SYLLABUS

For

MASTERS PROGRAMME (M.Sc.)

In

PHYSICS
(BATCH 2024 and onwards)

Under

CHOICE BASED CREDIT SYSTEM (CBCS)

DEPARTMENT OF PHYSICS
ISLAMIC UNIVERSITY OF SCIENCE AND TECHNOLOGY,
AWANTIPORA, KASHMIR - 192122

Approved in Fifth Board of Studies (BoS) Meeting held on 04-03-2024

Programme Objectives

The Department of Physics is committed to impart quality education both in theoretical as well as experimental physics with special emphasis on ‘learning by doing’ to produce quality manpower for teaching and research. The objectives of the M.Sc. Physics programme are:

- To inculcate scientific bent of mind and attitude relevant to science such as concern for efficiency, accuracy and precision, objectivity, integrity, enquiry, effective communication, ethical responsibilities, Initiative and Inventiveness.

- To impart quality education in physics through well designed courses of fundamental interest and of technological importance.

- To enable the students to acquire deep knowledge in fundamental aspects of all branches of Physics.

- To assist the students in acquiring basic knowledge in the specialized thrust areas such as condensed matter physics and nanoscience, electronics, high energy physics, radiation physics and applications, plasma physics and astrophysics and advanced nuclear physics.

- Advanced and specialized training in physics that prepares a student for the job of researcher, teacher or hospital physicist, a computer scientist depending on the focus chosen.

- Learning the most advanced experimental and modelling techniques that are indispensable for today's physics.

- To develop abilities and skills in students that encourage research and development activities and are useful in everyday life. This includes courses like python programming, computational physics and numerical analysis.

- Lot of practical works (exercises, laboratories, and personal or group projects).

Programme Outcomes

Upon a successful completion of M.Sc. Physics programme, a students will

- ➢ demonstrate a scientific mindset characterized by efficiency, accuracy, precision, objectivity, integrity, and ethical responsibility.

- ➢ have received a well-rounded education in physics encompassing both fundamental principles and topics of technological significance. They will demonstrate a comprehensive understanding of various branches of physics and their practical applications.

- ➢ acquire in-depth knowledge in fundamental aspects across all branches of physics, enabling them to grasp complex theories and phenomena. They will demonstrate proficiency in specialized thrust areas such as condensed matter physics, nanoscience, electronics, high energy physics, radiation physics and applications, plasma physics, astrophysics, and advanced nuclear physics.

- ➢ undergo advanced and specialized training tailored to prepare them for roles as researchers, educators, hospital physicists, or computer scientists, depending on their chosen focus area. They will be equipped with the necessary skills and expertise to excel in their respective fields.

- ➢ have extensive hands-on experience through practical works including exercises, laboratories, and personal or group projects. This practical exposure will enhance their problem-solving abilities, experimental skills, and collaborative teamwork capabilities.

- ➢ possess proficient abilities in computational physics, Fortran Programming, C Programming, Python programming, and numerical analysis, enabling them to engage effectively in research and development activities both in academia and industry. These skills will be applicable in various real-world scenarios, enhancing problem-solving capabilities.

- ➢ have some research experience within a specific field of physics, through a supervised project (Master's dissertation).

Overall, the M.Sc. Physics program aims to produce graduates who are not only proficient in theoretical knowledge but also skilled in practical applications, research methodologies, and communication, thus preparing them for successful careers in various scientific and technological domains.

Course Structure

Types of Courses:

- **C - Core Course**
- **E - Discipline Centric Elective Course**
- **0 - Open Elective Course**

SEMESTER I

Course Type	Course Code	Course Title	Credit Distribution				Marks Distribution			Total Credits
			L	P	T	Total	Int.	Ext.	Total	
Core Course (C)	PHY501C	Mathematical Methods in Physics I	3	0	1	04	30 + 20*	50	100	**20**
Core Course (C)	PHY502C	Quantum Mechanics I	3	0	1	04	30 + 20*	50	100	
Core Course (C)	PHY503C	Classical Mechanics	3	0	1	04	30 + 20*	50	100	
Core Course (C)	PHY504C	Lab I	0	4	0	04	30 + 20*	50	100	
Discipline Centric Elective Course (E)	PHY505E	Electronics	3	0	1	04	30 + 20*	50	100	
Discipline Centric Elective Course (E)	PHY506E	Thermal Physics	3	0	1	04	30 + 20*	50	100	

* Assignment/Presentation

No. of Core papers to be opted = 04 (12 credits Theory + 04 credit Lab) = 16 credits

No. of Discipline Centric Elective Papers to be opted = 01 (04 credit) = 4 credits

Total No. of credits = 20 credits

SEMESTER II

Course Type	Course Code	Course Title	Credit Distribution				Marks Distribution			Total Credits
			L	P	T	Total	Int.	Ext.	Total	
Core Course (C)	PHY550C	Classical Electrodynamics	3	0	1	04	30 + 20*	50	100	24
Core Course (C)	PHY551C	Statistical Physics	3	0	1	04	30 + 20*	50	100	
Core Course (C)	PHY552C	Quantum Mechanics II	3	0	1	04	30 + 20*	50	100	
Core Course (C)	PHY553C	Lab II	0	4	0	04	30 + 20*	50	100	
Discipline Centric Elective Course (E)	PHY554E	Mathematical Methods in Physics II	3	0	1	04	30 + 20*	50	100	
Discipline Centric Elective Course (E)	PHY555E	Radiation Physics and Applications	2	0	0	02	15+10*	25	50	
Discipline Centric Elective Course (E)	PHY556E	Experimental Techniques	2	0	0	02	15+10*	25	50	
Discipline Centric Elective Course (E)	PHY557E	Plasma Physics	2	0	0	02	15+10*	25	50	
Discipline Centric Elective Course (E)	PHY558E	Atmospheric Physics	2	0	0	2	15+10*	25	50	
Open Elective Course	To be chosen from the list of Open Elective Courses offered by other departments in the University		2	0	0	02	15+10*	25	50	

* Assignment/Presentation

No. of Core papers to be opted = 04 (12 credits Theory + 04 credit Lab) = 16 credits

No. of Discipline Centric Elective Papers to be opted = 02 (One 4 Credit and One 2 credit) = 06 credits

No. of Open Elective Papers to be opted = 01 = 02 credits

Total No. of credits = 24 credits

SEMESTER III

Course Type	Course Code	Course Title	Credit Distribution				Marks Distribution			Total Credits
			L	P	T	Tot.	Int	Ext	Tot.	
Core Course (C)	PHY601C	Nuclear Physics	3	0	1	4	30+20*	50	100	24
Core Course (C)	PHY602C	Condensed Matter Physics	3	0	1	4	30+20*	50	100	
Core Course (C)	PHY603C	Particle Physics	3	0	1	4	30+20*	50	100	
Core Course (C)	PHY604C	Project I\Seminar	0	0	0	4	30+20*	50	100	
Discipline Centric Elective Course (E)	PHY605E	Group Theory	2	0	0	2	15+10*	25	50	
Discipline Centric Elective Course (E)	PHY606E	Astrophysics I	2	0	0	2	15+10*	25	50	
Discipline Centric Elective Course (E)	PHY607E	Optics	2	0	0	2	15+10*	25	50	
Discipline Centric Elective Course (E)	PHY608E	C Programming	2	0	0	2	15+10*	25	50	
Discipline Centric Elective Course (E)	PHY609E	Python for Physics	2	0	0	2	15+10*	25	50	
Discipline Centric Elective Course (E)	PHY610E	Quantum Field Theory	2	0	0	2	15+10*	25	50	
Open Elective Course	To be chosen from a list of Open Elective Courses offered by other departments of the University		2	0	0	2	15+10*	25	50	

* Assignment/Presentation

No. of Core papers to be opted = 04 (12 credits Theory + 04 credit project) = 16 credits
No. of Discipline Centric Elective Papers to be opted = 03 (02 credits each = 06 credits) = 06 credits
No. of Open Elective Papers to be opted = 01 = 02 credits
Total No. of credits = 24 credits

SEMESTER IV

Course Type	Course Code	Course Title	Credit Distribution				Marks Distribution			Total Credits
			L	P	T	Tot.	Int	Ext	Tot.	
Core Course (C)	PHY650C	Atomic, Molecular and Laser Physics	3	0	1	4	30+20*	50	100	24
Core Course (C)	PHY651C	Materials Science	3	0	1	4	30+20*	50	100	
Core Course (C)	PHY652C	Numerical Methods and Fortran Programming	3	0	1	4	30+20*	50	100	
Core Course (C)	PHY653C	Project II	0	0	0	4			100	
Core Course (C)	PHY654E	Superconductivity	2	0	0	2	15+10*	25	50	
Discipline Centric Elective Course (E)	PHY655E	Quantum Electrodynamics	2	0	0	2	15+10*	25	50	
Discipline Centric Elective Course (E)	PHY656E	Astrophysics II	2	0	0	2	15+10*	25	50	
Discipline Centric Elective Course (E)	PHY657E	Advanced Nuclear Physics	2	0	0	2	15+10*	25	50	
Discipline Centric Elective Course (E)	PHY658E	Research Methodology	2	0	0	2	15+10*	25	50	
Discipline Centric Elective Course (E)	PHY659E	Quantum Computation	2	0	0	2	15+10*	25		
Discipline Centric Elective Course (E)	PHY660E	Fourier Optics and Applications	2	0	0	2	15+10*	25	50	

* Assignment/Presentation

No. of Core papers to be opted = 04 (12 credits Theory + 04 credit project) = 16 credits
No. of Discipline Centric Elective Papers to be opted = 04 (02 credits each) = 08 Credits

Total No. of credits = 24 credits

Total credit and marks distribution for the Four semesters.

Course Type	No. of Papers	Credits per paper	Total credits	Marks per paper	Total Marks
Core Course (Theory)	12	04	48	100	1200
Core Practical	02	04	08	100	200
Project core	02	04	08	100	200
Discipline Centric Elective	02	04	08	100	200
	08	02	16	50	400
Open Elective	02	02	04	50	100
TOTAL	28		92		2300

Open Elective Course (offered by Department of Physics for other Departments of the University)

Odd Semesters:

Course Type	Course Code	Course Title	Credit Distribution				Marks Distribution			Total Credits
			L	P	T	Total	Int.	Ext.	Total	
Open Elective Course	PHYOE001	Physics and Technology	2	0	0	2	15+10	25	50	2
Open Elective Course	PHYOE002	Philosophical Foundations of Physics	2	0	0	2	15+10	25	50	2
Open Elective Course	PHYOE003	Physics of Household Electrical Appliances	2	0	0	2	15+10	25	50	2
Open Elective Course	PHYOE004	Physics of Medical Diagnostic Equipments	2	0	0	2	15+10	25	50	2

Even Semesters:

Course Type	Course Code	Course Title	Credit Distribution				Marks Distribution			Total Credits
			L	P	T	Total	Int.	Ext.	Total	
Open Elective Course	PHYOE051	History of Physics	2	0	0	2	15+10	25	50	2
Open Elective Course	PHYOE052	Physics and our World	2	0	0	2	15+10	25	50	2
Open Elective Course	PHYOE053	Physics in Daily Use	2	0	0	2	15+10	25	50	2
Open Elective Course	PHYOE054	Physics of Sports	2	0	0	2	15+10	25	50	2

The following courses in the Program are Value Added Courses:

Course Title	Course code	No. of credits
Radiation Physics and Applications	PHY555E	2
Experimental Techniques	PHY556E	2
C Programming	PHY608E	2
Python for Physics	PHY609E	2
Atomic, Molecular and Laser Physics	PHY650C	4
Material Science	PHY651C	4
Numerical Methods and Fortran Programming	PHY652C	4
Quantum Computations	PHY659E	2
Fourier Optics and Applications	PHY660E	2

The following courses in the Program are Skill and Employable Courses:

Course Title	Course code	No. of credits
Electronics	PHY505E	4
Lab I	PHY504C	4
Lab II	PHY553C	4
Radiation Physics and Applications	PHY555E	2
Experimental Techniques	PHY556E	2
C Programming	PHY608E	2
Python for Physics	PHY609E	2
Atomic, Molecular and Laser Physics	PHY650C	4
Material Science	PHY651C	4
Numerical Methods and Fortran Programming	PHY652C	4
Quantum Computations	PHY659E	2
Fourier Optics and Applications	PHY660E	2

Semester First

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) I Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Mathematical Methods for Physicists - I**

Course Code: **PHY501C**

Credits: **04**

Type of Course: Core (Theory)

Contact Hours: 4 hours per week (Total: 52 lecture + 12 tutorials)

Internal assessment: 50% (30% Exam (1.5 Hour) and 20% assignments/presentations)

End-Term Examination: (2. 5 Hours) 50%

Course Objectives

The purpose of the course is to introduce students to methods of mathematical physics and to develop required mathematical skills to solve problems of interest to physicists.

Course Outcome

On completion of the course, student will be able to:

- Develop understanding of the basic concepts underlying complex analysis and complex integration.
- Solve ordinary and partial differential equations of second order that are common in the physical sciences.
- Mathematical methods and techniques that deal with differential equations and their applications .
- Will be familiar with special functions like Bessel functions, Legendre functions , Laguerre and Hermite polynomials and their properties.
- Learning of the theory of probability, Random variables and probability distributions, Expectation values and variance. Various examples of probability distributions used in physics.
- Perform parameter testing techniques like least square fitting, chi square test.

PHY501C: Mathematical Methods in Physics -I **Credits: 04**
L 3 T 1 P 0

UNIT I

Functions of a complex variable, Analytic functions, Cauchy-Riemann relations, Conjugate andharmonic nature of the real and imaginary parts of an analytic function, Cauchy's theorem, Cauchy’s integral formula, Taylor and Laurent expansions, classification of singularities, The Point at Infinity; Calculus of Residues, Residues at Infinity, Cauchy’s residue theorem, Evaluation of definite integrals using Cauchy’s residue theorem.

UNIT II

Partial Differential Equations (PDE), First-order Differential Equations, Separation of Variables, Singular Points, Series Solutions -- Frobenious Method, Second Solution, Non-homogeneous Equation-Green’s Function.
Self-Adjoint ODEs, Hermitian Operators, Gram-Schmidt Orthonormalization, Completeness of Eigenfunctions, Green’s Function-Eigenfunction expansion.

UNIT III

Special Functions: Bessel functions, Neuman Functions, Hankel Functions, Legendre Function, Associated Legendre Function, Spherical Harmonics, Hermite polynomial, Laguerre Functions; Orthogonality and recurrence relations of Bessel function, Associated Legendre polynomials, Spherical Harmonics and Hermite polynomials.

UNIT IV

Probability and Statistics: Introduction, Probability: Definition, Properties, Permutations and Combinations, Random Variable, Discrete Probability Distributions, Covariance and Correlations, Conditional Probability Distribution, Normal, Binomial and Poison Distributions.
Statistical Hypothesis, Error Propagation, Confidence Interval, Fitting Curves to data, The Chi- Square Fitting, Examples.

