NOORUL ISLAM CENTRE FOR HIGHER EDUCATION

(Deemed to be University Under Section 3 of the UGC Act, 1956)
Kumaracoil, Thuckalay

DEPARTMENT OF PHYSICS

M.Sc. PHYSICS

CURRICULUM AND SYLLABI

REGULATION 2023

NOORUL ISLAM CENTRE FOR HIGHER EDUCATION
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Regulation: 2023

Curriculum and Syllabi

M.Sc. Programme

DEPARTMENT OF PHYSICS

Vision of the University

To be recognized by the Government and society at large as an institution able to deliver excellence with relevance in the field of higher education and research focusing on the needs of the nation in tune with the technological revolution to cope with the knowledge explosion and global competence.

Mission of the University

To develop the institution as a Centre of Excellence, keeping pace with the advances in the field, so as to provide quality higher education to the students and instill in them high standards of discipline and ethics so that they become enlightened individuals in the service of humanity and to carry out focused research in the frontier areas of science and technology.

Faculty of Science and Humanities

Department of Physics

Vision of the Department

To excel in imparting Physics education and research through creativity and learning and to inculcate high standards in teaching and research.

Mission of the Department

- To provide high quality education to the students by imparting sound knowledge on the principles of physics.
- To enhance the teaching skills and to promote research.
- To sustain and improve a conducive environment for learning and research.

Description of the programme

The two year M.Sc. Physics program offers advanced study in a Physics, providing in-depth knowledge and skills to the students. Students delve into core Physics topics, engaging with cutting-edge theories and methodologies under the guidance of expert faculty. The curriculum often includes a blend of core courses and elective options, allowing for customization based on individual interests and career goals. Through projects, internships, and thesis work, students gain hands-on experience, critical thinking abilities, and advanced problem-solving skills, preparing them for diverse opportunities in academia, industry, or further research.

Programme Educational Objectives - PEO	
PEO-01	To impart sound knowledge on theoretical as well as experimental physics and problem solving skills
PEO-02	To make students realize the challenges involved in physics and to effectively disseminate the acquired knowledge
PEO-03	To nurture creativity and innovative thinking
PEO-04	To create a sense of ethical responsibility among students

Graduate Attributes-GA	
GA-1	**Advanced Scientific Knowledge and Specialization**: Acquire in-depth knowledge and expertise in specific scientific disciplines, building upon foundational concepts to explore advanced theories, methodologies, and applications in the chosen field of study.
GA-2	**Research Methodology and Innovation:** Demonstrate proficiency in designing, conducting, and interpreting complex research experiments, utilizing advanced research methodologies, tools, and technologies to contribute to scientific innovation

GA-3	**Data-Driven Decision Making:** Use sophisticated data analysis techniques, statistical tools, and computational models to solve complex scientific problems, make data-driven decisions, and predict outcomes in research and industry settings.
GA-4	**Critical Thinking and Problem-Solving:** Develop advanced critical thinking and problem-solving skills, enabling the formulation of innovative solutions to theoretical and practical challenges in scientific research and application
GA-5	**Interdisciplinary Collaboration and Leadership:** Work effectively in interdisciplinary teams, integrating knowledge from various scientific domains to tackle complex, real-world problems, and demonstrate leadership in collaborative research and professional projects
GA-6	**Environmental Stewardship and Sustainable Practices:** Apply scientific principles to address environmental challenges, promote sustainability, and contribute to the development of environmentally responsible technologies and practices.
GA-7	**Ethics and Professional Integrity in Science:** Uphold the highest standards of ethical conduct and professional integrity in scientific research, ensuring responsible data handling, experimentation, and reporting in accordance with global scientific standards.
GA-8	**Advanced Laboratory and Technological Skills**: Master cutting-edge laboratory techniques, instrumentation, and scientific tools, utilizing them to conduct sophisticated experiments and research that contribute to scientific progress and innovation.
GA-9	**Effective Communication of Scientific Ideas**: Develop strong communication skills, capable of presenting complex scientific concepts, research findings, and technical information clearly and persuasively to both scientific and non-scientific audiences,
GA-10	**Lifelong Learning and Professional Development**: Embrace a commitment to lifelong learning, staying updated with the latest scientific advances, technologies, and best practices, and continuously developing skills to remain at the forefront of the

Programme Outcome - PO	
PO-A	Demonstrate a thorough understanding of Physics principles at an advanced level and problem solving skills
PO-B	Apply knowledge to design and conduct experiments and to interpret the experimental data
PO-C	Ability to carry out Physics projects of quality and to present the related findings through written, oral, and visual presentations
P0-D	Students will demonstrate an understanding of the physics knowledge and ethics for professionals and societal benefits as well as a commitment to life long learning

Mapping of Graduate Attributes and Programme Educational Objective (PEOs)

GAs / PEOs	GA-01	GA-02	GA-03	GA-04	GA-05	GA-06	GA-07	GA-08	GA-09	GA-10
PEO-01	**H**	**H**	**H**	**H**	**A**	**H**	**H**	**A**	**A**	**H**
PEO-02	**H**	**H**	**H**	**H**	**H**	**H**	**A**	**A**	**A**	**H**
PEO-03	**H**	**H**	**H**	**A**	**H**	**H**	**H**	**H**	**H**	**H**
PEO-014	**H**	**A**	**A**	**A**	**H**	**A**	**A**	**H**	**A**	**H**

H- Highly Associated A- Associated Not – Not Associated

GAs / PEOs	GA-01	GA-02	GA-03	GA-04	GA-05	GA-06	GA-07	GA-08	GA-09	GA-10
PO-A	**H**	**H**	**H**	**H**	**A**	**H**	**H**	**A**	**A**	**H**
PO-B	**H**	**H**	**H**	**H**	**H**	**H**	**A**	**A**	**A**	**H**
PO-C	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**
P0-D	**H**	**A**	**A**	**A**	**A**	**A**	**A**	**H**	**A**	**H**

Mapping of Graduate Attributes and Programme Outcome (PO)

H- Highly Associated A- Associated Not – Not Associated

Mapping of Programme Educational Objective (PEOs) and Programme Outcomes (POs)

