	TOPIC				No. of Lectures	
<b>UNIT I</b>	<b>Relativistic Propagators I</b> 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,				<b>10</b>	
<b>UNIT II</b>	<b>Relativistic Propagators II</b> 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.				<b>10</b>	

<b>UNIT III</b>	<b>Operator Products, Feynman Propagators and S-matrix Expansion</b> Various type of operator products (Normal, Dyson products and Chronological T-products), Wick's theorem, Feynman propagators and its physical interpretation, Interacting fields, S-Matrix formulation as a perturbative series solution of collision processes, Dyson expansion of S-matrix.	<b>10</b>
<b>UNIT IV</b>	<b>S-matrix Formulation of QED</b> 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.	<b>15</b>

**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 Field Theory

**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](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		
<b>DSE A16 (d3): Spectroscopy-III</b>	3	3	0	According to University Ordinance	According to University Ordinance
<b>Course Outcomes:</b>					
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
<b>UNIT I</b>	<b>Molecular Symmetries and Group Theory:</b> 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.				<b>10</b>
<b>UNIT II</b>	<b>Mechanism of Absorption and Fluorescence:</b> 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.				<b>15</b>
<b>UNIT III</b>	<b>Instrumentation for Absorption and Fluorescence Spectroscopy:</b> 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,.				<b>10</b>
<b>UNIT IV</b>	<b>Advances in Fluorescence Spectroscopy:</b> Concept of fluorescence lifetime imaging, Theory and principle of Fluorescence Correlation Spectroscopy and Single molecule fluorescence spectroscopy, Applications of fluorescence spectroscopy.				<b>10</b>

**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](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

<b>DISCIPLINE SPECIFIC ELECTIVE (DSE A16(e3))</b>					
<b>Programme: Discipline Specific Elective</b>				<b>Year: V</b>	<b>Semester: IX</b>
<b>Course Title &amp; Code</b>	<b>Credits</b>	<b>Credit distribution of the course</b>		<b>Eligibility Criteria</b>	<b>Pre-requisite of the course</b>
		<b>Lecture</b>	<b>Tutorial</b>		
<b>DSE A16(e3): Condensed Matter Physics – III</b>	3	3	0	According to University Ordinance	According to University Ordinance
<b>Course Outcomes:</b>					
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.					
<b>UNIT</b>	<b>TOPIC</b>				<b>No. of Lectures</b>
<b>UNIT I</b>	<b>Dielectric properties of matter:</b> Polarization (ionic, electronic, orientation) Dielectric and ferroelectric properties of matter, polarizability, Clausen-Mossotti relation. Temperature dependence and frequency dependence of dielectric constant, dielectric loss and dielectric strength, Piezoelectricity. Langevin's theory of polarization.				<b>15</b>

<b>UNIT II</b>	<b>Advance Methods of Crystallography:</b> Different sources of error in Powder method of X-ray photography, Determination of error function for powder method, Accurate determination of lattice parameter, Applications of powder method, Moving film methods and advance methods of crystallography	<b>10</b>
<b>UNIT III</b>	<b>Methods of Microscopy and Surface Topography:</b> Observation of surface imperfections using X-ray, Electron microscopy: Transmission Electron Microscopy, Surface Scanning Electron Microscopy and Scanning-Tunneling Electron Microscopy, Atomic force microscopy (AFM).	<b>10</b>
<b>UNIT IV</b>	<b>Discarded Systems:</b> 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, colour centre of an ionic crystal system, Disorder in condensed Matter system: substitutional positional and topological disorders.	<b>10</b>

**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](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

**DISCIPLINE SPECIFIC ELECTIVE (DSE A17 (a4))**

<b>Programme: Discipline Specific Elective</b>		<b>Year: V</b>	<b>Semester: X</b>		
<b>Course Title &amp; Code</b>	<b>Credits</b>	<b>Credit distribution of the course</b>		<b>Eligibility Criteria</b>	<b>Pre-requisite of the course</b>
		<b>Lecture</b>	<b>Tutorial</b>		
<b>DSE A17 (a4): Advanced Electronics-IV</b>	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.