Books Recommended:

1. Mathematical Methods for Physicists, G. B. Arfken and H. J. Weber, Academic Press, 7thed.
2. Mathematical Methods for Students of Physics and Related Fields, Sadri Hassani, Springer, 2nd ed.
3. Advanced Engineering Mathematics, Michel D. Greenberg, Prentice Hall, 2nd ed.
4. Mathematical Methods for Physics and Engineering, K. F. Riley, M. P. Hobson and S. J.Bence, CUP, 3rd ed.,
5. Advanced Engineering Mathematics, E. Kreyszig, John Wiley, 10th ed.
6. Mathematical Physics, M. L. Boas, John Wiley, 3rd ed.
7. Mathematical Physics S. D. Joglekar, University Press, 1st ed.

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) I Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Quantum Mechanics I**

Course Code: **PHY502C**

Credits: **04**

Type of Course: Core (Theory)

Contact Hours: 4 hours per week (Total: 52 lecture + 12 tutorials)

Internal assessment: 50% (30% Exam (1.5 Hour) and 20% assignments/presentations)

End-Term Examination: (2. 5 Hours) 50%

Course Objectives

To understand the behaviour of the physical world at the atomic level. Connect the historical development of quantum mechanics with previous knowledge and learn the basic properties of quantum world.

Course Outcomes

On completion of the course, student will be able to

- Understand the need for quantum mechanics.
- Learn the various mathematical tools involving linear algebra.
- To learn the quantum mechanical algebra of angular momentum.
- To learn the concept of symmetry in the context of quantum mechanics.
- The time-dependent and time-independent Schrödinger equation for simple potentials like for instance the harmonic oscillator and hydrogen like atoms, as well as the interaction of an electron with the electromagnetic field.
- Quantum mechanical axioms and the matrix representation of quantum mechanics.

PHY502C: Quantum Mechanics I **Credits: 04**
L 3 T 1 P 0

UNIT I
Inadequacy of classical Physics, Double slit experiment with single photons/electrons/atoms/molecules, Wave particle duality-de Broglie hypothesis, The Schrodinger's equation and it's fundamental properties, Statistical interpretation of wave function, Wave-function in coordinate and momentum representations. Expectation values, Ehrenfest theorem, Solution of Schrodinger's equation for 1D problems (free particle, particle in a box, potential step, barrier potentials, and simple harmonic oscillator), stationary states and their properties.

UNIT II
Linear vector spaces, Inner Product spaces, Dual spaces and the Dirac notation, Subspaces, Linear Operators, Matrix elements of linear operators, Active and passive transformation, Eigen value problem. Commutators and Heisenberg's uncertainty principle, Simple harmonic oscillator by operator method. Postulates of quantum mechanics. Time development of a quantum mechanical system: Schrodinger, Heisenberg and interaction pictures.

UNIT III
Angular Momentum: Orbital, Spin and total angular momentum operators, ladder operators and their Commutation relations, Eigen values of *j2* and *Jz* operators, Matrix representation of in $|jm>$ basis, Computation of angular momentum matrices for simpler cases ($j = 1, 1/2$), Pauli spin matrices, Addition of angular momenta, Computation of Clebsch Gordon (CG) coefficients for simple cases.

UNIT IV
Time independent Schrodinger's equation in spherical coordinates, Spherical Harmonics and their properties, Solution of Schrodinger equation for hydrogen atom. Unitary transformation and symmetry in Quantum Mechanics, Space and Time translations, Parity, Time reversal, Discrete symmetries, Symmetry and conservation laws, Symmetry and degeneracy.

Books Recommended:

1. Quantum Mechanics, L. I. Schiff, McGraw Hill, 4^{th} edition.
2. Principles of Quantum Mechanics, R. Shankar, Springer, 2nd edition.
3. Lectures on quantum mechanics, Ashok Das, World Scientific, 2^{nd} edition
4. Modern Quantum Mechanics, J. J. Sakurai and J. J. Napolitano, Pearson Publications, 2nd edition.
5. Quantum Mechanics by L.D. Landau and E. M.Lifshitz, Elsevier, 3rd edition.
6. Quantum Mechanics Concepts and Applications by N. Zettili, John Wiley, 2nd edition.

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) I Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Classical Mechanics**
Course Code: **PHY503C**
Credits: **04**
Type of Course: Core (Theory)
Contact Hours: 4 hours per week (Total: 52 lecture + 12 tutorials)
Internal assessment: 50% (30% Exam (1.5 Hour) and 20% assignments/ presentations)
End-Term Examination: (2.5 Hours) 50%

Course Objectives

The objective of this core course is to teach the students how complex classical systems could be studied using Lagrangian, Hamiltonian formulations, advanced technique of co-ordinate transformation – the canonical transformations, Poisson bracket and Hamilton-Jacobi theory. The students also study the mechanics of rigid-bodies and small oscillations.

Course Outcomes

The completion of this core course will enable the students to:

- Write the Lagrangian and Hamiltonian for various classical systems.
- Derive Lagrange's and Hamilton's equations of motion using various principles and techniques and explain the relationship between symmetries and conservation laws.
- Comprehend and explain central force motion and Kepler's laws.
- Learn and solve the problems using canonical transformations, Poisson bracket and Hamilton-Jacobi theory.
- Understand the mechanics of rigid-bodies having large degrees of freedom and dig out the interesting dynamics using Euler-angles technique along with Euler's theorem and Euler equations.
- Understand and solve the problem of small oscillations using Lagrangian formalism.

PHY503C: Classical Mechanics

Credits: 04
L 3 T 1 P 0

UNIT I

The Lagrangian Formalism- Constraints and their classifications, Generalized coordinates Virtual displacement, D'Alembert's principle and Lagrangian equations of motion with few examples.
Variational Principles and Lagrange's Equations: Hamilton's Principle, Calculus of variations, Derivation of Lagrange's Equations from Hamilton's Principle; Symmetry properties of space and time and Conservation Theorems.
The Central Force Problem: Reduction to the equivalent one-body problem, First Integrals, classification of orbits, the differential equation of the orbit, Kepler's problem and scattering by a central field. Rutherford scattering.

UNIT II

Legendre Transformations and Hamilton Equations of motion, examples. Cyclic Coordinates and Conservation Theorems. Statement of Noether's Theorem. Physical significance of the Hamiltonian function. Derivation of Hamilton's Equations from Variational Principle, The Principle of Least Action.

UNIT III

The Equations of canonical transformations, properties and generating functions of four special types of canonical transformations, Examples of Canonical transformations, Poisson brackets (PB), Properties of Poisson brackets, Angular momentum and Poisson bracket relations. Equation of motion in the Poisson bracket notation. Invariance of P.B. under canonical transformations.
The Hamilton-Jacobi equation, example of the harmonic oscillator treated by the Hamilton-Jacobi method. Liouville's theorem.

UNIT IV

Review of Mechanics of rigid bodies; The Euler Angles, Euler's Theorem, Infinitesimal rotations, Coriolis effect, The inertia tensor and the moment of Inertia, Euler equations of motion for a rigid body. Small Oscillations: General formalism, Eigen-value equation, normal coordinates and normal modes. Two Coupled Oscillators, Vibrations of Linear Triatomic Molecules.

Books Recommended:

1. Classical Mechanics by H. Goldstein, Charles P. Poole, John Safko, 3rd Edition, Pearson.
2. Mechanics by Landau and Lifshitz, Butterworth-Heinemann
3. Classical Mechanics by R.D. Gregory, , Cambridge University Press
4. Classical Mechanics by N.C. Rana and P.S. Joag, Tata McGraw-Hill.
5. An introduction to Mechanics, D. Kleppner and R. Kolenkow, Tata McGraw-Hill.
6. Classical Mechanics by S. N. Biswas, Books and Allied Pvt. Ltd, 1998.
7. Classical Mechanics by J. C. Upadhaya, Himalaya Publishing House, Mumbai. 2006.
8. Classical Dynamics of particles and systems by S. T. Thornton and J. B.Marion, Cengage Learning, 2008.

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) I Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title:	**LAB I**
Course Number:	**PHY504C**
Credits:	**04**
Type of Course:	Core (Practical)
Contact Hours:	4 Classes per week (8 Hours)
Internal assessment:	30% (Attendance/Viva)
End-Term Examination:	70% (Performance/viva)

Course Objectives

The main objective of the course is to train students to realise the various physics concepts learnt in the class room in the laboratory and understand the various aspects of scientific measurement which include error analysis, data fitting and data interpretation.

Course Outcomes

- To gain practical knowledge by applying the experimental methods to correlate with the physics theory.
- To learn the usage of electrical and optical systems for various measurements.
- Apply the analytical techniques and graphical analysis to the experimental data.
- To develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.

PHY504C: Lab. I **Credits: 04**
L 0 T 0 P 4

A students will have to perform at least 10 experiments from the following list of experiments available. At least two experiments must be carried out from each category; General Lab, Solid State Physics & Electronics Lab and Optics Lab.

General Lab:

1) To determine the value of specific charge for an electron by Thomson's Method.
2) To study the characteristics and dead time of G.M. Counter.
3) To study Attenuation coefficient/ absorption coefficient, using GM Counter.
4) Study of Lissajous Figures using CRO.
5) To determine the Specific heat of solids.
6) To find the frequency of AC supply using an Electrical Vibrator (Melde's experiments).
7) To verify de-Broglie hypothesis using electron diffraction.

Solid State Physics & Electronics Lab:

8) To determine the band gap of semiconductor from temperature dependence of resistivity using Four Probe Method.
9) Study of Hall Effect.
   (a) Determination of Hall Voltage and $R_{H.}$
   (b) Determination of mobility of charge carriers and carrier concentration.
10) Design and study summer, inverting/non-inverting amplifier using operational amplifier (IC-741).
11) To study V-I characteristics of PN junction (Using breadboard).
12) To design and study the V-I characteristics of BJT (Using breadboard).
13) To design and study the characteristics of FET (Using breadboard).
14) Study of dielectric constant and determination of Curie temperature of Ferroelectric ceramics.
15) Verify Truth Tables of the various logic-gates using a digital electronic trainer
16) To study the characteristics of a photo-voltaic cell (Solar cell).
17) Design and study of RC filters (Active and Passive).

Optics Lab:

18) To verify the Malus Law (Cosine Square Law) for polarisation of light
19) To find the wavelength of sodium light by measuring the diameters of Newton's rings.
20) Precision measurement of wavelength of monochromatic light using Michelson interferometer.

Books Recommended:

1. C.L. Arora, Practical physics, S. Chand Publication.
2. B.L. Worsnop and H. T. Flint , Advanced Practical Physics, Asia Publishing House

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) I Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Electronics**
Course Code: **PHY505E**
Credits: **04**
Type of Course: Discipline Centric Elective (Theory)
Contact Hours: 4 hours per week (Total: 52 lecture + 12 tutorials)
Internal assessment: 50% (30% Exam (1.5 Hour) and 20% assignments/ presentations)
End-Term Examination: (2.5 Hours) 50%

Course Objective

To understand the basic concepts of Analog and Digital Electronics and apply it in experimental Physics and also for various Engineering Applications.

Course Outcome

On completion of the course, students will be able to:

- To understand material classification and semiconductor fundamentals.
- To understand the physics behind the functioning of the electronic devices like diodes and transistors.
- Understand the basic concepts of OP-AMP, its various parameters and oscillators.
- Understand fundamentals of digital electronics and its usage in practical applications.

PHY505E: Electronics **Credits: 04**
L 3 T 1 P 0

UNIT I

Need of Band theory of solids, Classification of materials, Occupational probability, Fermi level, Semiconducting Materials and properties, Conductivity in semiconductors, Direct and indirect band gap semiconductors, Variation of charge carrier concentrations and Fermi level with Doping and temperature in intrinsic semiconductors and extrinsic semiconductors, PN junction diode, diode equation, diode built in voltage, junction capacitance, Various types of PN junction diodes and their usage (LEDs, Photodetectors, Solar cells, Zener etc.) Semiconductor lasers, Fabrication of band gap

UNIT II

Fundamentals of operation of UJT and BJT, Configurations and modes of operation for BJT, dc biasing load line and operating point, Stability of operating point against thermal and Beta variations, stabilization factor, Biasing technique to BJT, fixed bias, emitter feedback bias, voltage divider bias, small signal BJT amplifiers, ac and dc equivalent circuits, hybrid model and hybrid parameters, approximate analysis of CE amplifier using h-parameters.
Field Effect Transistors (FET) and MOS-FET: Structure, Working, Derivations of the equations for I-V characteristics under different conditions.

UNIT III

Feedback Principle, Negative feedback, effect of negative feedback on input/output resistances, voltage gain, gain stabilization, band width, Oscillators: Oscillator operation, Phase shift Oscillator, Wien-bridge Oscillator, Hartley Oscillator. Block diagram of an operational amplifier – Characteristics of an ideal operational amplifier, Differential amplifier: voltage gain. Applications of op-amp, summing amplifier, inverting and non-inverting configurations, subtractor, difference summing amplifier, Integrator. Instrumentation amplifier.

UNIT IV

Number Systems, Boolean Algebra, Karnaugh map, Combinational Circuits like Adder, Subtrator, Encoder /Decoder, Mux/Demux, Comparators, Sequential Circuits like Flip Flops, Registers, Counters, Analog to Digital and Digital to analog converters, Microprocessor and microcontroller (basics).

Books Recommended:

1. Integrated Electronics, J. Millman and C. C. Halkias and C. D. Parikh, Tata McGraw Hill, 2nd ed.
2. Electronic Devices and Circuit Theory, R. L. Boylestad and L. Nashelsky, Pearson, 7th ed.
3. Solid State Electronic Devices, B. G. Streetman and S. K. Banerjee, PHI, 7th ed.
4. Digital Principles and Applications, D. P. Leach, A. P. Malvino and G. Saha, McGraw Hill, 8th ed.
5. Electronic Fundamentals and Applications, J. D. Ryder, PHI, 5th ed. Op-Amps and Linear Integrated Circuits, R. A. Gayakward, PHI, 4th ed.

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) I Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Thermal Physics**
Course Number: **PHY506E**
Credits: **04**
Type of Course: Discipline Centric Elective (Theory)
Contact Hours: 4 hours per week (Total: 52 lecture + 12 tutorials)
Internal assessment: 50% (30% Exam (1.5 Hour) and 20% assignments/ presentations)
End-Term Examination: (2.5 Hours) 50%

Course Objectives

To develop comprehension of fundamental thermodynamic concepts and principles including behaviour of real and ideal gases, and to apply them to different thermodynamics processes and systems.

Course Outcomes

On completion of the course, students will be able to:

- Apply the First law of Thermodynamics and calculate Heat, Internal Energy, Work in various thermodynamical processes and systems.
- Explain the concepts of Reversibility, Irreversibility, Carnot cycle, Entropy, Clausius theorem, Kelvin-Planck and Clausius statements of Second law of Thermodynamics, Thermodynamic potentials and Maxwell's relations.
- estimate the entropy changes in reversible and irreversible processes.
- Calculate the different measures of speeds in the Maxwell Boltzmann Distribution of velocities and derive the transport coefficients of Thermal conductivity, Viscosity and Diffusion in ideal gases.
- Describe the behaviour of real gases and obtain the critical constants of the gas.

PHY506E: Thermal Physics **Credits: 04**
L 3 T 1 P 0

UNIT I

Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics and Concept of Temperature, Concept of Work and Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes.