PEO / PO	PEO-01	PEO-02	PEO-03	PEO-04
PO-A	H	H	H	H
PO-B	H	H	H	H
PO-C	A	H	H	H
P0-D	H	H	A	H

H- Highly Associated A- Associated Not – Not Associated

Duration of the programme: 2 Years/ I- IV Semesters

Total credit: 90

CURRICULUM & SYLLABI

SEMESTER I

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	PH4701	Core 1 – Mathematical Physics	4	1	0	4
2.	PH4702	Core 2 - Classical Mechanics and Relativity	4	1	0	4
3.	PH4703	Core 3 - Linear and Digital ICs and Applications	4	1	0	4
4.	PH47xx	Elective - I (Choose any one from the list I)	4	0	0	4
5	PH47E1	Professional Competency Course - Computational Physics	2	0	0	2
PRACTICAL						
6	PH4741	Core Practical I - Electronics Laboratory	0	0	4	2
7	PH47P1	Ability Enhancement Compulsory Course- Physics Experiments	0	0	4	2
TOTAL			**18**	**3**	**8**	**22**

SEMESTER II

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	PH4704	Core 4 - Statistical Mechanics	4	1	0	4
2.	PH4705	Core 5 - Quantum Mechanics-I	4	1	0	4
3.	PH4706	Core 6 - Electromagnetic Theory	4	1	0	4
4.	PH47xx	Elective - II (Choose any one from the list II)	4	0	0	4

PRACTICAL						
5	PH4772	Core Practical II – Advanced Experiments	0	0	4	2
6	PH47S1	Skill Enhancement Course I – Hands on Training in Analytical Instruments	2	0	2	2
7.	PH47P2	Ability Enhancement Compulsory Course – Internship*/ Industrial Activity (Credits to be awarded on completion of Internship) *Internship will be carried out after the first semester with minimum 10 working days duration and shall be accessed during the second semester through report and	0	0	2	2
TOTAL			**18**	**3**	**8**	**22**

SEMESTER III

Sl. No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
THEORY						
1.	PH4707	Core 7 - Quantum Mechanics-II	4	1	0	4
2.	PH4708	Core 8 - Condensed Matter Physics	4	1	0	4
3.	PH4709	Core 9 - Spectroscopy	4	1	0	4
4.	PH47xx	Elective - III (Choose any one from the list III)	4	0	0	4
PRACTICAL						
5	PH4773	Core Practical III - Condensed Matter Physics and Spectroscopy laboratory	0	0	4	2
6	PH47S2	Skill Enhancement Course II – Green Energy Technologies / NPTEL (SWAYAM Online Certification Course) / Any of the skill based courses offered by other department	2	0	2	2
7	PH47P3	Ability Enhancement Compulsory Course - Mini Project	0	0	2	2
TOTAL			**18**	**3**	**8**	**22**

SEMESTER IV

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	PH4710	Core 10 - Nuclear and Particle Physics	4	1	0	4
2.	PH4711	Core 11 -Numerical Methods and Computer Programming	4	1	0	4
3.	PH47xx	Elective - IV (Choose any one from the list I, II & III)	4	0	0	4
PRATICAL And PROJECT						
4.	PH4774	Core Practical – IV - Numerical Methods and Computer Programming	0	0	2	2
5.	PH47S3	Skill Enhancement Course III - Problem solving skills - A Training for CSIR-NET Examination	2	1	0	2
6.	PH47P6	Ability Enhancement Compulsory Course - Extension Activity	0	0	2	2
7.	PH47P5	Core 12- Project and Viva-Voce	0	0	12	6
TOTAL			**14**	**3**	**16**	**24**

LIST OF ELECTIVES

Sl. No	Course Code	Course Title	L	T	P	C
LIST I						
1.	PH47A1	Laser and its application	4	0	0	4
2.	PH47A2	Energy Physics	4	0	0	4
3.	PH47A3	Crystal Growth and Thin Films	4	0	0	4
4.	PH47A4	Materials Science	4	0	0	4
5.	PH47A5	Physics of Nanomaterials	4	0	0	4
LIST II						
6.	PH47A6	Alternate fuels	4	0	0	4
7.	PH47A7	Radiation Physics	4	0	0	4
8.	PH47A8	Bio Physics	4	0	0	4
9.	PH47A9	Advanced Optics	4	0	0	4
10	PH47B1	Advanced Mathematical Physics	4	0	0	4
LIST III						
11	PH47B2	Solid Waste Management	4	0	0	4
12	PH47B3	Sewage and Waste Water Treatment	4	0	0	4
13	PH47B4	Microprocessor 8086 and Microcontroller	4	0	0	4
14	PH47B5	Characterization of Materials	4	0	0	4
15	PH47B6	Medical Physics	4	0	0	4
16	PH47B7	Intellectual Property Rights	4	0	0	4
17	PH47B8	Astronomy and Astrophysics	4	0	0	4

CERTIFICATE COURSE

Sl.	Course Code	Course Title	L	T	P	C
CERTIFICATE COURSE						
1.	PH47C1	Sustainable Green Energy Production	2	0	2	2
2.	PHXXXX	Indian Knowledge System	4	0	0	4

SEMESTER I

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	PH4701	Core 1 – Mathematical Physics	4	1	0	4
2.	PH4702	Core 2 - Classical Mechanics and Relativity	4	1	0	4
3.	PH4703	Core 3 - Linear and Digital ICs and Applications	4	1	0	4
4.	PH47xx	Elective - I (Choose any one from the list I)	4	0	0	4
5	PH47E1	Professional Competency Course - Computational Physics	2	0	0	2
PRACTICAL						
6	PH4741	Core Practical I - Electronics Laboratory	0	0	4	2
7	PH47P1	Ability Enhancement Compulsory Course- Physics Experiments	0	0	4	2
TOTAL			**18**	**3**	**8**	**22**

PH4701	MATHEMATICAL PHYSICS	L	T	P	C
		4	**1**	**0**	**4**

OBJECTIVES

- To equip students with the mathematical techniques needed for understanding theoretical treatment in different courses taught in their program
- To extend their manipulative skills to apply mathematical techniques in their fields
- To help students apply Mathematics in solving problems of Physics

Course Outcome		Cognitive Skill
CO-01	Learn about Gradient, Divergence and Curl in orthogonal curvilinear andtheir typical applications in physics.	R,U, A, An,
CO-02	Can understand different types of integral and its various applications inphysics.	R,U, A, E
CO-03	Analyze characteristics of matrices and its different types, and the process of diagonalization.	R,U, A An, E,
CO-04	Learn about special functions and solve equations using Laplace transform, grasp how these transformations can speed up analysis and correlate their importance in technology	R,U, An, E,
CO-05	Different types of differential equations and their importance in solving problems can be understood.	R,U, A, An, E,

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	M	S	S	S
CO-02	S	S	S	S
CO-03	S	S	S	S
CO-04	S	S	M	S
CO-05	S	S	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Vector Calculus I **9**

Partial differentiation of vectors, Partial Derivatives - Gradient of a scalar field, physical interpretation, divergence of a vector point function, divergence of product, curl of a vector point function-orthogonal curvilinear coordinates (grad, div, curl) –conditions for orthogonal curvilinear coordinates.