<b>UNIT</b>	<b>TOPIC</b>	<b>No. of Lectures</b>
<b>UNIT I</b>	<b>Analog Computation</b> 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.	<b>10</b>
<b>UNIT II</b>	<b>Logic Circuits and Logic Families</b> 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.	<b>15</b>
<b>UNIT III</b>	<b>Combinational Circuits</b> 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).	<b>10</b>
<b>UNIT IV</b>	<b>Sequential Circuits</b> 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.	<b>10</b>

**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, Tata Mcgraw Hill

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

**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](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

<b>DISCIPLINE SPECIFIC ELECTIVE DSE A17 (b4)</b>					
<b>Programme: Discipline Specific Elective</b>			<b>Year: V</b>	<b>Semester: X</b>	
<b>Course Title &amp; Code</b>	<b>Credits</b>	<b>Credit distribution of the course</b>		<b>Eligibility Criteria</b>	<b>Pre-requisite of the course</b>
		<b>Lecture</b>	<b>Tutorial</b>		
<b>DSE A17 (b4): Astrophysics-IV</b>	3	3	0	According to University Ordinance	According to University Ordinance
<b>Course Outcomes:</b> 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.					
<b>UNIT</b>	<b>TOPIC</b>				<b>No. of Lectures</b>
<b>UNIT I</b>	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				<b>10</b>
<b>UNIT II</b>	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-Pre-main sequence, main sequence, giants.				<b>15</b>
<b>UNIT III</b>	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				<b>10</b>

	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.	
<b>UNIT IV</b>	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.	<b>10</b>

**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](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		
<b>DSE A17 (c4): High Energy Physics-IV</b>	3	3	0	According to University Ordinance	According to University Ordinance
<b>Course Outcomes:</b>					
The course would provide the knowledge of some more advanced concepts of HEP. The students will also be able to learn the detailed theory of weak interactions, electromagnetic interactions and strong interactions.					
UNIT	TOPIC				No. of Lectures
<b>UNIT I</b>	<b>Quarks and Gluons:</b> Quark-Lepton Symmetry, Theoretical and experimental need of charm quark, $J/\psi$ 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.				<b>10</b>
<b>UNIT II</b>	<b>Strong Interaction :</b> 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.				<b>10</b>
<b>UNIT III</b>	<b>Weak Interaction:</b> Classification of weak interaction in terms of Leptonic, Semi-leptonic and non-leptonic weak Decays, Fermi Non relativistic theory of beta decay, Fermi & Gamow 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.				<b>15</b>
<b>UNIT IV</b>	<b>Weak Gauge Bosons &amp; Weak currents:</b> 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				<b>10</b>

**Suggested Readings:**

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

3. F. Halzen & A.D. Martin : Quarks and Leptons
4. D.H. Perkins : Introduction of High Energy Physics, Cambridge University Press 2000
5. P.Cheng and G.LF Li : Gauge Field Theory ED 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](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

<b>DISCIPLINE SPECIFIC ELECTIVE DSE A17 (d4)</b>					
<b>Programme: Discipline Specific Elective</b>			<b>Year: V</b>	<b>Semester: X</b>	
<b>Course Title &amp; Code</b>	<b>Credits</b>	<b>Credit distribution of the course</b>		<b>Eligibility Criteria</b>	<b>Pre-requisite of the course</b>
		<b>Lecture</b>	<b>Tutorial</b>		
<b>DSE A17 (d4): Spectroscopy-IV</b>	3	3	0	According to University Ordinance	According to University Ordinance
<b>Course Outcomes:</b>					
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.					
<b>UNIT</b>	<b>TOPIC</b>				<b>No. of Lectures</b>
<b>UNIT I</b>	<b>Ultrashort Pulses and Dynamics of Laser Processes:</b> 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.				<b>15</b>
<b>UNIT II</b>	<b>Non-Linear Optics:</b> Harmonic generation, phase matching, second harmonic generation, third harmonic generation, optical mixing, parametric generation of light, Self focusing of light.				<b>10</b>
<b>UNIT III</b>	<b>Multi Photon Processes:</b> Multi quantum photoelectric effect, two photon processes, experiments in two photon processes, parametric light oscillator, frequency up-conversion, phase conjugate optics, Femtosecond laser.				<b>10</b>
<b>UNIT IV</b>	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				<b>10</b>

**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/>

- 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](https://www.swayamprabha.gov.in/index.php/program/current_he/8)