UNIT II

Second Law of Thermodynamics Reversible and Irreversible processes. Carnot Cycle, Carnot engine, Refrigerator. Second Law: Kelvin-Planck and Clausius Statements and their Equivalence. Concept of Entropy, Clausius Theorem & Inequality, Second Law in terms of Entropy, Entropy Changes in Reversible and Irreversible processes, Temperature–Entropy diagrams. Third Law. Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz & Gibb's Functions, Maxwell's Relations.

UNIT III

Kinetic Theory of Gases Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Molecular Collisions: Mean Free Path. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion

UNIT IV

Real Gases Behavior of Real Gases. Critical Constants. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and Van der Waal Gases. Joule-Thomson Cooling.

Books Recommended:

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
2. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
3. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1958, Indian Press.
4. Classical and Quantum Thermal Physics, R. Prasad, 2016, Cambridge University Press.
5. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
6. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press.

Semester Second

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) II Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Classical Electrodynamics**
Course Code: **PHY550C**
Credits: **04**
Type of Course: Core (Theory)
Contact Hours: 4 hours per week (Total: 52 lecture + 12 tutorials)
Internal assessment: 50% (30% Exam (1.5 Hour) and 20% assignments/ presentations)
End-Term Examination: (2.5 Hours) 50%

Course Objectives

To develop understanding of the advanced concepts related to electrostatics, magnetostatics, electrodynamics and relativistic electrodynamics.

Course Outcomes

Completion of this core course will enable the students to:

- Find the electric field using Coulomb's law and Gauss' law for various charge distributions.
- Learn the relationship between electrostatic field and electrostatic potential.
- Solve the Poisson's and Laplace's equation.
- Use Biot-Savart law and Ampere's law to calculate magnetic fields.
- Explain Faraday's laws, Maxwell's equations and significance of displacement current.
- Understand the physics of gauge transformations and use of different gauges. Explain electromagnetic field energy and momentum.
- Use of Maxwell's equations to explain the behaviour of electromagnetic wave propagation in different media, phenomenon of refraction, reflection, interference, diffraction and polarization.
- Understand Dispersion phenomena, physics of transmission lines and wave guides.
- Understand the concept of retarded and Lienard-Wiechert potentials, and electrodynamics of a point charge.
- Learn the covariant form of Maxwell's equations, equation of continuity, transformation of fields and Lagrangian and Hamiltonian in presence of external magnetic field.

PHY550C: Classical Electrodynamics

Credits: 04
L 3 T 1 P 0

UNIT I

Electrostatics: The Electric Field, Coulomb's law, Divergence and Curl of Electrostatic Fields, Gauss's law, applications of Gauss's law, Electric Potential, Work and Energy in electrostatics, Conductors, Poisson's equation and Laplace's equation, Laplace's Equation in one, two and three Dimensions, Boundary Conditions and Uniqueness Theorems, Method of Images, Separation of Variables, Multipole expansion.
Electric Fields in Matter: Polarization, The Field of a Polarized object, The Electric displacement, Linear Dielectrics.

UNIT II

Magnetostatics: The Lorentz force law, Biot-Savart Law, The divergence and curl of B, Ampere's law and applications, Magnetic vector potential. Multipole expansion, Magnetization and the field of a magnetised object, Boundary conditions, Multipole expansion of vector potential, Faraday's law, Energy in the magnetic Field, Maxwell's displacement current, Maxwell's equations in free space and linear isotropic media, Boundary conditions on the fields at interfaces, Charge and energy, Poynting's theorem and Conservation of Energy and momentum.

UNIT III

Electromagnetic waves: Waves in one dimension, Electromagnetic waves in vacuum and matter, Energy and momentum in electromagnetic waves, Guided waves.
Scalar and Vector potentials, Gauge transformations, Coulomb and Lorentz Gauge, Maxwell's equations in terms of potentials, Retarded potentials, Lienard-Wiechert potentials, fields of a moving point charge, Electric and Magnetic dipole radiation, power radiated by a point charge.

UNIT IV

Relativistic mechanics, Four-Vectors in Electrodynamics, Transformation of electric and magnetic fields under Lorentz transformations, Field Tensor, Electrodynamics in tensor notation, Relativistic potentials, Covariant form of Maxwell's equations, Lorentz force on a relativistic charged particle. Lagrangian and Hamiltonian for a relativistic charge particle in external electromagnetic fields.

Books Recommended:

1. Classical Electrodynamics, J. D. Jackson, John Wiley, 3rd ed.
2. Introduction to Electrodynamics, D. J. Griffiths, Pearson, 4th ed.
3. A. Das, Lectures on Electromagnetism, Hindustan Book Agency
4. Classical Electromagnetic Radiation, M. A. Heald and J. B. Marion, Suanders College Publishing.
5. R.P. Feynman, Feynman Lectures on Physics (Vol. II), Addison-Wesley

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) II Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Statistical Physics**
Course Code: **PHY551C**
Credits: **04**
Type of Course: Core (Theory)
Contact Hours: 4 hours per week (Total: 52 lecture + 12 tutorials)
Internal assessment: 50% (30% Exam (1.5 Hour) and 20% assignments/ presentations)
End-Term Examination: (2.5 Hours) 50%

Course Objectives

To understand the theory and methods of statistical physics and thermodynamics. The aim of this course is to understand the basic as well as advanced concepts of both classical and quantum statistical physics.

Course Outcomes

On completion of this course, student will be able to:

- Understand the connection between statistics and thermodynamics.
- Understand different ensemble theories used to explain the behaviour of macroscopic systems.
- Understand the basic concepts of classical statistics and quantum statistics.
- Understand the statistical behaviour of ideal Bose and Fermi systems.
- Understand different types of phase transitions.

PHY551C: Statistical Physics **Credits: 04**

L 3 T 1 P 0

UNIT I

Statistical distributions, Statistical independence, Liouville's theorem, The significance of energy, The statistical matrix, Statistical distributions in quantum statistics, Entropy, The law of increase of entropy,

Temperature, Macroscopic motion, Adiabatic processes, Pressure, Work and quantity of heat, The heat function, The free energy and the thermodynamic potential, The dependence of the thermodynamic quantities on the number of particles, Equilibrium of a body in an external field, Rotating bodies.

UNIT II

The Gibbs distribution, The Maxwellian distribution, The probability distribution for an oscillator, The free energy in the Gibbs distribution, Thermodynamic perturbation theory, Expansion in powers of h,

Ideal gases, The Boltzmann distribution, The Boltzmann distribution in classical statistics, Molecular collisions, Ideal gases not in equilibrium, The free energy of an ideal Boltzmann gas, The equation of state of an ideal gas.

UNIT III

The Fermi distribution, The Bose distribution, Femi and Bose gases not in equilibrium, Fermi and Bose gases of elementary particles, A degenerate electron gas, The specific heat of a degenerate electron gas, Magnetism of an electron gas (weak fields and strong fields), A relativistic degenerate electron gas, A degenerate Bose gas, Black-body radiation.

Deviations of gases from the ideal state, Expansion in powers of the density, Van der Waals' formula.

UNIT IV

Isolated system, System in contact with a reservoir at constant temperature, System in contact with a reservoir at constant temperature and pressure, Stability conditions for a homogeneous substance, Equilibrium conditions and the Clausius-Clapeyron equation, Phase transformations and equations of state, General relations for a system with several components, Alternative discussion of equilibrium between phases, General conditions for chemical equilibrium, Chemical equilibrium between ideal gases,

Phase transitions of the second order, the discontinuity of specific heat, Effect of an external field on a phase transition, Change in symmetry in a phase transition of the second kind, Fluctuations of the order parameter, The effective Hamiltonian, Critical indices, Scale invariance.

Books Recommended:

1. Statistical Physics Part 1, L. D. Landau and E. M. Lifshitz, Elsevier, 3rd ed.
2. Statistical Mechanics, R.K. Pathria and P. D. Beale, Elsevier, 3rd ed.
3. Statistical Physics, F. Reif, McGraw Hill, Berkeley series, Vol. 5, 2nd ed.
4. Statistical Mechanics, R.P. Feynman,Westview Press, 1st ed.
5. Statistical Mechanics, K. Huang, John Wiley, 2nd ed.

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) II Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Quantum Mechanics II**
Course Code: **PHY552C**
Credits: **04**
Type of Course: Core (Theory)
Contact Hours: 4 hours per week (Total: 52 lecture + 12 tutorials)
Internal assessment: 50% (30% Exam (1.5 Hour) and 20% assignments/ presentations)
End-Term Examination: (2. 5 Hours) 50%

Course Objectives

The main objective of this course is to expose the students to the approximation methods in quantum mechanics such as the Variational Method, WKB approximation and perturbation theory. The other objectives are to teach scattering theory and the relativistic theory of quantum mechanics viz. Klein-Gordon equation and Dirac equation.

Course Outcomes

On completion of the course, student will be able to

- Understand the physics behind such technologies as Nuclear Magnetic Resonance Imaging, Lasers etc.
- Learn the quantum mechanics of scattering and its role to understand matter at subatomic level.
- To learn the quantum mechanics of identical particle systems.
- To learn the advanced concepts of relativistic quantum mechanics involving the Klein-Gordon and the Dirac equations.

PHY552C: Quantum Mechanics II **Credits: 04**
L 3 T 1 P 0

UNIT I

Time independent perturbation theory: Non-degenerate and Degenerate energy level, Applications: 1-D harmonic oscillator subjected to a perturbing potential in x and x^2. Variational Method, Applications: ground state of Helium atom. WKB approximation, the classical region, connection formulae.
Time dependent perturbation theory; Statement of the problem, Approximate solution of the Schrodinger equation, Transition probability, Constant perturbation, Harmonic perturbation, Adiabatic approximation, Transition to the continuum, The Fermi golden rule, Semi-classical theory of radiation, selection rules under dipole approximation.

UNIT II

The scattering experiment, Scattering cross-section, Asymptotic behaviour of wave function and scattering amplitude, Relation between scattering amplitude and scattering cross-section, Solution of Schrödinger equation for scattering (Lippmann-Schwinger equation), Born approximation, Scattering by a spherically symmetric potential, Cross-section for scattering in a screened coulomb potential, validity of Born's approximation.
Method of partial waves, Expansion of a plane wave in terms of partial waves, Scattering by a central potential, Optical theorem.

UNIT III

Many particle systems, systems of identical particles, exchange degeneracy, symmetrization postulate, construction of symmetric and anti-symmetric wave functions from unsymmetrized functions, Slater determinant, The Pauli Exclusion Principle and spin statistics connection, spin angular momentum, Density operator and density matrix.

UNIT IV

Klein-Gordon equation, charge and current densities for KG equation, Plane wave solution of KG equation, problems with KG equation, Dirac equation, Dirac matrices and their properties, plane wave solution of free particle Dirac equation, significance of negative energy solutions (Dirac's hole theory), spin angular momentum of the Dirac particle, Electron in electromagnetic field, Covariance of KG and Dirac equations.

Books Recommended

1. Quantum Mechanics, L. I. Schiff, McGraw Hill, 4th edition.
2. Principles of Quantum Mechanics, R. Shankar, Springer, 2nd edition.
3. Modern Quantum Mechanics, J. J. Sakurai and J. J. Napolitano, Pearson Publications, 2nd edition.
4. Quantum Mechanics by L.D. Landau and E. M.Lifshitz, Elsevier, 3rd edition.
5. Quantum Mechanics Concepts and Applications by N. Zettili, John Wiley, 2nd edition

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) II Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title:	**LAB II**
Course Number:	**PHY553C**
Credits:	**04**
Type of Course:	Core (Practical)
Contact Hours:	4 Classes per week (8 Hours)
Internal assessment:	30% (Attendance/Viva)
End-Term Examination:	70% (Performance/viva)

Course Objectives

The course is designed for the students of 2^{nd} semester to train them to handle some advanced level experiments. The main objective of the course is to teach the students how these experiments led to the discovery and advancement of modern physics.

Course Outcomes

- Students will perform advanced experiments specific to modern Physics, Solid State Physics & Electronics and Optics so as to gain practical knowledge in these areas of Physics.
- After completing the course, the students will be able to measure things like Bohr magnetron, nuclear magnetron, g-factors for atomic and molecular orbitals.
- Students would gain physical experience working with various advanced experimental setups like Millikan's Oil drop setup, Zeeman effect setup, Fabry Perot interferometer setup and other advanced electronics experiments.

PHY553C: LAB II **Credits: 04**
L 0 T 0 P 4

A students will have to perform at least 10 experiments from the following list of experiments available. At least two experiments must be carried out from each category; General Lab/Solid State Physics & Electronics Lab and Optics Lab.

General Lab:

1. To determine the charge of electron by Millikan's Oil Drop method.
2. To study the photoelectric effect.
3. To determine the value of e/m for an electron by long Solenoid helical method.
4. To determine the g-factor by the ESR Spectrometer.
5. To determine the g-factor by the NMR Spectrometer.
6. To study the Meissner effect.
7. To determine magnetic susceptibility of a paramagnetic/diamagnetic material using Quincke's tube method.
8. To study Poisson and Gaussian distributions using a GM counter.
9. To study the absorption of gamma rays using GM counter.
10. Frank-Hertz Experiment: To demonstrate the concept of quantisation of energy levels according to Bohr's model of atom.

Solid State Physics & Electronics Lab:

11. **(a)** To study the characteristics of a PN junction with varying temperature and to find the energy band gap of semiconductor.
    (b) To measure the capacitance of the junction.
    (c) Determination of Reverse Saturation of current I_0 and Material Constant.
12. To study the different hybrid parameters of transistor.
13. Study of RC-coupled amplifier.
14. Study of forward and reverse bias Photodiode Characteristics.
15. Realization of Fourier series.
16. Study of Hysteresis loop of Magnetic Materials; To verify B-H curve and to find out the values of coercivity, retentivity and saturation magnetization of experimental materials.
17. Design and study of Integrator and differentiator using operational amplifier (IC-741).
18. Study of regulated and stabilized power supply.

Optics Lab:

19. To study Zeeman Effect and to measure the value of Bohr Magnetron.
20. To measure the attenuation or propagation loss in an optical fibre using He-Ne laser source.
21. Fabry-Perot Interferometer.

Books Recommended:

1. C.L. Arora, Practical physics, S. Chand Publication.
2. B.L. Worsnop and H. T. Flint , Advanced Practical Physics, Asia Publishing House

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) II Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Mathematical Methods for Physicists - II**
Course Code: **PHY554E**
Credits: **04**
Type of Course: Core (Theory)
Contact Hours: 4 hours per week (Total: 52 lecture + 12 tutorials)
Internal assessment: 50% (30% Exam (1.5 Hour) and 20% assignments/ presentations)
End-Term Examination: (2. 5 Hours) 50%

Course Objectives

To impart knowledge about various mathematical tools employed to study physics at an advanced level.

Course Outcome

After successfully completing the course, student will be able to

- Learn the fundamentals and applications of Fourier series, Fourier transform, the inverse Fourier transform, their properties and their applications in physical problems. They are also expected to learn the Laplace transform, the inverse Laplace transforms, theirproperties and their applications in solving physical problems.
- Develops ability to handle physics problems involving tensors.
- Handle special functions like the beta and gamma functions to tackle various physical problems.
- Give an account of the foundations of calculus of variations and of its applications in physics.