Unit II: Vector Calculus Ii **9**

Line integral, surface integral, volume integral, Gauss divergence theorem- deductions from Gauss divergence theorem, Gauss's law in differential form, Green theorem, Poisons equations and Laplace equation with solution- Stokes theorem- classification of vector fields, Helmholtz Theorem.

Unit III: Matrices **9**

Matrix types – special matrices – properties - rank of matrix -Trace of a matrix- Transformation of a matrices characteristic roots and vectors of matrix (eigen values and eigen vectors), Cayley-Hamilton Theorem – Diagonalization, matrixes in physics (rotation matrix, pauli spin matrices, dirac matrices).

Unit IV: Special Functions & Laplace Transforms **9**

Gamma and Beta functions - Legueree, Bessel, Hermite differential equations and their solutions- Generating functions- Orthogonality relations – Important recurrence relations, Laplace transform and its inverse – Transforms of derivatives and Integrals.

Unit V: Ordinary DIFFERENTIAL EQUATIONS **9**

Solution for linear differential equation of first order, second order power series solution Legendre differential equation, functions, generating function, Rodrigues formula, orthogonality properties – Dirac delta function.

TOTAL: 45 HOURS

TEXT BOOKS

1. H K Dass and Rama Verma, Mathematical Physics, 8th Edition, S Chand Publishing, 2019.
2. B.D. Gupta, Mathematical Physics, 4th Edition, S Chand and Company Ltd., 2022.
3. Satya Prakash, Mathematical Physics with Classical Mechanics, 6th Edition, Sultan Chand & Sons, New Delhi, 2014.
4. Eugene Butkov, Mathematical Physics, Pearson, 1968.
5. Ajoy Kumar Ghatak, I. C. Goyal and S. J. Chua, Mathematical Physics: Differential Equations and Transform Theory, Laxmi Publications Private Ltd., 2017.
6. P.K. Chattopadhyay, Mathematical Physics, 2nd Edition, New Age International Publishers, 2013.
7. M.C. Jain, Vector Spaces and Matrices in Physics, 2nd Edition, Alpha Science International Ltd., 2007.

REFERENCE

1. Louis A. Pipes and Lawrence R. Harvill, Applied Mathematics for Engineers and Physicists, 3rd Edition, Dover Publications Inc., 2014.
2. George B. Arfken, Hans J. Weber and Frank E Harris, Mathematical Methods for Physicists: A Comprehensive Guide, Seventh Edition, Elsevier, 2012.
3. George B. Arfken and Hans J. Weber, Mathematical Methods for Physicists, 6th Edition, Academic Press, 2005.

PH4702	CLASSICAL MECHANICS AND RELATIVITY	L	T	P	C
		4	1	0	4

OBJECTIVES

- To understand fundamentals of classical mechanics.
- To apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.
- To provide foundation for the modern understanding of dynamics.

Course Outcome		Cognitive Skill
CO-01	Understand the fundamentals of classical mechanics.	R,U, A, An, E, S
CO-02	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	R,U, A, An, E,S
CO-03	Reduce two body problem to a single body problem and construct energy diagrams using the effective potential	R,U, A, An, E, S
CO-04	Analyze the small oscillations in systems and determine their normal modes of oscillations.	R,U, A, An, E, S
CO-05	Understand and apply the principles of relativistic kinematics to the mechanical systems.	R,U, A, An, E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	M	S
CO-02	S	S	L	S
CO-03	S	M	M	S
CO-04	S	S	M	S
CO-05	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Fundamental Principles and Lagrangian Formulations **9**

Mechanics of a particle and a system of particles - conservation laws - Constraints -Generalized coordinates - Principle of virtual work - D' Alembert's principle and Lagrange's equation – Applications : simple pendulum and atwood's machine - Hamilton's principle - Lagrange's equation from Hamilton's principle-examples- conservation theorems and symmetry properties.

Unit II: Hamilton's Formulations **9**

Hamilton's equation from variational principle - Principle of least action – applications - Legendre transformations – generalised momentum and cyclic co-ordinates - Canonical transformations - Lagrange and Poisson brackets - Equation of motion and conservation theorems in Poisson brackets – Hamilton Jacobi method, Application to harmonic oscillator - Hamilton's characteristic function – separation of variables action – angle variables – Kepler problem in action angle variable.

Unit III: Central Force and Non-Inertial Frame **9**

Motion in a central force field in a Lagrangian formalism - Reduction of two body problem to the equivalent one body problem - Classification of orbits for inverse square forces - Differential equation for the orbits-Two body collisions-Classical scattering in a laboratory and center of mass frames - Non inertial frames - Rotating frame of reference-Pseudo forces-Coriolis force and effects of coriolis force on the moving bodies.

Unit IV: Rigid Body Dynamics and Small Oscillations **9**

Mechanics of a rigid body - Displacement of a rigid body - Orthogonal transformation -Eulerian angles - infinitesimal rotation - Coriolis effect - Kinematics of a rigid body – Moments and products of inertia - Kinetic energy of a rigid body - Euler's equation of motion – Torque free motion - Spinning top. Oscillatory motion: Theory of small oscillation-periodic motion-frequencies of vibration and normal modes-linear triatomic molecules.

UNIT V: RELATIVITY **9**

Postulates of special theory of relativity - Lorentz transformation equation – kinematic effects of Lorentz transformation - Variation of mass with velocity - Equivalence of mass and energy-Relativistic Lagrangian and Hamiltonian - Minkowski's space - Four vectors - Covariant four dimensional formulation of the law of mechanics - Covariance of Maxwell field equations under Lorentz transformation.