<b>DISCIPLINE SPECIFIC ELECTIVE (DSE A17(e4))</b>					
<b>Programme: Discipline Specific Elective</b>			<b>Year: V</b>	<b>Semester: X</b>	
<b>Course Title &amp; Code</b>	<b>Credits</b>	<b>Credit distribution of the course</b>		<b>Eligibility Criteria</b>	<b>Pre-requisite of the course</b>
		<b>Lecture</b>	<b>Tutorial</b>		
<b>DSE A17 (e4): Advanced Condensed Matter Physics – IV</b>	3	3	0	According to University Ordinance	According to University Ordinance
<b>Course Outcomes:</b> 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.					
<b>UNIT</b>	<b>TOPIC</b>				<b>No. of Lectures</b>
<b>UNIT I</b>	<b>Exotic solids:</b> Structure and symmetry of liquids, Amorphous solids, Quasicrystals, Glass transition temperature. Alloys, solid solutions, substitutional solid solutions, Kondo effect, order disorder transformation, theory of order eutectic phase diagrams. Transition metal alloys. Heat capacity and thermal conductivity of amorphous solids.				<b>15</b>
<b>UNIT II</b>	<b>Soft Matter:</b> 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.				<b>10</b>
<b>UNIT III</b>	<b>Thin film and Surface States:</b> Definition and proprieties of thin films, Difference in the properties of a thin film from its corresponding bulk material, Boltzmann Transport equation for diffused Scattering of electron in the thin film, surface states, and surface reconstruction, metallic surface.				<b>10</b>
<b>UNIT IV</b>	<b>Relaxation and resonance phenomena:</b> 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.				<b>10</b>

**Suggested Readings:**

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

3. Poole: Nanotechnology
4. K. L. Chopra: Thin Film
5. Steinhardt and Ostlund: 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		
<b>(GE P13 (a)): Medical Physics</b>	4	3	1	According to University Ordinance	According to University Ordinance
<b>Course Outcomes</b>					
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
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### 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](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
<b>Course Outcomes:</b>					
<ol style="list-style-type: none"> <li>1. To Gain sufficient knowledge in the area of laser technology</li> <li>2. To Classify optical fibers based on their refractive index profiles</li> <li>3. To Examine the loss mechanisms in optical fibers and to compute various losses</li> <li>4. To Understand the non-linear coefficient and conversion efficiency for various non-linear phenomena</li> <li>5. To Understand and visualise the different quantum states of light for their applications in the field of quantum technology</li> </ol>					
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.	
<b>Unit II</b>	<b>Fiber Optics:</b> Light propagation in optical fibers, Attenuation and dispersion; Single-mode fibers, material dispersion. Optical fiber communication, Fiber amplifiers and lasers. Optical fibers in sensing.	<b>12</b>
<b>Unit III</b>	<b>Electro-Optic (E.O) Effect:</b> 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.	<b>12</b>
<b>Unit IV</b>	<b>Nonlinear Optics:</b> 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)	<b>12</b>
<b>Unit V</b>	<b>Quantum Optics:</b> Quantum states of light and their properties, Generation and detection of quantum light Entanglement and its applications: quantum computing, cryptography and teleportation.	<b>12</b>

### Suggested Reading

1. Optics, Ajoy Ghatak, 6<sup>th</sup> edition, Tata McGraw Hill, (2017)
2. Optics, Eugene Hecht and A R Ganesan , 4<sup>th</sup> 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, 2<sup>nd</sup> 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, 2<sup>nd</sup> 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		
<b>GE P 14: Basics of Astrophysics</b>	4	3	1	According to University Ordinance	According to University Ordinance
<p>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.</p>					
Unit	Topic				No. of Lectures
<b>Unit I</b>	<b>Introduction to Astronomy:</b> 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.				<b>15</b>
<b>Unit II</b>	<b>The Sun:</b> Solar parameters, Sun's internal structure: Core, Radiative, and convective 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.				<b>15</b>
<b>Unit III</b>	<b>Our Solar System:</b> 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				<b>15</b>
<b>Unit IV</b>	<b>Telescopes and instrumentation :</b> 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).				<b>15</b>

### 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](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
<b>Course Outcomes:</b> 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
	<b>List of Experiments: (a) Advanced Electronics</b> 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 and demodulations. 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
	<b>List of Experiments: (b) Astrophysics</b> 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 with inverse 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 of inverse square law .
2. Characteristic curve of a GM Detector and Absorption coefficient 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.