PHY554E: Mathematical Methods in Physics II **Credits: 04**
L 3 T 1 P 0

UNIT I

Fourier Series: Definition, Properties, Convergence, Application of Fourier series, Fourier Integral and Fourier transform and inverse Fourier transform, Convolution theorem, Parseval's theorem, Laplace transform and its properties, inverse Laplace transforms, solution of differential equations using Laplace transforms, Fourier transform & Laplace transform of distributions: Gaussian and Poisson Distributions.

UNIT II

Tensor Analysis: Occurrence of tensors in physics, Notation and conventions, Tensors and their Ranks, Contravariant, covariant and mixed tensors, Addition and subtraction of tensors, Inner and Outer Product, Contraction, symmetric and anti-symmetric tensors, The Kronecker Delta, Quotient law, Conjugate symmetric tensors of second rank. The metric tensor, Associate tensors Cartesian tensors: rotation and translation, Isotropic tensors. Examples: Moment of Inertia, dielectric susceptibility, stress and strain-Hooke's law.

UNIT III

Tensor Calculus; Covariant and contravariant derivative, The curvature tensor (Riemann-Christoffel tensor), Covariant curvature tensor, Tensor forms of operators, Einstein gravitational equation.

Beta and Gamma functions, Fundamental property of gamma functions, transformation of a gamma function, different forms of a beta function, relation between beta and gamma functions, Reduction of definite integrals to gamma function.

UNIT IV

Variational Calculus: Introduction of variational calculus, Euler Equation (for one variable), Examples: Shortest path between two points on a plane, optical path near a black hole, Alternate forms of Euler Equations, More General Variations (Several dependant variables), Hamilton's principle, Examples: Moving Particle in Cartesian and cylindrical coordinates, Hamilton's equations. Geodesics.

Books Recommended:

1. Mathematical Methods for Physicists (7th Ed.), G. B. Arfken and H. J. Weber, AcademicPress
2. Mathematical Methods for Students of Physics and Related Fields, Sadri Hassani, Springer,2nd ed.
3. Matrices and Tensors in Physics 4th Edition, A. W. Joshi, New age international publishers.
4. Advanced Engineering Mathematics, Michel D. Greenberg, Prentice Hall, 2nd ed.
5. Mathematical Physics (4th Edition) B D Gupta, VIKAS

Syllabus with Course Objectives and Course Outcomes

M. Sc (Physics) II Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Radiation Physics and Applications**

Course Code: **PHY555E**

Credits: **02**

Type of Course: Discipline Centric Elective (Theory)

Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)

Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/ presentations)

End- Term Examination: (1. 25 hours) 50%

Course Objectives

To understand the basic concepts of radiation physics and its application in the medical science. Also, the aim is to make students familiarize with the construction of various radiotherapy units and their working principle.

Course Outcomes

On completion of this course, student will be able to

- Understand the basic principles of radiation physics and various radiotherapy units.
- Understand the basic physics of the electromagnetic and particulate forms of ionizing & non ionizing radiation.
- Understand the distinctions between the units of radiation quantity, exposure and dose.
- Understand the basic concepts of dosimetry.

PHY555E Radiation Physics and Applications

Credits: 02
L 2 P 0 T 0

Unit I:

Ionizing and Non-Ionizing Radiation: Electromagnetic spectrum: Introduction, Interaction of electromagnetic radiation with matter, Thomson scattering, Rayleigh scattering, Compton scattering, Photoelectric absorption, Pair production, Cerenkov radiation-mass-energy attenuation and absorption coefficient.

Radiation quantities and units, Radiometry, particle flux and fluence, energy flux and fluence, Linear and mass attenuation coefficients, Mass energy transfer and mass energy absorption coefficients, stopping power, LET, Radiation chemical yield, W value, Dosimetry, Measurement of Absorbed Dose, Definition of absorbed dose, relationship between kerma, exposure, and absorbed dose.

Unit II:

Radiotherapy Units

Introduction, Considerations in the design of high energy beams, Physics of X-ray production, X-ray energy spectra, X-ray Therapy and its types, General Introduction to Tele, Bracy and Internal Therapy,

Linear Accelerator: Magnetron, Klystron, Medical Linacs, Betatron, Microtron, Cyclotron, Isotope Machines, Typical Cobalt 60 Units, Particles for radiotherapy.

Recommended Books:

1. The Physics of Radiology, Harold Elford Johns, J.R. Cunningham, 4th edition.
2. The Physics of Radiation Therapy, Faiz M. Khan, J. P. Gibbons, Fifth Edition
3. Basic Physics of Radiation Therapy, J. Selman, Third Edition.

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) II Semester
Department of Physics
Islamic University of Science and Technology

Course Title: **Experimental Techniques**

Course Code: **PHY556E**

Credits: **02**

Type of Course: Discipline Centric Elective (E)

Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)

Internal assessment: 50% (30% Exam (45 minutes) and 20% assignments/ presentations)

End-Term Examination: (1. 25 Hours) 50%

Course Objectives

The purpose of Experimental Techniques is to

- Guide students about the data analysis.
- Teach them the use of various software's.
- Make them understand that how to gauge the more reliable data.
- Make them aware about the functioning of the various types of transducers.

Course Outcomes

On successful completion of the course the students will be able to:

- Join as a data scientist in any industry, which relies on data analysis and data evaluation.
- Carry out research from any leading University/ research institute.

PHY556E: Experimental Techniques **Credits: 02**
L 2 T 0 P 0

UNIT I

Measurement Concepts; Data Interpretation and Analysis; Precision and Accuracy; Error Analysis; Propagation of Errors. Plotting of Graphs using ORGIN and GNUPLOT software.

Curve Fitting of Data; Least square fitting (Linear and non-linear); Chi-Square Test.

UNIT II

Transducers (temperature, pressure/vacuum magnetic fields, vibration, optical and particle detectors)

Fundamentals of Vacuum Technology, Gas Flow Mechanism, Concept of Throughput and Pumping Speed; Mechanical Pump, Diffusion Pump, Gauges: Penning and Pirani.

Measurement and Control: Signal conditioning and recovery, impedance matching, shielding and grounding.

Books Recommended:

1. Introduction to Experimental Nuclear Physics, R. M. Singura, John Wiley Eastern.
2. Elements of X-Ray Diffraction, B. D. Cullity, and S. R. Stock, Pearson, 3rd ed.
3. Core Level Spectroscopy of Solids, F. De Groot, CRC Press, 1st Ed.
4. Instrumentation Measurement Analysis, B. C. Nakra and B. C. Chudhary, McGraw Hill, 4th ed.
5. The Art of Experimental Physics, D. W. Preston and E. R. Dietz, John Wiley, 1st ed.
6. Probability and Statistics in Experimental Physics, B. P. Roe, Springer, 1st ed.
7. Introduction to Nuclear Physics, V. K. Mittal, R. C. Verma, and S. C. Gupta, PHI, 3rd ed.
8. Vacuum Technology: Alexander Roth
9. Material Science and Engineering: V. Raghavan

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) II Semester
Department of Physics
Islamic University of Science and Technology

Course Title: Plasma Physics

Course Code: PHY557E

Credits: 02

Type of Course: Discipline Centric Elective (E)

Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)

Internal assessment: 50% (30% Exam (45 minutes) and 20% assignments/attendance)

End-Term Examination: (1. 25 Hours) 50%

Course Objectives

The purpose of this course is to make students understand the physics of plasma. This course will convey how our understanding of plasma physics extends to a description of a huge diversity of systems over varying scales of space, time, density, and temperature

Course Outcomes

On successful completion of this course the students:

- may have an opportunity for employability in plasma research and application industry.

PHY557E: Plasma Physics **Credits: 02**
L 2 T 0 P 0

UNIT I

Plasma: definition and elementary concepts, concept of temperature, Debye Shielding and Debye length, Plasma Parameters and criteria for plasma, plasma frequency, important applications of plasma physics: Controlled Thermonuclear fusion, The magnetohydrodynamic generator, Plasma Propulsions and other plasma devices.
Production of plasma in laboratory: DC discharge, RF discharge and photo-ionization.

UNIT II

Single particle motion in uniform E and B fields, single particle motion in non-uniform E and B fields, motion in time varying electromagnetic fields, Guiding and center drifts, tokamak confinement.
Plasmas as fluids, the fluid equation of motion, equation of continuity and state, fluid drifts.

Books Recommended:

1. Introduction to plasma Physics and Controlled Fusion, F. F. Chen, Springer, 2nd ed.
2. Fundamentals of Plasma Physics, J. A. Bittencourt, Springer, 3rd ed.
3. Principles of Plasma Physics, N. A. Krall, and A. W. Trivelpiece, Mc Graw Hill.
4. Space Plasma Physics, A. C. Das, Narosa Publishing House.

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) II Semester
Department of Physics
Islamic University of Science and Technology

Course Title: Atmospheric Physics
Course Code: PHY558E
Credits: 02
Type of Course: Discipline Centric Elective (E)
Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)
Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)
End-Term Examination: (1. 25 Hours) 50%

Objectives

This course is designed for the students of the department of physics especially those who aspire to take up higher studies in the field of atmospheric physics research.

Course Outcomes

- The students will learn about the structure, composition, and temperature and density profiles of the earth's lower atmosphere, physics and importance of variations of these parameters with reference to terrestrial weather.

- The students will learn about the upper atmospheric physics such structure, morphology, stratification, formation and the principal processes taking place in upper atmosphere as well as its importance with reference to communication and navigation.

PHY558E: Atmospheric Physics

Credits: 02
L 2 T 0 P 0

Unit I

Atmosphere of earth, Origin, Composition and Structure and morphology, Vertical profiles of pressure, density and temperature, General Circulation of the Atmosphere, Energy Balance of the Earth, Global Patterns of Insulation, Heating Imbalances, Earth's Energy Budget, Surface Energy Budget Modeling Energy Balance, Global Heat Balance, Atmosphere's Energy Budget, Natural Greenhouse Effect, Effect on Surface Temperature.

Unit II

Ionosphere: origin, composition and morphology, formation of ionosphere, photo-ionization and recombination, major geographical divisions of ionosphere, importance of ionosphere, ionospheric variability, effect of solar disturbances on ionosphere, ionospheric disturbances and irregularities, Ionospheric observation techniques, ground and satellite based.
Magnetosphere: structure of magnetosphere, interaction of solar wind with magnetosphere, geomagnetic activity and geomagnetic indices, geomagnetic storms.

Books Recommended:

1. The Physics of atmosphere, J.T. Houghton, 1986
2. McIlveen R., Fundamentals of Climate, Chapman Hall, 1992
3. J. R. Holton, An introduction to dynamic metrology, 3rdEd.
4. An introduction to ionosphere and magnetosphere, J. A. Ratcliff, CUP.
5. Ionospheric Radio, K. Davies, IET.

Semester Third

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) III Semester
Department of Physics
Islamic University of Science and Technology

Course Title: **Nuclear Physics**
Course Code: **PHY601C**
Credits: **04**
Type of Course: Core
Contact Hours: 4 hours per week (Total: 52 lecture + 12 tutorials)
Internal assessment: 50% (30% Exam (1.5 Hour) and 20% assignments/presentations)
End-Term Examination: (2.5 Hours) 50%

Course Objectives

The purpose of this course is to

- make students understand the concept of Nuclear Physics.
- give them the knowledge of various Nuclear Models.
- make them understand about the working of various detectors and accelerators used for research purposes.

Course Outcomes

On successful completion of the course the students will be able to:

- join as a Nuclear Scientist in the reputed Labs. of the country.
- carry out research in Experimental/ Theoretical Nuclear Physics from any leading University/research institute.
- pursue their carrier in Radiation Physics.

PHY601C: Nuclear Physics **Credits: 04**
L 3 T 1 P 0

UNIT I

Mass, Charge and Constituents of the nucleus, Nuclear size and the distribution of nucleons, what holds a nucleus together, Parity and statistics, Characteristics of nuclear force, nucleon-nucleon potential.

Simple theory of two nucleon system –Deuteron problem, Spin states of two nucleon system, Isotopic Spin, Effect of Pauli's exclusion principle, Magnetic dipole moment and electric quadrupole moment of Deuteron, Yukawa meson theory, The Tensor forces.

UNIT II

Liquid drop model, Weizsacker's semi-empirical mass formula and its applications, Evidence for Magic Numbers, prediction of energy levels in an infinite square well potential, Shell model: Shell structure, spin-orbit interaction, prediction of ground state spin, parity and magnetic moment of odd-A nuclei, Collective model.

UNIT III

Kinds of nuclear reactions, Kinematics of nuclear reactions, standard Q-equation and its solution, Threshold Energy, nuclear reaction cross-section, Differential cross-section, Compound reaction mechanism, nuclear fission and fusion, laws of successive disintegration, Alpha Decay: Gamow's Theory, Beta Decay: Fermi's theory of beta decay, selection rules

UNIT IV

Interaction of charged particles and electromagnetic radiation with matter, Energy loss and stopping power, Bethe-Bloch formula, Energy loss of fast electrons: Bremstrahlung and Cerenkov Radiation. Detectors: Scintillation Detectors-NaI(Tl), HpGe Clover detector, Gas detectors (GM-Counter), Particle accelerators: Linacs, elementary idea of Tandem accelerator, Pelletron accelerator.

Books Recommended:

1. Introductory Nuclear Physics, S. M. Wong, John Wiley, 2nd ed.
2. Introductory Nuclear Physics, K. S. Krane, John Wiley, 2nd ed.
3. Introductory Nuclear Physics, D. Halliday, John Wiley, 2nd ed.
4. Concepts of Nuclear Physics, Bernard L Cohen, Mc Graw Hill.
5. Atomic and Nuclear Physics, S. N. Ghosal, S. Chand, 2nd ed.
6. Introduction to Nuclear Physics, H. A. Enge, Addison-Wesley.
7. Introductory Nuclear Physics, P. E. Hodgson, and E. Gadoili, OUP, illustrated ed.

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) III Semester
Department of Physics
Islamic University of Science and Technology

Course Title: **Condensed Matter Physics**

Course Code: **PHY602C**

Credits: **04**

Type of Course: Core (Theory)

Contact Hours: 4 hours per week (Total: 52 lecture + 12 tutorials)

Internal assessment: 50% (30% Exam (1.5 Hour) and 20% assignments/presentations)

End-Term Examination: (2. 5 Hours) 50%

Course Objectives

To learn some of the basic properties of the condensed phase of matter especially solids

Course outcomes

Students will have achieved the ability to:

- Differentiate between different Lattice types and explain the concepts of reciprocal lattice and crystal diffraction.
- Predict electrical and thermal properties of solids and explain their origin.
- Explain the concept of energy bands and effect of the same on electrical properties.
- Have an understanding of the magnetic properties of condensed matter.
- Have an understanding of the elastic properties of solids and lattice vibrations.

PHY602C: Condensed Matter Physics **Credits: 04**
L 3 T 1 P 0

UNIT I

Introduction to crystal structure, Symmetry operations, Miller indices, closed packed structures, Common crystal structures, Quasi crystals, Reciprocal lattice, Brillouin zones, X-ray diffraction by a crystal and their equivalence, Laue equations, Edwald construction, Brillouin interpretation, Crystal and atomic structure factors, Experimental methods of structure analysis: Types of probe beam, the Laue, rotating crystal and powder methods. Imperfections: Point defects, Colour Centres, Shear strength of crystals, Dislocations, Illustration of types of dislocation, Burger's vector, Role of dislocation in crystal growth, Low angle grain boundaries, Whiskers.