TOTAL: 45 HOURS

TEXT BOOKS

1. H. Goldstein, Classical Mechanics, 3rd Edition, Pearson Education, 2014.
2. J. C. Upadhyaya, Classical Mechanics, 3rd Edition, Himalaya Publshing. Co. New Delhi, 2022.
3. R. Resnick, Introduction to Special Theory of Relativity, Wiley Eastern, New Delhi, 1968.
4. R. G. Takwala and P.S. Puranik, Introduction to Classical Mechanics –Tata – McGraw Hill, New Delhi, 2018.
5. N. C. Rana and P.S. Joag, Classical Mechanics - Tata McGraw Hill, 2001.

REFERENCES

1. L.D. Landau and E.M. Lifshitz, Mechanics, 3rd Edition, Buttorworth-Heinemann, 1976.
2. I.C. Percival and D. Richards, Introduction to Dynamics, Cambridge University Press, 1983
3. J.V. Jose and E.J. Saletan, Classical Dynamics: A Contemporary Approach, Cambridge University Press, 1998.
4. E.T. Whittaker, A Treatise on the Analytical Dynamics of Particles and Rigid Bodies, 4th edition, Cambridge University Press, 1989.

PH4703	LINEAR AND DIGITAL ICs AND APPLICATIONS	L	T	P	C
		4	1	0	4

OBJECTIVES

- To introduce the basic building blocks of linear integrated circuits.
- To teach the linear and non-linear applications of operational amplifiers.
- To introduce the theory and applications of PLL.
- To introduce the concepts of waveform generation and introduce one special function ICs.
- Exposure to digital IC‘s

Course Outcome		Cognitive Skill
CO-01	Explain integrated circuits and operational amplifiers, including their characteristics, features, and internal workings, with practical application insights.	R,U, A, An, E, S
CO-02	Create and implement linear and non-linear op-amp circuits, such as instrumentation amplifiers and waveform generators, for various applications.	R,U, A, An, E,S
CO-03	Design and analyze active filters, timers, and phase-locked loops, including practical use of IC 555 and PLL circuits.	R,U, A, An, E, S
CO-04	Design voltage regulators and apply DAC/ADC techniques to convert between digital and analog signals effectively in various applications.	R,U, A, An, E, S
CO-05	Design and analyze combinational and sequential logic circuits using CMOS and TTL technology, including adders, flip-flops, and multiplexers.	R,U, A, An, E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	S	M
CO-02	S	S	S	S
CO-03	S	S	M	S
CO-04	M	S	S	S
CO-05	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Integrated Circuits and Operational Amplifier 9

Introduction, Classification of IC's, basic information of Op-Amp 741 and its features, the ideal Operational amplifier, Op-Amp internal circuit and Op-Amp. Characteristics.

Unit II: Applications of Op-Amp 9

LINEAR APPLICATIONS of OP-AMP: Solution to simultaneous equations and differential equations, Instrumentation amplifiers, V to I and I to V converters. NON-LINEAR APPLICATIONS of OP-AMP: Sample and Hold circuit, Log and Antilog amplifier, multiplier and divider, Comparators, Schmitt trigger, Multivibrators, Triangular and Square waveform generators.

Unit III: Active Filters & Timer And Phase Locked Loops 9

ACTIVE FILTERS: Introduction, Butterworth filters – 1st order, 2nd order low pass and high pass filters, band pass, band reject and all pass filters. TIMER AND PHASE LOCKED LOOPS: Introduction to IC 555 timer, description of functional diagram, monostable and astable operations and applications, PLL - introduction, basic principle, phase detector/comparator, voltage controlled oscillator (IC 566), low pass filter, monolithic PLL and applications of PLL

Unit IV : Voltage Regulator & D To A And A To D Converters 9

VOLTAGE REGULATOR: Introduction, Series Op-Amp regulator, IC Voltage Regulators, IC 723 general purpose regulators, Switching Regulator. D to A AND A to D CONVERTERS: Introduction, basic DAC techniques -weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, A to D converters -parallel comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC, DAC and ADC Specifications.

Unit V: CMOS Logic, Combinational Circuits Using Ttl 74xx Ics & Sequential Circuits Using TTL 74xx Ics 9

CMOS LOGIC: CMOS logic levels, MOS transistors, Basic CMOS Inverter, NAND and NOR gates, CMOS AND-OR-INVERT and OR-AND-INVERT gates, implementation of any function using CMOS logic. COMBINATIONAL CIRCUITS USING TTL 74XX ICs: Study of logic gates

using 74XX ICs, Four-bit parallel adder (IC 7483), Comparator (IC 7485), Decoder (IC 74138, IC 74154), BCD to 7-segment decoder (IC7447), Encoder (IC74147), Multiplexer (IC74151), Demultiplexer (IC 74154). SEQUENTIAL CIRCUITS USING TTL 74XX ICs: Flip Flops (IC 7474, IC 7473), Shift Registers, Universal Shift Register (IC 74194), 4- bit asynchronous binary counter (IC 7493).

TOTAL: 45 HOURS

TEXT BOOKS

1. Millman and Halkias, Integrated Electronics, McGraw-Hill, New Delhi. 2010
2. D. Roy Choudhury, Shail B. Jain, Linear Integrated Circuit, 4th edition, New Age International Pvt. Ltd., New Delhi, India, 2012.
3. Ramakant A. Gayakwad, OP-AMP and Linear Integrated Circuits, 4th edition, Prentice Hall / Pearson Education, New Delhi. 2012
4. B.L. Theraja and A.K. Theraja, A Textbook of Electrical technology, S. Chand & Co. 2004
5. V.K. Mehta and Rohit Mehta, Principles of Electronics, S. Chand & Co, 12th Edition. 2008
6. V. Vijayendran, , Introduction to Integrated electronics (Digital & Analog), S. Viswanathan Printers & Publishers Private Ltd, Reprint. 2008

REFERENCES

1. Sergio Franco (), Design with operational amplifiers and analog integrated circuits, McGraw Hill, New Delhi. 1997
2. Gray, Meyer, Analysis and Design of Analog Integrated Circuits, Wiley International, New Delhi. 1995
3. Malvino and Leach, Digital Principles and Applications 5th Edition, Tata McGraw Hill, New Delhi.2005
4. Floyd, Jain, Digital Fundamentals, 8th edition, Pearson Education, New Delhi. 2009.
5. Integrated Electronics, Millman & Halkias, Tata McGraw Hill, 17th Reprint. 2000.