UNIT II

Free electron gas model: Electrical conductivity and Ohm's law, Density of states, Fermi energy, effective mass, Limitations of the free electron gas model, Band theory of solids: Electrons in periodic potentials, Bloch's Theorem, Kronig-Penney model, Nearly free electron model, Tight-binding model: density of states, examples of band structures. Fermi surfaces of metals and semiconductors. Semiconductors: Band gap, concept of hole; equations of motion of charge carriers in electric and magnetic fields, effective mass, physical basis, cyclotron resonances (Ge, Si); mobility, intrinsic and extrinsic conductivity, Hall effect, Quantum Hall effect (qualitative idea only).

UNIT III

Origin of magnetism, Classical theory of diamagnetism and paramagnetism, Curie law, Ferromagnetism, Weiss Theory of Ferromagnetism and Curie-Weiss law, Exchange interaction of free electrons, Band model of Ferromagnetism, super exchange, double exchange, Hubbard model, Antiferromagnetism, Neel temperature, Quantum theory of magnetic susceptibility, van Vleck paramagnetism, Pauli-paramagnetism, Exchange interaction (two electron system), Heisenberg model (spin Hamiltonian)

UNIT IV

Classical theory of lattice dynamics: Vibrations of crystals with monatomic basis and Two atomic basis, Dispersion relation, Group velocity, Acoustical and optical modes; Phonons: Quantization of lattice vibration, Phonon-momentum. General Theory of harmonic approximation for a three-dimensional crystal, normal modes of real crystals, dispersion curve Theory of neutron-phonon scattering. Thermal properties: heat capacity, Normal modes, Debye and Einstein models, lattice thermal conductivity of solids- Umklapp process.

Books Recommended:

1. Introduction to Solid State Physics, C. Kittel, John Wiley, 7th ed.
2. Solid State Physics, N. W. Ashcroft, and N. D. Mermin, Saunders College, 2nd ed.

3. Solid State Physics, S. O. Pillai, New Age Sci., 6th ed.
4. Solid State Physics, M. A. Wahab, Narosa Pub., 3rd ed.
5. Elements of Solid State Physics, J. P. Srivastava, PHI, 3rd ed.
6. Solid State Physics: An Introduction to the Theory, James Patterson and Bernard Bailay, Springer, 2nd ed.

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) III Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Particle Physics**
Course Code: **PHY603C**
Credits: **04**
Type of Course: Core (Theory)
Contact Hours: 4 hours per week (Total: 52 lecture + 12 tutorials)
Internal assessment: 50% (30% Exam (1.5 Hour) and 20% assignments/ presentations)
End-Term Examination: (2.5 Hours) 50%

Course objective

The objective of this core course is to understand the nature of particles and their interactions at fundamental level. Further to study the physics of collisions of particles and nuclei at relativistic energies, concept of origin of the universe and quark gluon plasma.

Course outcome

Upon the completion of the above course, the student will be able to:

- Learn about the basic interactions and their mediating quanta.
- Classify the particles; learn about various particle quantum numbers and the role of symmetries in their interactions.
- Understand Quark Model of hadrons and be able to calculate the charge and magnetic moment of particles.
- Study of weak interactions in detail and CP violation.
- Understand the various scattering processes including deep inelastic scattering.
- Have an idea of Standard Model.
- Solve the particle flavor oscillation based on semi-quantum mechanical approach for neutrino and K-mesons.
- Apply concept of relativistic kinematics in solving related problems.
- Explain the mechanism and features of particle production in hadronic and ion collisions.

PHY603C: Particle Physics **Credits: 04**

L 3 T 1 P 0

UNIT I

Basic interactions and their mediating quanta, types of particles - fermions and bosons, leptons and hadrons, particles and antiparticles, resonances, Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.), conservation rules, Gellmann- Nishijima Relation. Introduction to Quark model,

Relativistic Kinematics: Lorentz transformations for energy and momentum, Four vectors and mass invariants, collisions in Lab and Centre of mass frames,

UNIT II

Symmetries: Symmetries and conservation laws, Charge conjugation, Parity, and Time reversal, and CPT theorem. Parity non-conservation in weak interaction, parity of Pions, Helicity of neutrino.

CP violation: Tau-theta puzzle, Neutral K mesons, $K_L - K_S$ mass difference and CP violation in the neutral kaon system.

Quark model of hadrons: Combining quarks into baryons and Mesons -SU(2), SU(3) isospin symmetry. Mass formula for baryons and mesons. Calculation of charge and magnetic moments of baryons.

UNIT III

Lepton and quark scattering: Feynman rules, Electron-positron annihilation ($e^+e^- \rightarrow \mu^+\mu^-$), electron-proton scattering, deep inelastic scattering.

Weak Interactions: Classification, leptonic weak interactions (W□ and Z^0 exchange), lepton universality, charged weak interactions of Quarks, neutrino interactions, parity violation in β - decay, V – A interaction, Lepton-Quark symmetry and mixing, Conservation of weak currents, Pion and muon decay, Cabibbo theory, Cabibbo-GIM scheme, Neutral weak currents.

UNIT IV

Light-cone Variables Rapidity and pseudorapidity variables Ultra-relativistic nucleus-nucleus collisions: Glauber model of nucleus-nucleus collision, Bjorken estimate of the initial energy density, hadron structure and quark confinement, hydrodynamics of Quark-Gluon Plasma and phase diagram, possible signatures of Quark- Gluon Plasma formation.

Books Recommended:

1. Introduction to Elementary Particles, D. J. Griffiths, John Wiley, 4th ed.
2. Particle Physics, B. R. Martin and G. Shaw, John Wiley, 3rd ed.
3. Introduction to High Energy Physics, D. H. Perkins, Addison Wesley, 4th ed.
4. Introduction to Nuclear and Particle Physics, Ashok Das, T. Ferbel, 2nd Edition, World Scientific
5. Quarks and Leptons, F. Halzen and B. R. Martin, John Wiley.
6. An Introduction to Quarks and Partons, F. E. Close, Academic Press, 1st ed.
7. Introduction to High Energy Heavy Ion Collisions, C. Y. Wong, World Scientific.

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) I Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Project I/Seminar**

Course Code: **PHY604C**

Credits: **04**

Type of Course: Core (Project)

Contact Hours: 8 hours per week

Internal assessment: (No internal assessment)

End-Term Examination: 100% (Presentation and Viva)

Course Objective

- Conceptual Understanding: Develop a deep understanding of theoretical concepts and principles relevant to the chosen project area.
- Research Skills: Acquire and enhance research skills, including literature review, data collection, and analysis techniques.
- Problem-solving: Apply theoretical knowledge to real-world problems, fostering critical thinking and problem-solving abilities.
- Communication Skills: Improve written and oral communication skills by preparing project reports and presenting findings to peers and faculty.
- Team Collaboration: Foster teamwork and collaborative skills through group projects, encouraging effective communication and task distribution.

Course Outcome

By the end of the third-semester project work, students should be able to:

- Demonstrate In-depth Knowledge: Exhibit a comprehensive understanding of the chosen project's theoretical framework and relevant literature.
- Conduct Independent Research: Independently conduct literature reviews, gather data, and analyse results using appropriate methods.
- Apply Concepts to Real-world Issues: Apply theoretical knowledge to address practical problems in the chosen project area.
- Effectively Communicate Results: Present project findings coherently in both written reports and oral presentations.
- Collaborate in a Team Environment: Work collaboratively, demonstrating effective communication, coordination, and contribution.

PHY604C: Project I **Credits: 04**

Every student is required to engage in project work alongside a faculty member serving as their supervisor from the department. This project entails selecting a specific problem, whether experimental or theoretical, conducting a thorough literature survey, analysing data, and presenting the findings accumulated throughout the semester. The presentation takes place before a committee appointed by the department. Upon successful evaluation by the committee members, the student may gain approval to continue the project into the fourth semester. Subsequently, they are tasked with preparing a comprehensive dissertation report, which must be submitted to the department for final evaluation and undergo a presentation and viva-voce examination at the semester's conclusion.

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) III Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Group Theory**
Course Code: **PHY605E**
Credits: 02
Type of Course: Discipline Centric Elective (Theory)
Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)
Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)
End-Term Examination: (1. 25 Hours) 50%

Course Objectives

To train a student in the advanced tools of mathematical physics involving group theoretical concepts required in such fields as condensed matter physics, quantum field theories, particle physics and quantum mechanics.

Course Outcomes

On completion of the course, student will be able to

- To learn the continuous group theory.
- Use group theoretical concepts in understanding physical problems.
- Use of group theory in understanding concepts line quark model and isospin.

PHY605E: Group Theory **Credits: 02**
L 2 T 0 P 0

UNIT- I
Symmetry in physics: groups and representations, Definition of a group; some simple examples, Some simple point groups, The permutation group S_n.
Conjugacy and conjugacy classes, Subgroups, Normal subgroups, Homomorphisms.

Group Representations: A simple example; formal definition, Induced transformation of the quantum mechanical wavefunction, Equivalence of representations; characters; reducibility, Groups acting on vector spaces, Scalar product; unitary representations; Maschke's theorem.

UNIT II

Properties of Irreducible Representations: Schur's lemmas, The fundamental orthogonality theorem, Orthogonality of characters, Construction of the character table, Direct products of representations and their decomposition.

Physical Applications: Macroscopic properties of crystals, Molecular vibrations (H_2O), Raising of degeneracy.
Continuous Groups (SO(N): $SO2$, $SO(3)$, $SU(2)$, Clebsch-Gordan coefficients.

Books Recommended

1. Groups, Representations and Physics, H. F. Jones, Taylor and Frances Group, 2nd edition.
2. Group Theory and it's Applications to physical problems, M. Hammermesh, Dover publications, reprint 2017.
3. Group Theory in Physics, Wu-Ki Tung, World Scientific, Reprint 2010.
4. Elements of Group Theory for Physicists, A. W. Joshi, New Age International Publishers, 5th edition.
5. Group Theory for Physicists with Applications, P. Ramadevi and V. Dubey, Cambridge University Press, 2019.
6. Mathematical Physics, P. K. Chattopadhyay, New Age International Publishers, 2nd edition.
7. Mathematical Methods for Physicists, Arfken, Weber and Harris, Academic Press, 7th edition.

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) III Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Astrophysics I**
Course Code: **PHY606E**
Credits : **02**
Type of Course: Discipline Centric Elective (Theory)
Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)
Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)
End- Term Examination: (1.25 Hours) 50%

Course Objectives

To familiarize and expose students to various fields, basic principles and theories of astronomy and astrophysics. The aim of this particular course is to provide knowledge of formation, evolution, classification of stars in particular.

Course Outcomes

On completion of this course, student will be able to:

- Understand the basic concepts in astronomy and astrophysics
- Understand the various physical processes in stars.
- Understand the stellar evolution and in-depth understanding of binary stars.

PHY606E: Astrophysics I **Credits: 02**
L 2 T 0 P 0

UNIT I

Celestial coordinate systems: Horizontal and Equatorial coordinate system**,** The stellar system, Evolution of the Stars, Observational properties of stars (stellar Magnitudes and Colors, Brightness and distance, Luminosity, temperature), Spectral Classification, H-R Diagram and main sequence stars, Boltzmann & Saha Ionization Formula, Equation of Stellar Structure (Hydrostatic Equilibrium, Mass &Temperature Distribution and Energy Transport in Stellar Interiors). Polytropic Model: Lane Emden equation, Virial theorem.

UNIT II

Binary Stars: Classification, Mass determination, White-Dwarf, Classes of White Dwarf Stars, The Physics of degenerate Matter, The condition for degeneracy, Electron Degeneracy Pressure, The Chandrasekhar Limit, The Mass-Volume Relation, Neutron Stars, black holes, Thermodynamics of black holes.

Books Recommended:

1. An Introduction to Modern Astrophysics, B. W. Carroll and D. A. Ostlie, Addison-Wesley Publishing Co., ISBN 0-321-44284-9.
2. The Physical Universe: An Introduction to Astronomy, Frank H. Shu, Mill Valley : University Science Books, ISBN 0-935702-05-9.
3. An Introduction to Astrophysics, Baidyanath Basu, PHI Learning Pvt. Ltd ISBN 9788120340718
4. Theoretical Astrophysics, Volume II: Stars and Stellar Systems, T. Padmanabhan, Cambridge University Press, ISBN: 0521562414

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) III Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Optics**
Course Code: **PHY607E**
Credits: **02**
Type of Course: Discipline Centric Elective (Theory)
Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)
Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)
End-Term Examination: (1.25 Hours) 50%

Course Objective

To understand the basic concepts of lights, its properties and few applications

Course Outcome

On completion of the course, the student will be able to:

- Understand mathematical framework to analyze the light waves.
- learn the interaction of light with matter and few applications.
- understand polarization.
- Explain theoretical background of interference and diffraction

PHY607E: Optics **Credits: 02**
L 2 T 0 P 0

UNIT I

Three-dimensional differential wave equation, Plane, Spherical, and cylindrical waves, Electromagnetic waves, The Poynting Vector, Radiation pressure and momentum, Light in bulk matter, Dispersion, Propagation of light: Rayleigh Scattering, Fermat's principle, Electromagnetic approach to reflection and refraction, Fresnel equations, Aperture and Field Stops, Relative Aperture and f-Number, Fiber optics, Optical systems, Wavefront shaping

UNIT II

Aberrations: coma, astigmatism. Polarization: The nature of polarized light, Polarizers, Birefringence, Scattering and polarization, Retarders, Optical activity, Induced optical effects-optical modulators, Kerr and Pockels effect, Liquid crystals, The Stokes parameters, The Jones vectors, Interference: Wavefront splitting interferometers, Amplitude Splitting interferometers, Multiple beam interferometer. Diffraction: Kirchhoff's diffraction theory, regimes of diffraction, Fresnel and Fraunhofer diffraction, single and multiple slit diffraction. Basics of Coherence theory

Books Recommended:

1. Optics, E. Hecht and A. R. Ganesan, Pearson, 4th ed.
2. Optics, A. Ghatak, McGraw Hill, 7th ed.
3. Introduction to Modern Optics, G. R. Fowles, Dover Pub., 2nd ed.
4. Lasers and Non-Linear Optics, B. B. Laud, New Age Pub., 3rd ed.
5. Optical Electronics, A. Ghatak and K. Thyagarajan, Cambridge University Press, 1989
6. Optics Principles and Applications, K. K. Sharma, Academic Press, 2006.

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) III Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **C Programming**
Course Code: **PHY608E**
Credits: **02**
Type of Course: Discipline Centric Elective (Theory)

Contact Hours: 2 hours per week (Total: 32 lecture)

Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)

End-Term Examination: (1.5 Hours) 50%

Course objective

- To provide solutions to simple physics problem by applying the basic programming principles of C language and basic mathematical knowledge.
- Develop simple C programs to illustrate the applications of different data types such as arrays, pointers, functions.

Course outcome

Upon the completion of the above course, the student will be able to:

- Develop C programs to solve simple mathematical and decision making problems
- Students will be able to develop logic that will help them to write programs in C. Also by learning the basic programming constructs, they can easily switch over to any other language in future.
- Able to implement the algorithms and draw flowcharts for solving Mathematical and Engineering problems.