PH4771	ELECTRONICS LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES

To familiarize the students with the various electronics instruments and components which basically equip them to construct complex circuits in near future.

Course Outcome		Cognitive Skill
CO-01	The students will be able to measure voltage, frequency and phase of any waveform using CRO.	R,U, A, An, E
CO-02	The students will be able to generate sine, square and triangular waveforms with required frequency and amplitude using function generator.	R,U, A, An, E

CO-03	The students will be able to analyze the characteristics of different electronic devices.	R,U, A, An, E
CO-04	The students will be able to acquire knowledge on basic digital electronic gates.	R, U, A, An, E
CO-05	The students will be able to analyze and solve the varieties of problems and issues coming upin the vastfield of electrical measurements.	R,U, A, An, E

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	S	S
CO-02	S	S	M	S
CO-03	S	S	M	S
CO-04	S	S	M	S
CO-05	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

List of experiments (Any Eight Experiments)

1. Saw tooth wave generator
2. Construction of square wave Triangular wave generator using IC 741
3. Construction of a quadrature wave using IC 324
4. Half adder and Full adder using IC 7408, IC 7486 and IC 7432
5. Digital to Analog conversion
6. Astable multivibrator – using IC 555 Timer and operational amplifier
7. Modulus N counter using IC-7490
8. Monostable multivibrator – op amp
9. Study of R-S, clocked R-S and D-Flip flop using NAND gates
10. Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp.

11. BJT CE Input and output Characteristics

12. RC Frequency Response

13. RC Differentiator and Integrator

TEXT BOOKS

1. Chandra S. Poorna and B. Sasikala, Electronic Laboratory, S Chand & Company, 2005.
2. K A Navas, Electronic lab manual, Vol I, 5th Edition, PHI Learning Pvt. Ltd., Delhi, 2015.
3. K A Navas, Electronic lab manual Vol II, PHI Learning Pvt. Ltd., Delhi, 2018.

REFERENCES

1. S.P Singh, Advanced Practical Physics, Pragati Prakashan, 1976.
2. Ramakanth A Gayakwad, Op-amps and linear integrated circuits, Prentice Hall, 2000.
3. T. D. Shyam Mohan S Kuryachan, Electronic lab manual, Vol I, 2nd Edition, Ayodhya Publications, 2010.

		L	T	P	C
PH47E1	**PROFESSIONAL COMPETENCY COURSE COMPUTATIONAL PHYSICS**	**2**	**0**	**0**	**2**

OBJECTIVES

- To discuss and implement simple methods for the solution of ODEs;
- To understand the idea about the basics of numerical methods for the analysis of experimental results.

Course Outcome		**Cognitive Skill**
CO-01	To fit any curve easily by finding the constants and also to determine the error.	R,U, A, An, E, S
CO-02	To be familiar in solving the set of equations by various methods.	R,U, A, An, E,S
CO-03	To recognize and visualize the methods for finding the values (anywhere) of a given function from a given set of tabular alues	R,U, A, An, E, S
CO-04	To understand the concept of Numerical integration from the given set of tabular values	R,U, A, An, E, S
CO-05	Solves an ordinary differential equation by Taylor series.	R,U, A, An, E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	S	S
CO-02	S	S	M	S
CO-03	S	M	S	M
CO-04	S	S	M	S
CO-05	S	S	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Errors and Measurements **3**

Errors- Errors of observation and measurement Empirical formula: Estimation of constants – Graphical method – method of group averages.

Unit II: Solution of Non-Linear Equations **3**

Roots of polynomials, Fixed point iteration, Bolanzo method, Convergence and rate of convergence Gauss–Seidel method of iteration

Unit: III Interpolation and Approximation: **3**

Unequal Intervals: –Lagrange's interpolation- – Divided differences- Newtons divided difference formula.

Unit IV: Numerical Integration **3**

Trapezoidal rule, Simpson's rule – Extended Simpson's rule -Two and three point Gaussian Quadrature formula.

Unit V: Initial Value Problems For Ordinary Differential Equations: **3**

Taylor series method for first order and second order differential equations

TOTAL: 15 HOURS

TEXT BOOKS

1. Introductory Methods of Numerical analysis; S.S. Sastry, *Prentice – Hall of India, New Delhi (2003) 3rd Edition.*
2. Numerical Mathematical Analysis (sixth edition); James B. Scarborough, *Oxford &IBH Publishing Co.Pvt.Ltd.* 6th edition 2008.
3. Numerical Methods Dr.P.Kandasamy, Dr. K. Thilagavathy, Dr.K. Gunavathy, *S.Chand & Company Pvt. Ltd. New Delhi*. 7th Edition 2007.

REFERENCE

1. Numerical Methods for Scientific and Engineering Computation; M.K.Jain, S.R.K.Iyengar, R.K.Jain, New *age International publishers limited* 6th Edition 2012.
2. Numerical Methods in Science and Engineering; Rajasekaran S, *S Chand & Company;* 2nd Edition 2003.
3. Numerical Methods in Engineering & Science: with Programs in C and C++; B.S. Grewal, *Khanna;* Eleventh edition (2013)

		L	T	P	C
PH47P1	**ABILITY ENHANCEMENT COURSE – PHYSICS EXPERIMENTS**	**0**	**0**	**4**	**2**

OBJECTIVES

To familiarize the students with the application oriented experiments to understand the principles of working.