PHY608E: C Programming **Credits: 02**
L 2 T 0 P 0

UNIT I

Introduction to programming: Computer software, classification, compilers and interpreters, programming languages. C programming: Programme Characteristics, structure of C program, C character set, identifiers and key words, Data types, Constants, Variables, input\output statements in C, operators in C, modify operators, Functions: function definition, function call.

Decision control and looping statements: conditional branching statements(if-statement, if – else statement, switch case), Iterative statements (while, do-while, for loop), nested loops, goto statement. Programming exercises.

UNIT II

Arrays: One and two dimensional arrays, deceleration, accessing array elements. Strings: reading writing strings, string operations, array of strings. Pointers: Pointer declaration, Operation on pointers, Pointers and one-dimensional arrays, Arrays of pointers, User defined data types: Structure, Union and Enumerated data types, Programming exercises.

Developing algorithms and Computer programs in C-Language based on numerical methods.

Books Recommended:

1. Programming in ANSI C by E. Balaguruswamy. 6th ed. McGraw Hill Education
2. Numerical Methods, E. Balaguruswamy, Tata McGraw Hill (1999)
3. Let Us C: Authentic guide to C programming language by Yashavant Kanetkar, 19th Edition
4. Introduction to C programming by Reema Thareja, 2nd Edition, Oxford Higher Education

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) III Semester
Department of Physics
Islamic University of Science and Technology

Course Title: Python for Physics
Course Code: PHY609E
Credits: 02
Type of Course: Discipline Centric Elective (E)
Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)
Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)
End-Term Examination: (1. 25 Hours) 50%

Objectives

The course aims to equip students with a holistic understanding of Python. Covering fundamental aspects such as variables, data, functions, and control flow, the course transitions into practical application. Students explore file handling, data visualization, and Pandas for data frames. Additionally, the course includes the implementation of numerical techniques.

Course Outcomes

- Understand Python fundamentals, including variables and data types.
- Master control flow structures and functions.
- Apply NumPy for array manipulation.
- Implement Python in real-world scenarios through file handling, data visualization, and Pandas.
- Utilize numerical techniques such as the Bisection Method, Numerical Integration, Differential Equations, and Least Square Fit for problem-solving

PHY609E: Python for Physics

Credits: 02
L 2 T 0 P 0

Unit I:

Introduction to Python Programming: Overview of Python, Python Variables and Data Types: Numeric Data Types, Boolean Data Type, Sequence Data Types: Lists, Tuples, Set and Dictionary Data Types, Print Statement, Input Function, Functions in Python, Lambda Functions, Function Parameters and Return Values, Control Flow in Python: Conditional Statements, If, Elif, Else Statements, Looping Structures: While Loop, For Loop, Break and Continue Statements, Python Libraries, Introduction to NumPy, Arrays and Operation

Unit II:

Application: Introduction to SciPy, File Handling in Python, Data Visualization in Python, Basic Plotting, Introduction to Pandas, Data Frames, Implementation of Numerical Techniques: Bisection Method, Numerical Integration and Numerical Solution of Differential Equations, Least Square Fit

Books Recommended:

1. Introduction to Scientific Programming with Python by Joakim Sundnes, volume 6: Springer
2. Computational Methods in Physics and Engineering by Samuel S M Wong, 2nd Edition: World Scientific

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) III Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title**: Quantum Field Theory**

Course Code: **PHY610E**

Credits: **02**

Type of Course: Discipline Centric Elective (Theory)

Contact Hours: 2 hours per week (Total: 32 lecture)

Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)

End-Term Examination: (1.5 Hours) 50%

Course Objectives

Quantum Field Theory (QFT) is a mathematical framework which combines the concepts in classical field theory, special relativity, and quantum mechanics. Objective of the course is to develop basic understanding of the field concept and obtain its quantized version.

Course Outcomes

On completion of this elective course, students will learn:

- The concept of second quantisation.
- Quantization of Lagrangian field theory.
- Quantization of Klein-Gordon field.
- Quantization of Dirac field.
- Gauge Quantization.
- Using Feynman diagrams to calculate amplitude/ reaction cross section for few QED processes.

PHY610E: Quantum Field Theory **Credits: 02**
L 2 T 0 P 0

Unit I

The classical electromagnetic field and its quantization, Classical Lagrangian field theory, Quantized Lagrangian field theory, symmetries and conservation laws- Noether's theorem.

Unit II

The real and complex Klein-Gordon field, covariant commutation relations, the meson propagator. The Dirac field: Number representation for Fermions, Dirac equation, second quantization, the Feynman Propagator.

Books Recommended:

1. Quantum Field Theory, F. Mandal and G. Shaw, John Wiley, 2nd ed.
2. Quantum Field Theory, L. H. Ryder, CUP, 2nd ed.
3. Lectures on Quantum Field Theory by Ashok Das, World Scientific.
4. A Modern Introduction to Quantum Field Theory, M. Maggiore, Cambridge University Press.
5. Field theory, A Modern Primer, P. Ramond, Addison-Wesley.
6. Relativistic Quantum Fields, J. D. Bjorken and S. D. Drell, McGraw Hill, 1st ed.
7. An Introduction to Quantum Field Theory, M.E. Peskin and D.V. Schroeder, Levan
8. Amitabha Lahiri and Palash. B. Pal, A first book of Quantum Field Theory, Narosa Publishing House.

Semester Fourth

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) IV Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Atomic, Molecular and Laser Physics**
Course Code: **PHY650C**
Credits: **04**
Type of Course: Core (Theory)
Contact Hours: 4 hours per week (Total: 52 lecture + 12 tutorials)
Internal assessment: 50% (30% Exam (1.5 Hours) and 20% assignments/presentations)
End-Term Examination: (2.5 Hours) 50%

Course Objective

To develop basic theoretical knowledge in Atomic, Molecular and Laser Physics

Course Outcome

On completion of the course, students will be able to:

- Understand quantum states of atoms.
- know atomic spectra of atom.
- explain the various types of spectra of di-atomic molecules.
- understand the Physics of Lasers.
- understand various types of Lasers, their working and applications.

PHY650C: Atomic, Molecular and Laser Physics **Credits: 04**
L 3 T 1 P 0

UNIT I
Classical theories of radiating dipoles, Quantum theory of radiative transitions, Electric dipole (E1) transitions, Selection rules for E1 transitions, Higher order transitions, Radiative lifetimes, The width and shape of spectral lines, Natural broadening, Collision (Pressure) broadening, Doppler broadening, Converting between line widths in frequency and wavelength units, Non-resonant excitation — Comparison with the elastically bound electron model; Resonant excitation — Induced absorption and emission.

UNIT II
Spin-orbit interaction, Lamb shift, Fine spectra, Fine spectra of hydrogenic atoms, hyperfine structure. Coupling of orbital and spin angular momenta of many electron atoms, LS and JJ coupling schemes, Breit Scheme, Lande interval rule. Spectroscopic notation and multiplicity of energy states. Normal and anomalous Zeeman effect. Paschen Back effect, Stark effect.

UNIT III
Molecular Spectra, Born-Oppenheimer Approximation, Rotational, Vibrational, Rotational Vibrational and Electronic energy and spectra of Di-atomic molecules, Selection rules, Frank Condon principle, Raman spectra, Intensity of bands in absorption and emission. Isotopic effect, Resonance: ESR and NMR. Mossbauer Effect.

UNIT IV
Basic of Laser, Boltzmann equation, Spontaneous and Stimulated transitions, Einstein coefficients, Population inversion. Transition rates, Light matter interaction, Pumping schemes, Two level, The three level and four level systems, Line broadening mechanism. Shape and width of spectral lines. Optical resonators: Quality factor. Losses inside the cavity. Threshold conditions. Schawlow-Townes condition. Transverse and longitudinal modes, He-Ne laser, Ruby laser, CO2 laser, Dye lasers

Books Recommended:

1. Fundamentals of Molecular Spectroscopy, C. N. Banwell, McGraw Hill, 4th ed.

2. Introduction to Atomic Spectra, H. E. White, McGraw Hill.

3. Lasers: Fundamentals and Applications, K. Thyagarajan and A. Ghatak, Springer, 2^{nd} ed.

4. Physics of Atoms and Molecules, B. H. Bransden and C. J., Joachain, PHI, 2nd ed.

5. Atoms, Molecules and Photons, W. Demtroder, Springer.

6. Molecular Spectra & Molecular Structure-I, Diatomic Molecules, G. Herzberg, Krieger Pub., 2^{nd} ed.

7. Principles of Lasers, O. Svelto, Springer, 5th ed.

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) IV Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Material Science**

Course Code: **PHY651C**

Credits: **04**

Type of Course: Core (Theory)

Contact Hours: 4 hours per week (Total: 52 lecture + 12 tutorials)

Internal assessment: 50% (30% Exam (1.5 Hour) and 20% assignments/presentations)

End-Term Examination: (2. 5 Hours) 50%

Course Objectives

[illegible]

Course Outcomes

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

PHY651C: Material Science **Credits: 04**
L 3 T 1 P 0

UNIT I

Introduction to Materials Science and Technology. Material Ages. Crystalline solids, liquids, amorphous and liquid crystals, Thin Film and nanomaterials. Crystal Structures of few multifunctional materials. Structure-processing-property-performance relationship. Ceramics and vdW materials, Example of Different Ceramics, polymers, and glasses.

Electronic Properties: Density of states, Variation of the density of states with energy and Size of crystal, quantum confinement, Bulk to nano transition – Semiconducting nanoparticles, Conductance formula for nanostructures, Quantized conductance. Ballistic transport, Diffusive transport, Coulomb blockade.

UNIT II

Phase equilibria and phase transformation. Gibbs free energy – composition diagrams, Gibbs-Thompson effect, Phase diagram (phase rule, unary and binary diagrams), diffusion, phase transformation-mechanism and kinetics, nucleation and growth, TTT Curves, Microstructure and effect of Sintering. Order-disorder and Martensite phase transition. Shape Memory Alloys.

Mechanical Properties. Tensile properties (elasticity, yield and tensile strengths, ductility and toughness). Plastic deformation, slip, dislocation motion, Peierls Stress. Strengthening mechanism, Facture, Fatigue and creep. stress-strain behaviour.

UNIT III

Synthesis of Materials, Key issue in the synthesis of Bulk and Nanomaterials, Top down and Bottom up approaches: Photo and Electron beam lithography, Ball Milling and solid-state reaction, Chemical Vapor Deposition, Sol gel (hydrothermal and solvothermal synthesis).

Carbon nanotubes (CNT): Properties and Applications of CNTs, Fullerenes, Graphene: Band Structure and Electronic properties. MEMS and NEMS, Nanocomposites, Fuel cells, Hydrogen storage.

UNIT IV

Structural analysis: X-ray Diffraction (XRD), Microscopic techniques: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM),

Scanning probe techniques: Scanning Tunnelling Microscopy (STM), Atomic Force Microscopy (AFM), Spectroscopy techniques: X-ray Absorption (XAS). X-ray Photoelectron spectroscopy (XPS). Photoluminescence Emission (PL) and Excitation (PLE) spectroscopy; Infrared (IR) and Raman spectroscopy.

Books Recommended:

1. Nanotechnology: An Introduction, Jeremy Ramsden, Elsevier, 1st ed.
2. Nanoscience and Nanotechnology, M. S. R. Rao and S. Singh, John Wiley, Ist ed.

3. Introduction to Nanotechnology, C. P. Poole Jr. and F.J. Owens, John Wiley.
4. Nanostructured Materials: Processing, Properties and Applications, C. C. Koch, Taylor & Francis, 2nd ed.
5. Materials Science and Engineering, An Introduction, 9th edition, by William D Callister, William D Callister Jr., David G Rethwisch, (2007) John Wiley & Sons, Inc.
6. Engineering Materials Science, 1st Edition, by Milton Ohring, (1995) Academic Press.
7. Introduction to Materials Science for Engineers. J. Shackelford, (2004) 6th edition. Upper Saddle River, NJ: Pearson

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) IV Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Numerical Methods and Fortran Programming**
Course Code: **PHY652C**
Credits: **04**
Type of Course: Core (Theory)
Contact Hours: 4 hours per week (Total: 52 lecture + 12 tutorials)
Internal assessment: 50% (30% Exam (1.5 Hour) and 20% assignments/ presentations)
End-Term Examination: (2.5 Hours) 50%

Course objective

- The course will expose a student to the numerical techniques used to solve scientific problems which include solution to algebraic and transcendental equations, interpolation, numerical differentiation and integration.
- To train students in Fortran language and to enable them to write Fortran programs for solving various mathematical and physics problems numerically.

Course outcome

Upon the completion of the above course, the student will be able to:

- Use numerical techniques to solve problems in science and engineering.
- Understand the basic format of a Fortran program.
- Understand the use of function and subroutine in a Fortran program.
- Write Fortran programs for various numerical methods used to solve various differential problems.

PHY652C: Numerical Methods and Fortran Programming

Credits: 04
L 3 T 1 P 0

UNIT I

Introduction to numerical analysis, Some mathematical preliminaries, Errors and their computations, General error formula, Error in series approximation, Solution of algebraic and transcendental equations: Bisection method, Method of False Position, Iteration method, Newton – Raphson method, Secant method, Convergence of solutions.

Interpolation, Errors in Polynomial Interpolation, Finite differences (forward, backward and central differences), symbolic relations and separation of symbols, Detection of errors by use of difference tables, Newton's formulae for interpolation.

UNIT II

Numerical differentiation, Errors in numerical differentiation, Maximum and minimum values of a tabulated function. Numerical Integration: Trapezoidal rule, Simpson's 1/3 and 3/8 rule.

Numerical solution of ODEs: Solution by Taylor's series, Picard's Method of successive approximations, Euler's Method, Error Estimates for the Euler's Method, Modified Euler's Method, Runge Kutta methods: Second and Fourth order.

UNIT III

Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants, Variables Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements, Executable and Non-Executable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Types of Logic (Sequential, Selection, Repetition), Branching, Looping and Jumping Statements, Arrays: Types of Arrays, Dimension Statement, Reading and Writing Arrays, Functions and Subroutines, Structure, Disk I/O Statements, open a file, writing in a file, reading from a file.

UNIT IV

Preparing flow chart, writing, compiling and executing the following programmes:

- Sin(x) series and Cos(x) series
- Exp(x) and Exp(-x) series
- Fibonacci Series
- Addition and multiplication of matrices
- Inverse of a matrix
- Trapezoidal Rule,
- Simpson's 1/3 Rule
- Newton-Raphson Method
- Runge Kutta second order and Fourth order Method

Books Recommended:

1. Introductory Methods of Numerical Analysis, S. S. Sastry, PHI, 3rd ed.
2. Numerical Mathematical Analysis, J. B. Scarborough, The John Hopkins University Press, 6th ed.
3. An Introduction to Numerical Analysis, K. E. Atkinson, John Wiley.
4. Computer programming in FORTRAN 77 and 90, V. Rajaraman, PHI, 4th Ed.
5. Numerical Recipes in FORTRAN 77, W. H. Press and S. A. Teukolsky, CUP, 2nd Ed.
6. Fortran For Scientists & Engineers, Stephen Chapman, McGraw Hill Education, 4th Ed.