Course Outcome		**Cognitive Skill**
CO-01	Understand the concepts and use research equipments for materialsanalysis and data acquisition	R,U,A, An,E
CO-02	Design and conduct experiments that probe material properties	R, U, A, An, E,S
CO-03	Apply science concepts to the analysis of experimental data	R, U, A, An, E, S
CO-04	Develop communication skills (oral, graphic and written)	R, U, A, An ,E, S
CO-05	Interpret the data from various instruments	R, U, A , An, E

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	S	S
CO-02	S	S	S	S
CO-03	S	S	S	S
CO-04	S	S	S	M
CO-05	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

List of Experiments

1. Michelson Interferometer
2. Cauchy‟s constant- using spectrometer
3. Thermal conductivity
4. Dielectric constant
5. Ultrasonic Interferometer-Velocity measurement
6. Ultrasonic diffraction- Compressibility of a liquid
7. Band gap determination
8. Hartmann‟s constant
9. Determination of Planck’s Constant
10. Cornu’s Method–Determination of Elastic Constants of Transparent Materials
11. Electron Spin Resonance

SEMESTER II

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	PH4704	Core 4 - Statistical Mechanics	4	1	0	4
2.	PH4705	Core 5 - Quantum Mechanics-I	4	1	0	4
3.	PH4706	Core 6 - Electromagnetic Theory	4	1	0	4
4.	PHxxxx	Elective - II (Choose any one from the list II)	4	0	0	4
PRACTICAL						
5	PH4772	Core Practical II – Advanced Experiments	0	0	4	2
6	PH47S1	Skill Enhancement Course I – Hands on Training in Analytical Instruments	2	0	2	2
7.	PH47P2	Ability Enhancement Compulsory Course – Internship*/ Industrial Activity (Credits to be awarded on completion of Internship) *Internship will be carried out after the first semester with minimum 10 working days duration and shall be accessed during the second semester through report and	0	0	2	2
TOTAL			**18**	**3**	**8**	**22**

PH4704	STATISTICAL MECHANICS	L	T	P	C
		4	1	0	4

OBJECTIVES

- To understand and make proper analyses of physical problems related to temperature, energy and phase trnsition.
- To acquire the knowledge of various statistical distributions.
- To gain knowledge on partition function and fluctuation of thermodynamic properties that vary with time.

Course Outcome		Cognitive Skill
CO-01	Students will be able to understand the principles of thermodynamics and its significance and understand phase transition in thermodynamics	R,U, A, An, E
CO-02	Gains the knowledge about the probability and various distributions and also provide the idea about M.B.distribution, application and limitations	R,U, A, An, E
CO-03	Gains knowledge on black body radiation and Planck`s radiation. Provides the concept about B.E distribution, ideal B.E and B.E condensation and F.D. distribution, degeneracy and its various levels.	R,U, A, An, E
CO-04	Students will be able to understand specific heat of gases and its approach with different molecules.	R,U, A, An, E
CO-05	Provides the detailed explanation about partition function and fluctuation of thermodynamic properties that vary with time	R,U, A, An, E

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	M	M	S
CO-02	S	M	S	S
CO-03	S	S	S	S
CO-04	S	S	S	M
CO-05	S	M	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Thermodynamics and Phase Transition **9**

Review of thermodynamics – thermodynamics laws and its consequences –Gibb`s free energy and Helmholtz`s free energy – Maxwell relations - Thermodynamical potential – significance of thermodynamic potential—relations of thermodynamic potentials with their variables- Phase Equilibrium - Gibb's phase rule -Phase-space –Micro canonical, canonical and grand canonical ensembles – Chemical potential –Gibbs Duhem Equation.

Unit II: Maxwell Boltzman's Distribution **9**

Probability– General expression for probability of distribution – Stirling‟s formula –Maxwell-Boltzmann‟s distribution law – M.B. energy distribution function for an ideal gas– Maxwell`s distribution law of velocities - Application of M. B distribution. Limitation of M.B method-Equitation energy theorem and its proof.

Unit III: Bose Einstein Distribution and Fermi-Dirac Distribution **9**

Black body radiation – Planck`s radiation law – Bose-Einstein distribution law - Ideal Bose-Einstein gas – Degeneracy of Bose-Einstein gas – Bose-Einstein Condensation. Fermi-Dirac distribution law – Ideal Fermi-Dirac gas – Fermi energy – degeneracy – Weak degeneracy, strong degeneracy – Electron gas in metals – Thermionic emission of electrons.

Unit IV: Specific Heat Capacity of Solids and Gases **9**

Specific heat of solids – Einstein theory – limitations- Debye‟s theory –limitations – applications. Specific heat of gases – monoatomic, diatomic and polyatomic gases – variation with temperature.

Unit V: Partition Function and Fluctuations **9**

Partition function and thermodynamical quantities – Entropy mixing and Gibbs paradox – Saucker-tetrode equation for entropy – Molecular partition function – Translational partition function – rotational and vibrational partition functions and applications. Fluctuations and transport phenomena - Brownian motion - Langevin's theory - Fluctuation-dissipation theorem - The Fokker-Planck equation.

TOTAL: 45 HOURS

TEXT BOOKS

1. F.W. Sears and G. L. Salinger, Thermodynamics, Kinetic theory, and statisticalThermodynamics - Third Edition, Narosa Publishong House (1986).
2. A.K. Agarwal and Melvin Eisner - Statistical Mechanics – New Age International (P) Limited, New Delhi, 1998.
3. S. Lokanathan Statistical and Thermal Physics: An Introduction. Prentice Hall India Learning Private Limited. 1991.

REFERENCES

1. Reichl, Linda E. A Modern Course in Statistical Physics. Wiley-VCH, 2016.
2. Kerson Huang – Statistical Mechanics – John Wiley & Sons, Inc., New York,1987, Second edition.
3. A.K.Dasgupta – Fundamentals of Statistical Mechanics – New Central BookAgency (P) Ltd., Calcutta, 2000.

4. Federick Reif. Fundamentals of Statistical and thermal Physics — McGraw Hill International Editions, Singapore, 1985.
5. F. Mandl - Statistical Physics – Second edition, ELBS & Wiley (1988).

PH4705	QUANTUM MECHANICS - I	L	T	P	C
		4	1	0	4

OBJECTIVES

- To develop the physical principles and the mathematical background important to quantum mechanical descriptions.
- To describe the propagation of a particle in a simple, one-dimensional potential.
- To formulate and solve the Schrodinger's equation to obtain eigenvectors and energies for particle in a three-dimensional potential.
- To explain the mathematical formalism and the significance of constants of motion, and see their relation to fundamental symmetries in nature
- To discuss the Approximation methods like perturbation theory, Variational and WKB methods for solving the Schrödinger equation.