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) IV Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Project II**

Course Code: **PHY653C**

Credits: **04**

Type of Course: Core (Project)

Contact Hours: 8 hours per week

Internal assessment: (No internal assessment)

End-Term Examination: 100% (Dissertation defence and Viva)

Course Objective

Dissertation involves project work with the intention of exposing the student to research /development. It involves open ended learning based on student ability and initiative, exposure to scientific writing and inculcation of ethical practices in research and communication.

Course Outcome

- Exposure to research methodology.
- Picking up skills relevant to dissertation/project.
- Development of creative ability and intellectual initiative.
- Developing the ability for scientific writing.
- Becoming conversant with ethical practices in acknowledging other sources.

PHY653C: Project **Credits: 04**

The student will continue the project initiated in the 3rd Semester, subject to departmental approval. They will then compile a dissertation report, due at the semester's end, for final assessment and viva-voce examination by the department.

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) IV Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Superconductivity**
Course Code: **PHY654E**
Credits: **02**
Type of Course: Discipline Centric Elective (Theory)
Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)
Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)
End-Term Examination: (1. 25 Hours) 50%

Course Objectives

To predict the effect of temperature change on the electrical resistivity superconductors.

Course Outcomes

Students will have achieved the ability to:

- Describe the historical background of superconductor
- Explain their properties
- Apply basic theory and concepts of superconductivity
- Analyse and evaluate superconducting applications
- Describe the advantages and disadvantages of superconductor
- Describe their function and uses in daily life.

PHY654E: Superconductivity **Credits: 02**
L 2 T 0 P 0

UNIT I

The superconducting state, Basic properties of the superconducting state: Zero resistance, Critical temperature, The Meissner effect (Perfect diamagnetism), Flux quantization, Isotope effect, Critical magnetic fields, Type-I and Type-II superconductors, Critical Current, Penetration depth, Coherence length, Thermodynamics of transition, First and Second order transitions, Entropy, specific heat, Energy gap, The Josephson effects.

UNIT II

Models and theories: Two fluid model, London equations, Ginzburg-Landau theory, main results of Bardeen Cooper and Schrieffer (BCS) theory: Instability of the Fermi Surface in the presence of attractive Interaction between electrons, Electron distribution in the ground state of a Superconductor, Critical temperature, Energy gap, Origin of the attractive interaction. Introduction to High T_C superconductivity. Applications: SQUIDS, Magnetic Shielding, Power Transmission, Energy Storage devices, and Medical Applications, Topological superconductivity (qualitative idea only).

Books Recommended:

1. Introduction to Superconductivity, C. Rose-Innes and E. H. Rhederick, Pregamon Press, 2nd ed.
2. Handbook of superconductivity, C. P. Poole Jr., Academic Press, 1st ed.
3. Room Temperature Superconductivity, Andrei Mourachkine, CISP, 1st ed.
4. High Temperature Superconductivity, Jeffrey W. Lynn, Springer.
5. Superconductivity Today, T. V. Ramakrishnan and C. N. R. Rao, Universities Press, 2nd ed.
6. Introduction to Superconductivity, M. Tinkham , Dover Pub., 2nd ed.

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) IV Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title**: Quantum Electrodynamics**

Course Code: **PHY655E**

Credits: **02**

Type of Course: Discipline Centric Elective (Theory)

Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)

Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)

End-Term Examination: (1.5 Hours) 50%

Course Objectives

Quantum Electrodynamics (QED) is the quantum field theory of electrodynamics. The main objective of the course is to develop basic understanding and skills of the subject of quantum electrodynamics.

Course Outcomes

Students will have achieved the ability to:

- know the Klein-Gordon and the Dirac equations and the mechanism of quantum field theory
- draw simple Feynman diagrams and calculate the corresponding transition amplitudes
- be familiar with the principle and techniques of renormalization

PHY655E: Quantum Electrodynamics

Credits: 02
L 2 T 0 P 0

Unit I

Brief recapture of Dirac field, Canonical quantization of the electromagnetic field, gauge invariance, QED propagator, quantization in Coulomb gauge and Lorentz gauge, expansion of S-matrix.

Unit II

Feynman Diagrams, Feynman rules for QED, lowest order processes of QED, electron-electron scattering, Bhabha scattering, photon bremsstrahlung. (Tutorial problems based on trace algebra, invariant matrix elements and cross-section formula).

Books Recommended:

1. 1 F. Mandl and G. Shaw, Quantum Field Theory, 2nd edition, Wiley publication.
2. L. H. Ryder, Quantum Field Theory, 2nd edition, Cambridge University Press.
3. Amitabha Lahiri and Palash. B. Pal, A first book of Quantum Field Theory, Narosa Publishing House.
4. W. Greiner and Reinhardt, Quantum Electrodynamics, Springer-2009

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) IV Semester
Department of Physics
Islamic University of Science and Technology, Awantipora

Course Title: **Astrophysics II**
Course Code: **PHY656E**
Credits : **02**
Type of Course: Discipline Centric Elective (Theory)
Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)
Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)
End- Term Examination: (1.25 Hours) 50%

Course Objectives

To familiarize and expose students to various fields, basic principles and theories of astronomy and astrophysics. The aim of this particular course is to understand various aspects of our own galaxy. Also, this course will focus on Cosmology which is the study of large-scale structure of the universe.

Course Outcomes

On completion of this course, student will be able to:

- Understand the formation and evolution of our own Galaxy-The Milky Way.
- Understand the origin and evolution of our universe as whole and various models which have been proposed.
- Understand basic concepts about dark matter, dark energy and expansion of universe.

PHY656E: Astrophysics II **Credits: 02**
L 2 T 0 P 0

UNIT I

Our Galaxy: The Milky Way, Shape of Size of the Milky Way, Differential Rotation of the galaxy, The local Standard of rest, Local differential motions, Crude estimates of the mass of the Galaxy, Determination of Rotation parameters in the Solar neighborhood, Spiral Structure: The nature of the spiral arms, Magnetic field in the Galaxy.

UNIT II

Cosmology: Newtonian Cosmology, The Einstein Universe, The expanding Universe, Redshift, Hubble's law, Cosmic Microwave Background Radiation (CMBR), Simplifying assumptions of cosmology, The Einstein field equations in cosmology, The Friedmann models, The solution of Friedmann's equations, Alternatives to Friedmann cosmologies, The steady state theory, Observable parameters of the steady state theory, Dark Matter and Dark Energy.

Books Recommended:

1. The Physical Universe: An Introduction to Astronomy, Frank H. Shu, Mill Valley: University Science Books, ISBN 0-935702-05-9.
2. An Introduction to Astrophysics, Baidyanath Basu, PHI Learning Pvt. Ltd ISBN 9788120340718
3. Introduction to Cosmology, 3rd Edition, J. V. Narlikar, Cambridge University Press, ISBN 0-521-41250.
4. Theoretical Astrophysics, Volume III: Galaxies and Cosmology, T. Padmanabhan, Cambridge University Press, ISBN: 0521562422

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) IV Semester
Department of Physics
Islamic University of Science and Technology

Course Title: **Advanced Nuclear Physics**

Course Code: **PHY657E**

Credits: **02**

Type of Course: Discipline Centric Elective (Theory)

Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)

Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)

End-Term Examination: (1. 25 Hours) 50%

Course Objectives

To understand the advanced concepts of nuclear physics in order to enable a student to take up research in nuclear theory. The other objective involves imparting the knowledge of some important theoretical tools such as the rotation of spherical harmonics and second quantization that are used in a variety of physical problems.

Course Outcomes

On the completion of the course, students will be able to

- Understand the quantum mechanics of a 3D harmonic oscillator, both isotropic as well as anisotropic.
- Parametrization of a 3D surface and its rotation in terms of spherical harmonics.
- Understand the origin and need of second quantization.
- The student will learn the Nilsson model of nucleus.
- The student will learn the Particle Rotor Model of nucleus.

PHY657E: Advanced Nuclear Physics **Credits: 02**
L 2 T 0 P 0

UNIT I

Three-dimensional isotropic harmonic oscillator (wave-functions in cartesian, spherical and cylindrical coordinates), LS coupling.

Parametrization of surface deformation, Types of multipole deformations, Quadrupole deformation, Two-level mixing, Rotation of spherical harmonics, D-matrix and it's properties.

UNIT II

Introduction of second quantization, Second quantization for bosons and fermions, One-body and two-body operator in second quantization.

Review of spherical shell model, Nilsson Model; The potential, Nilsson model (Qualitative treatment).

Nilsson model (exact treatment), solution of hypergeometric function, The asymptotic quantum numbers.

Particle-Rotor mode: Hamiltonian, wave-function and transition matrix elements.

Books Recommended:

1. Peter Ring and Peter Schuck, The Nuclear many-Body Problem, Text & Monographs inPhysics, Springer-Verlag New-York.
2. M.K. Pal, Theory of Nuclear Structure (Affiliated East - West, Madras,1982).
3. Greiner and Maruhn, Nuclear Models, Springer International (Reprint 2010).
4. Atomic and Nuclear Physics, S. N. Ghosal, S. Chand, 2nd ed.
5. Introduction to Nuclear Physics, H. A. Enge, Addison-Wesley.
6. Introductory Nuclear Physics, P. E. Hodgson, and E. Gadoili, OUP, illustrated ed.

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) IV Semester
Department of Physics
Islamic University of Science and Technology

Course Title: Research Methodology

Course Code: PHY658E

Credits: 02

Type of Course: Discipline Centric Elective (E)

Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)

Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)

End-Term Examination: (1. 25 Hours) 50%

Course Objectives

The purpose of this course is to

- make students understand how to carry out the scientific research.
- give them the knowledge of Scientific writing and presentation.

Course Outcomes

On successful completion of this course the students:

- will be able to learn various tools to carry out the research work.
- should be familiar with ethical issues in educational *research*.

PHY658E: Research Methodology **Credits: 02**
L 2 T 0 P 0

UNIT I

What is science? Scientific reasoning, Scientific Temper, Scientific Method, Scientific measurement, The Criteria for Good Measurement.

Introduction to Research, Types of research: exploratory, conclusive, modeling and algorithmic, Identification of research problems, formulation of a problem, Data collection: data analysis, interpretation of results and validation of results.

UNIT II

Scientific Writing: Goals and Objectives, Structure of documents, importance of clear title, abstract or summary, Introduction, Methods, Results and Discussion, Illustrations and aids

Numbers and statistics, Tables and Figures, Language and grammar, writing proposals and instructions, making presentations, Formatting documents, Drafts and revisions, Editing, Writing popular science / journal article, Science fiction.

Books Recommended:

1. Research Methodology: An introduction for science and engineering students, Stuart Milville & Wayne Goddard, McGraw Hill International.
2. Research Methodology: Methods & Techniques, C.R. Kothari New Age International Publishers, New Delhi.
3. Research Methodology, N. Thanulingon , Himalaya Publishing House, New Delhi
4. Research Methodology, R. Pannerselvam Prentice Hall of India Pvt. Ltd
5. The Craft of Scientific Writing (3rd Edition), Michael Alley, Springer, New York, 1996.
6. Science and Technical Writing – A Manual of Style (2nd Edition), Philip Reubens (General editor), Routledge, New York, 2001.
1. Writing Remedies – Practical Exercises for Technical Writing Edmond H. Weiss, Universities Press (India) Ltd., Hyderabad, 2000.
8. Effective Technical Communication, M. Ashraf Rizvi, Tata Mc Graw – Hill, New Delhi, 2005.

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) IV Semester
Department of Physics
Islamic University of Science and Technology

Course Title: Quantum Computation
Course Code: PHY659E
Credits: 02
Type of Course: Discipline Centric Elective (E)
Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)
Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)
End-Term Examination: (1. 25 Hours) 50%

Course Objectives

The objective of the course is to familiarize students with the emerging field of quantum computation. It will cover the mathematical formalism of Quantum Computation from Single Qubit concepts and progressing to multiple Qubits. The curriculum will delve into Quantum Computation Algorithms. Additionally, a concise overview of Error Correction and Cryptography in the context of quantum computation will be presented. The course will also explore various Models of Quantum Computation to enrich the students' knowledge in this cutting-edge domain.

Course Outcomes

On successful completion of the course the students will be able to:

- develop the comprehension of Quantum Computation.
- get familiar with Quantum Algorithms.
- develop basic understanding of Quantum Key Distribution and BB84 protocol.
- get familiar with some realisation of Quantum Computers.

PHY659E: Quantum Computation

Credits: 02
L 2 T 0 P 0

UNIT I

Foundation: Introduction, Review of Linear Algebra, Bra-Ket Notation, Postulates of Quantum Mechanics, Pauli matrices, Density Matrix, Composite Systems, Bell States, Bell Inequalities, Entanglement, Qubit, Bloch Sphere, Single Qubit Gates, Multiple Qubit Gate, Schmidt Number, No-cloning Theorem, Quantum Circuit, Quantum Teleportation, Universal Set of Quantum Gates.

UNIT II

Applied Quantum Computation: Deutsch's Algorithm, Deutsch-Jozsa Algorithm, Quantum Fourier Transform, Quantum Operations, Operator Sum Representation, Quantum Noisy Channel, Quantum Error Correction, Quantum Key Distribution, Brief Overview of BB84 Protocol, Simple Harmonic Oscillator and Optical Photon as Qubit.

Books Recommended:

1. Quantum Computing Explained by David McMahon: 1st Edition, IEEE Press
2. Quantum Computation and Information by Michael A. Nelson and Isaac L. Chaung: 10th Anniversary Edition, Cambridge Press
3. Principles Of Quantum Computation and Information by Giuliano Strini and Giulio Casati: 2nd Edition, World Scientific

Syllabus with Course Objectives and Course Outcomes
M. Sc (Physics) IV Semester
Department of Physics
Islamic University of Science and Technology

Course Title: **Fourier Optics and Applications**

Course Code: **PHY660E**

Credits: **02**

Type of Course: Discipline Centric Elective (E)

Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)

Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)

End-Term Examination: (1. 25 Hours) 50%

Course Objective

To develop understanding of the optical systems using Fourier analysis

Course Outcome

On completion of course, the student will be able to:

- Understand the fundamentals of signal sampling.
- Understand Fourier domain analysis of diffraction theory
- To know frequency response of optical systems under coherent and incoherent illumination.
- To understand working of various imaging system

PHY660E: Fourier Optics and Applications **Credits: 02**
L 2 T 0 P 0

Unit I

Signals and systems, Fourier Transform(FT), Sampling theorem; Diffraction theory; Fresnel-Kirchhoff formulation and angular spectrum method, brief discussion of Fresnel and Fraunhofer diffraction, FT Properties of lenses and Image formation by a lens; Frequency response of a diffraction-limited system under coherent and incoherent illumination, OTF-effects of aberration and apodization.

Unit II

Comparison of coherent and incoherent imaging, Analog optical information processing: Abbe-Porter experiment, phase contrast microscopy, Image restoration: Inverse and Wiener Filters; Coherent image processing: Vander Lugt filter; Joint-transform correlator; Synthetic Aperture Radar. Basics of holography, in-line and off-axis holography; Super-resolution: Structured Illumination microscopy; Ghost Imaging

Books Recommended:

1. GOODMAN, J. W. (1996). Introduction to Fourier optics. New York, McGraw-Hill.
2. KHARE, Kedar (2016). Fourier Optics and Computational Imaging. John Wiley and Sons.