Course Outcome		Cognitive Skill
CO-01	Formalize the rules of quantum mechanics through a clear understanding of its postulates	R,U, A,An,E,S
CO-02	Apply and analyze the Schrodinger equation to solve one dimensional problems and three dimensional problems.	R,U, A,An,E,S
CO-03	Discuss the various representations, space time symmetries and formulations of time evolution.	R,U, A,An,E,S
CO-04	Formulate and analyze the approximation methods for various quantum mechanical problems	R,U, A,An,E,S
CO-05	To apply non-commutative algebra for topics such as angular and spin angular momentum and hence explain spectral line splitting.	R,U, A,An,E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	S	S
CO-02	S	M	S	S
CO-03	S	S	S	S
CO-04	S	M	S	S
CO-05	S	S	S	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Foundation of Quantum Mechanics 9

Interpretation of the wave function – Time dependent Schrodinger equation –Time independent Schrodinger equation – Stationary states – Ehrenfest's theorem – Linear vector space – Linear operator – Eigen functions and Eigen Values – Hermitian Operator – Postulates of Quantum Mechanics – Simultaneous measurability of observables – General Uncertainty relation

Unit II: One Dimensional and Three Dimensional Eigen Value Problems 9

Square well potential of finite depth, rectangular barrier potential, – Square potential Alpha emission – Bloch waves in a periodic potential – Kronig-penny square – well periodic potential, Harmonic oscillator potential. Three dimensional problems-Spherically symmetric potential, spherical harmonics, Harmonic oscillator potential, hydrogen atom.

Unit Iii: General Formalism of Quantum Mechanics 9

Dirac notation – Equations of motions – Schrodinger representation – Heisenberg representation – Interaction representation – Coordinate representation – Momentum representation – Symmetries and conservation laws – Unitary transformation – Parity and time reversal

Unit IV: Angular Momentum 9

Eigenvalue spectrum of general angular momentum – Ladder operators and their algebra – Matrix representation – Spin angular momentum – Addition of angular momenta – CG Coefficients – Symmetry and anti – symmetry of wave functions – Construction of wave-functions and Pauli's exclusion principle.

Unit V: Approximation Methods 9

Time independent perturbation theory for non-degenerate energy levels – Degenerate energy levels – Stark effect in Hydrogen atom – Ground and excited state – Variation method – Helium atom – WKB approximation – Connection formulae (no derivation) – WKB quantization – Application to simple harmonic oscillator.

TOTAL: 45 HOURS

TEXT BOOKS

1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics, 2nd edition (37th Reprint), Tata McGraw-Hill, New Delhi, 2017.
2. G. Aruldhas, Quantum Mechanics, 2nd edition, Prentice Hall of India, New Delhi, 2021.
3. David J Griffiths, Introduction to Quantum Mechanics. 4th edition, Pearson, 2020.
4. SL Gupta and ID Gupta, Advanced Quantum Theory and Fields, 2nd Edition, S.Chand & Co., New Delhi, 2018.
5. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 4th Edition, Macmillan, India, 2004.

REFERENCE

1. E. Merzbacher, Quantum Mechanics, 3rd Edition, John Wiley and Sons, New York, 1998.
2. V. K. Thankappan, Quantum Mechanics, 4th Edition, Wiley Eastern Ltd, New Delhi, 2014.
3. L. D. Landau and E. M. Lifshitz, Quantum Mechanics, vlol.3 3rd edition, Pergomon Press, Oxford, 2000.
4. S. N. Biswas, Quantum Mechanics, Books and Allied Ltd., Kolkata, 1999.
5. V. Devanathan, Quantum Mechanics, 2nd edition, Alpha Science International Ltd, Oxford , 2011.
6. Sl,GuptaV.Kumar,Hv.Sharma,QuantumMechanics, 34th edition, Jai Prakash Nath Publications 2017.

PH4706	ELECTROMAGNETIC THEORY	L	T	P	C
		4	1	0	4

OBJECTIVES

The course provides an understanding of forces, fields, Maxwells equations, electromagnetic waves and radiation systems.

Course Outcome		Cognitive Skill
CO-01	Students will be able to apply the tools of vector calculus in Electromagnetic Theory	R, U, A, An
CO-02	Students will be able to explain fundamentals laws associated with electromagnetic fields	R, U, A
CO-03	Students will be able to solve potential problems in electrostatics, magnetostatics and electrodynamics	U, A, An, E
CO-04	Students will understand the importance of Maxwell's equations in electromagnetic theory and modifications of Maxwell's equations needed in a medium	R, U, A, An, E
CO-05	Students will be able to analyze radiation systems in which the electric dipole, magnetic dipole or electric quadrupole dominate	U, A, An, E

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	L	M
CO-02	S	M	L	S
CO-03	S	M	M	S
CO-04	S	M	M	S
CO-05	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Electrostatics **9**

Boundary value problems and Laplace equation – Boundary conditions and uniqueness theorem – Laplace equation in three dimension – Solution in Cartesian and spherical polar coordinates – Examples of solutions for boundary value problems. Polarization and displacement vectors - Boundary conditions - Dielectric sphere in a uniform field – Molecular polarizability and electrical susceptibility – Electrostatic energy in the presence of dielectric – Multipole expansion.

Unit II: Magnetostatics **9**

Lorentz force law - Biot-Savart's Law - Ampere's law - Magnetic vector potential and magnetic field of a localized current distribution - Magnetic moment, force and torque on a current distribution in an external field - Magneto static energy - Magnetic induction and magnetic field in macroscopic media - Boundary conditions - Uniformly magnetized sphere.

Unit III: Electrodynamics **9**

Faraday's laws of Induction - Maxwell's displacement current - Maxwell's equations - Maxwell's equation in matter - Vector and scalar potentials - Gauge invariance - Coulomb and Lorentz gauges - Energy and momentum of the field - Poynting's theorem - Lorentz force - Conservation laws for a system of charges and electromagnetic fields.

Unit IV: Electromagnetic Waves **9**

Electromagnetic wave equations – sinusoidal waves – boundary conditions reflections and transmissions – polarization – wave equation for E and B – Plane waves in non-conducting media - Linear and circular polarization, reflection and refraction at a plane interface - Waves in a conducting medium - Frequency dependence of permittivity - Propagation of waves in a rectangular wave guide.