Syllabus for Open Elective Courses (offered by Department of Physics for other Departments of the University)

Course Title: **Physics and Technology**
Course Number: **PHYOE001**
Credits: **02**
Type of Course: Open Elective (Theory)
Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)

Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)

End-Term Examination: (1. 25 Hours) 50%

Course Objectives

This course being open elective in nature is designed for the students from other departments to let them know the significance of the subject of Physics in connection with the advancements made in the present-day technology. This course contains some basic and important concepts of physics that will make the students acquainted and will infuse in them the technological importance of the subject.

Course Outcomes

- The students will gain the knowledge of the technological advancements made in physics and also the concepts underlying this technological advancement.

- The students will especially from the engineering background will come to know about the research or job opportunities in the field of physics.

PHYOE001: Physics and Technology **Credits: 02**
L 2 P 0 T 0

UNIT I

Industrial physics, Vacuum tube technology, Semiconductor technology, Wireless communication, Nuclear fission, Nuclear reactors, Nuclear fusion and Source of energy in Sun, ITER, Concept of Plasma and Bose-Einstein Condensate, Super conductivity and its Applications, SQUID.

UNIT II

Transistor and microwave technology, the laser, quantum optics, optical fibres, idea of quantum computers and Super computers, Technology development at CERN: particle accelerators. Nanotechnology, Novel materials, idea of Solar technology.

Books Recommended:

1. Radiation Detection and Measurement, G. F. Knoll, John Wiley, 2nd ed.
2. Introduction to Nanotechnology, Charles P. Poole Jr. and Frank J. Owens, John Wiley.
3. Plasma Physics and Controlled Fusion, F. F. Chen, Springer, 2nd ed.
4. Superconductivity, C. P. Poole Jr., H. A. Farach, R.J. Creswick and R. Prozorov, Academic Press, 2nd ed.
5. Feynman Lectures on Physics Vol.I, II & III, Narosa Publishing House.

Course Title: **Philosophical Foundations of Physics**
Course Number: **PHYOE002**
Credits: **02**
Type of Course: Open Elective (Theory)
Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)

Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)

End-Term Examination: (1. 25 Hours) 50%

Course Objectives

This course is designed for the students from the other departments especially Humanities who are interested in the philosophical aspect of physics.

Course Outcomes

- The students will gain the knowledge of the important concepts like determinism, unification and their philosophical interpretation.

- The students will learn some important concepts in quantum mechanics like its probabilistic interpretation, Copenhagen interpretation besides the incompleteness and the philosophical interpretation of quantum mechanics.

PHYOE002: Philosophical Foundations of Physics **Credits: 02**
L 2 P 0 T 0

UNIT I

Classical Physics and Determinism, defining the object, subjectivity, Aristotelian space-time, Newtonian mechanics and space-time, The Leibnitz-Clarke Debate, Space as metaphor, Concept of Ether, Unification of Electricity and Magnetism: Maxwell's equations.

Special Relativity: Simultaneity and Relativity of time, Unification of Space and time (Four-dimensional space-time), time as metaphor, unification of mass and energy ($E = mc^2$).

UNIT II

The Epistemology of Physics: Probabilistic interpretation of Quantum Mechanics, why interpretation? Uncertainties, Copenhagen interpretation: Reduction of wave function, Principle of Complementarity, Rudiments of Quantum Dialect, The role of Probabilities, The logic of Quantum world, Incompleteness of Quantum Mechanics and EPR experiment.
Process of measurement: The Decoherence effect, Quantum Physics and Realism. The religious Interpretation of Science, Physics as Metaphor.

Books Recommended:

1. Physics as Metaphor, R. S. Jones, Wildwood House, 1982.
2. Quantum Philosophy, R.Omnes, University Press, 1999.
3. Doubt and Certainty, Tony Rothman and George Sudarshan, CUP, 1998.
4. Probabilities of Quantum World, D. Danin, Mir Publishers Moscow, 1983

Course Title: **Physics of Household Electrical Appliances**
Course Number: **PHYOE003**
Credits: **02**
Type of Course: Open Elective (Theory)
Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)

Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)

End-Term Examination: (1. 25 Hours) 50%

Course Objectives

This course is designed for the students from the other departments such as Engineering, Humanities and Social Sciences with the objective to understand the fundamental principles of physics as they apply to common household electrical devices and appliances.

Course Outcomes

- The students will gain fundamental understanding of the principles and applications of physics in the working and operation of various household electrical appliances.
- The students will evaluate the energy consumption and energy wastage in household appliances as well as identify the potential risks and necessary safety measures associated with these appliances.

PHYOE003: Physics of Household Electrical Appliances

Credits: 02
L 2 T 0 P 0

UNIT I

Heating Appliances: Heating effects of current, working and operation of home appliances based on this effect such as coil heater, Water heater; room heater, hot air blower, Induction heater, Microwave oven and Refrigerator
Concept of illumination, Electric bulbs, CFL, LED lights, Energy efficiency in electrical appliances

UNIT II

Motorized Appliances: Principle construction and working of electric motor, operation and working of motorized appliances such as Mixer, Grinder, Washing Machine, Hand Drill, table fan, water pumps, power consumption and power rating of the appliances.

Books Recommended:

1. Mittal, A K, “Electrician Theory”, Arihant Publishers (Hindi), India, 2019.
2. B.L.Theraja, A Text book on Electrical Technology, S.Chand& Co.,
3. A. K. Theraja A Text book on Electrical Technology.
4. Handbook of Repair & Maintenance of domestic electronics appliances; BPB Publications
5. K. P. Anwer, Domestic Appliances Servicing, Scholar Institute Publications.

Course Title: **Physics of Medical Diagnostic Equipments**
Course Number: **PHYOE004**
Credits: **02**
Type of Course: Open Elective (Theory)
Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)

Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)

End-Term Examination: (1. 25 Hours) 50%

Course Objectives

This course is designed for the students from the other departments and encompass a comprehensive understanding of the physical principles behind various medical diagnostic instruments and technologies.

Course Outcomes

- The students will gain fundamental understanding of the physics underlying various medical diagnostic equipments particularly imaging modalities like X-ray imaging, computed tomography, ultrasound etc.

- The students will gain knowledge about the design and operation of diagnostic equipment instrumentation as well as components of imaging devices, detectors, image formation and reconstruction.

- The students will understand the importance of safety consideration and radiation protection measures for patients and healthcare professionals as well as quality assurance procedures and protocols for maintaining equipment performance.

PHYOE004: Physics of Medical Diagnostic Equipments

Credits: 02
L 2 T 0 P 0

UNIT I

X-rays: Electromagnetic spectrum, production of X-rays. X-ray Spectra, Bremsstrahlung and characteristic X-rays, Quality and intensity of X-rays, X-ray tubes and types, X-ray tube design, Coolidge tube, tube cooling, stationary mode, Rotating anode X-ray tube.

UNIT II

X-ray diagnostics and imaging, x-ray films and film processing, principle of Computed tomography, ultrasound imaging, physics of nuclear magnetic resonance (NMR), NMR imaging, MRI radiological imaging.

Books Recommended:

1. The Physics of Radiation Therapy, Faiz M. Khan, 5th Edition, Lippincott Williams and Wilkins, 2014
2. Diagnostic Radiology Physics, D. R. Dance, S. Christofides et al., , IAEA, 2014
3. Basic Radiological Physics 2Nd Edition 2017 by Thayalan Kuppusamy, Jaypee Brothers Medical Publishers
4. The Physics Of Radiology And Imaging Thayalan K JAYPEE BROTHERS MEDICAL PUBLISHERS P LTD
5. Essential Physics For Radiology And Imaging 3/E 2022 By Akash Ganguly Akash Ganguly, Rezaul Karim Edition: 3rd Publisher: Academic Publisher Year: 2022

Course Title: **History of Physics**
Course Number: **PHYOE051**
Credits: **02**
Type of Course: Open Elective (Theory)
Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)

Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)

End-Term Examination: (1. 25 Hours) 50%

Course Objectives

This course is an open elective designed for the students from the other departments to make them aware of the developments, discoveries, crisis, opportunities etc. in physics.

Course Outcomes

- The students will gain the knowledge of how the important theories and laws came into being.

- The students will also learn how political leadership and different ideologies affected the development of physics.

PHYOE051: History of Physics **Credits: 02**
L 2 T 0 P 0

UNIT I

Galilean and Newtonian Physics, law of inertia, laws of motion, Early history of thermodynamics and kinetic theory of gases, Concept of ether and Michelson Morley experiment, Electricity and Magnetism unified.

History of Atom- Aristotle to Bohr Development of quantum theory of light, Theory of Relativity (General and Special)-How I (Einstein) created it?

Development of quantum mechanics-Schrödinger and Heisenberg picture, crisis in quantum theory, discovery of spin.

UNIT II

Indian, Arab and Chinese contribution to physics, Physics under political leadership: the shadow of Nazism and Mussolini, Physics Dialectical Materialism and Stalinism, Physics in the great depression, Nuclear bomb and death of two cities.

Rise of Nuclear and Particle Physics, Engineering Physics and Quantum Electronics, Physics in crisis.

Concept of Unification and String Theory.

Books Recommended:

1. History of Physics, S. R. Weart and Melba Phillips, AIP publication, 1985.
2. Quantum Generations A History of Physics in The Twentieth Century, Helge Kragh, Universities Press.
3. Physics as Metaphor, R. S. Jones, Wildwood House, 1982.
4. Probabilities of Quantum World, D. Danin, Mir Publishers Moscow, 1983.

Course Title: **Physics and Our World**
Course Number: **PHYOE052**
Credits: **02**
Type of Course: Open Elective (Theory)
Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)

Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)

End-Term Examination: (1. 25 Hours) 50%

Course Objectives

This course is designed to make understand, the general undergraduate and masters students about the world around us ranging from the size of atom to the size of galaxies through the concepts of Physics. It includes very fundamental and useful concepts that will be helpful for a general student to have better understanding of the world around us.

Course Outcomes

- The students will grasp the ideas about the various length scales on which matter exists in nature.
- The students will learn about some basic phenomena like formation of day and night, change in seasons and other important phenomena of nature that we experience in day to day life.
- The students will have an elementary idea of space-time through the introduction of special theory of relativity besides the laws of thermodynamics and concept of entropy.
- The concept of matter and energy, elementary particles and unification of forces will be learnt.
- Idea about different sources of energy will be learnt.

PHYOE052: Physics & Our World **Credits: 02**
L 2 T 0 P 0

UNIT I

A brief account of the special theory of relativity, Lorentz transformation, Time dilation and Length contraction, Relativistic momentum, Mass and Energy, Energy and Momentum. Elementary particles: a brief overview, Classification and interactions, Fundamental forces in nature, Unification of fundamental forces, The standard model, History of universe.

UNIT II

A discussion on length scales and dimensions, Galaxies, The solar system and the planet earth, Rotation and revolution of the earth, Seasons, Calendars in history and the recording of time. Development of laws of motion. Laws of thermodynamics and probabilistic interpretation of entropy.
Renewable and Non-Renewable sources of energy.

Books Recommended:

1. Concepts of Modern Physics, Arthur Beiser, 7^{th} Ed. McGraw Hill Education
2. Relativity The Special and The General Theory, Pigeon Books India.
3. Introduction to Elementary Particles, D. J. Griffiths, John Wiley, 4th ed.
4. Introduction to High Energy Physics, D. H. Perkins, Addison Wesley, 4th ed.
5. Cosmos, Carl Sagan, Random House, 1980.
6. The Universe in a Nutshell, Stephen Hawking, Bantam Press
7. Renewable Energy Resources, Twidell, 3^{rd} Edition, Taylor & Francis Ltd

Course Title: **Physics in Daily Use**
Course Number: **PHYOE053**
Credits: **02**
Type of Course: Open Elective (Theory)
Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)

Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)

End-Term Examination: (1. 25 Hours) 50%

Course Objectives

The objectives of Physics in Daily sue is to

- Educate students of disciplines other than physics on the basics of physics.
- Educate students to appreciate the surroundings by understanding the basic rules of nature.
- Educate students to understand the physics principles behind the working of various domestic appliances.

Course Outcomes

On the successful completion of the course the students will be able to:

- Connect some daily life observations to physics principles.
- Use basic physics knowledge to calculate the power consumption and power generation of domestic appliances.
- Understand the various temperature scales and their inter relationship.

PHYOE053: Physics in Daily Use **Credits: 02**
L 2 T 0 P 0

UNIT I

Fundamental and derived quantities, Units and dimensions, dimensional analysis, order of magnitude, significant figures, errors.
Reflection, refraction, diffraction, interference, scattering (elementary ideas only) – examples from daily life – apparent depth, blue colour of sky, twinkling of stars.
Total internal reflection, mirage, sparkling of diamond, primary and secondary rainbow – optical fibres.

UNIT II

Voltage and current, ohms law. Electric energy, electric power, calculation of energy requirement of electric appliances – transformer, generator, hydroelectric power generation – wind power – solar power – nuclear power.

Lasers, fluorescence, phosphorescence, electromagnetic waves – applications – microwave oven, radar, super conductivity.

Heat energy, temperature, different temperature scales – degree Celsius, Fahrenheit and Kelvin.

Books Recommended:

1. Fundamentals of Physics with Applications by Arthur Beiser, Kent A. Peterson, 6th Edition.
2. Conceptual Physics by Paul G Hewitt, Pearson 12th Edition.
3. The Physics in our Daily Lives by Umme Ammara, Gurucool, 1st Edition.
4. The Physics of Everyday Things: The Extraordinary Science Behind an Ordinary Day by James Kakalios, RH US, 1st Edition.

Course Title: **Physics of Sports**
Course Number: **PHYOE054**
Credits: **02**
Type of Course: Open Elective (Theory)
Contact Hours: 2 hours per week (Total: 26 lecture + 6 tutorials)

Internal assessment: 50% (30% Exam (45 Minutes) and 20% assignments/presentations)

End-Term Examination: (1. 25 Hours) 50%

Course Objectives

The objective of this course is to explore the fascinating intersection of physics and sports. The curriculum will focus on applying physics concepts to various sports letting the students gain insights into the fundamental principles that govern athletic performance. The students will appreciate the scientific intricacies of sports besides understand how physics plays a pivotal role in optimizing athletic abilities.

Course Outcomes

After finishing the course, students ought to:

- Use fundamental physics principles to explain physics behind sports.
- Solve simple problems related to sports using basic estimations and calculations.
- Make use of important physics principles to take correct decisions using physics to improve upon a given sporting activity.
- This course aims to provide an understanding of the physical mechanisms behind many popular sporting events

PHYOE054: Physics of Sports **Credits: 02**
L 2 T 0 P 0

UNIT I

Linear Momentum, Force, Energy, Projectile Motion, Rotation, Moment of Inertia, Angular Momentum, Collision, Forces involved in Cycling. Rock Climbing, Skating, Projection angle for Shot Put, Tight Rope Walk, How speed and acceleration relate to sprinting? Path of balls in Snooker.

UNIT II

Determine the path of a football using Newton's laws, rotational motion in gymnastics, figure skating and diving, principle of energy conversion for determination of the height achieved in the pole vault, use aerodynamics principles in javelin throw, ski jumping and swimming.

Books Recommended:

1. An Introduction to Mechanics: by Kleppner, McGraw Hill.