Unit V: Elecromagnetic Radiation **9**

Radiation - Inhomogeneous wave equation and retarded potentials - Radiation from a localized source - Oscillating electric dipole - radiation from an arbitrary source - power radiated by a point charge – radiation reaction – physical basis of the radiation reaction- Radars - Atmospheric Applications.

TOTAL: 45 HOURS

TEXT BOOKS

1. Introduction to Electrodynamics, David J Griffiths., Prentice Hall of India, 3rd Edition, 2012.
2. M.N.O.Sadiku, Elements of electromagnetics, Oxford University Press (2007)

REFERENCES

1. Classical Electrodynamics, J.D. Jackson., Wiley Eastern Publication, second edition, 1975.
2. Foundations of electromagnetic theory, J.R. Reitz, E.J. Milford and R.W. Christy, 3rd Edition, Narosa Publication, New Delhi, 1986.
3. Electromagnetic fields and waves, P. Lorrain and D. Corson. CBS Publishers and distributors, 1986.
4. Electrodynamics, B.P. Laud, New Age International Pvt. Ltd. 1987.
5. Principles of Electrodynamics, B. Chakraborty, Books and Allied, Kolkata, 2002.
6. Electromagnetic with Applications, J.D. Kraus and D.A. Fleisch, 5th Edition WCB McGraw- Hill, New York, 1999.
7. Fundamentals of Electromagnetic Theory, Saroj K.Dash and Smruthi R.Khuntia, PHI Learning Private Limited, New Delhi, 2010.
8. e-PG Pathshala

PH4772	ADVANCED EXPERIMENTS	L	T	P	C
		0	0	4	2

OBJECTIVES

To familiarize the students with the advanced optical experiments and to understand the basic principle behind the experiments

Course Outcome		Cognitive Skill
CO-01	Able to understand the various phenomenon of light and the laser parameters.	R,U, A, An, E,S
CO-02	Gains knowledge Total internal reflection process and numerical aperture.	R,U, A, An, E,S
CO-03	Able to gain knowledge on diffraction and Young's double slit.	R,U, A, An, E,S
CO-04	Able to determine refractive index of liquid using spectrometer.	R,U, A, An, E,S
CO-05	Gains knowledge to obtain various types of fringe formation and determination of the properties of the material.	R,U, A, An, E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	M	S	S
CO-02	S	S	S	S
CO-03	S	S	S	M
CO-04	S	S	M	S
CO-05	M	S	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

List of Experiments:

1. Determination of wavelength of laser beam
2. Determination of particle size, numerical aperture and loss calculation using laser beam.
3. Laser beam divergence and spot size
4. Brewsters Angle determination
5. Young‟s double slit experiment
6. Haidinger‟s fringes – Laser
7. Fraunhoffer diffraction- Laser

8. Spectrometer- Determination of refractive index of liquid
9. Elliptical fringes
10. Hyperbolic fringes
11. Transmission -Attenuation and Intermodal dispersion Characteristics of Optical Fiber
12. Investigate the Misalignment and Bending losses Losses in Optical Fiber
13. Investigate the Link budget (power budget and rise time budget) of Optical Fiber communication link
14. Photoelectric effect
15. Solar Panel Experiment (Remote Trigger)
16. Solar PV Tracker

		L	T	P	C
PH47S1	**TRAINING ON INSTRUMENTATION / INSTRUMENTAL TECHNIQUES**	**2**	**0**	**2**	**2**

OBJECTIVES

- To gain knowledge on the principles and instrumentation of UV-Visible spectroscopy, IR spectroscopy, Electrochemical Analyzer, TGA/DTA, and Powder XRD.
- To provide hands-on experience to students in operating spectroscopic instruments, performing sampling, and recording spectra.
- To develop students' skills in data analysis, interpretation, and problem-solving related to spectroscopic measurements

Course Outcome		**Cognitive Skill**
CO-01	Students will gain a solid understanding of the principles underlying UV-Visible spectroscopy, IR spectroscopy, Electrochemical Analyzer, TGA/DTA, and Powder XRD.	R,U, A, An,
CO-02	Students will be able to analyze and interpret spectroscopic data, identifying key features and making connections to molecular structure and properties.	R,U, A, E
CO-03	Students will develop practical skills in using spectroscopic techniques for solving scientific problems and conducting research.	R,U, A An, E,
CO-04	Students will be able to apply spectroscopic techniques to real-world applications in fields such as chemistry, materials science, and environmental analysis	R,U, An, E,
CO-05	Students will enhance their critical thinking and analytical skills through the analysis and interpretation of spectroscopic data.	R,U, A, An, E,

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	M	S	S	S
CO-02	S	S	S	S
CO-03	S	S	S	S
CO-04	S	S	M	S
CO-05	S	S	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

Unit-I:UV-Visible spectroscopy

Principle, Instrumentation, Applications- Demonstration of UV-Visible spectrophotometer – Sampling and Recording spectrum

Unit-II: IR spectroscopy

Principle, Instrumentation, Applications- Demonstration of IR – Sampling and Recording spectrum

Unit-III: Electrochemical Analyzer

Principle, Instrumentation, Applications- Demonstration of Electrochemical Analyzer – Sampling and measurement of different techniques.

Unit-IV:TGA/DTA

Principle, Instrumentation, Applications- Demonstration of Powder XRD – Sampling and Recording spectrum

Unit-V: Powder XRD

Principle, Instrumentation, Applications- Demonstration of Powder XRD – Sampling and Recording spectrum.

SEMESTER III

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	PH4707	Core 7 - Quantum Mechanics-II	4	1	0	4
2.	PH4708	Core 8 - Condensed Matter Physics	4	1	0	4
3.	PH4709	Core 9 - Spectroscopy	4	1	0	4
4.	PH47xx	Elective - III (Choose any one from the list III)	4	0	0	4
PRACTICAL						
5	PH4773	Core Practical III - Condensed Matter Physics and Spectroscopy laboratory	0	0	4	2
6	PH47S2	Skill Enhancement Course II – Green Energy Technologies / NPTEL (SWAYAM Online	2	0	2	2
7	PH47P3	Ability Enhancement Compulsory Course - Mini Project	0	0	2	2
TOTAL			**18**	**3**	**8**	**22**

PH4707	QUANTUM MECHANICS-II	L	T	P	C
		4	**1**	**0**	**4**

OBJECTIVES

- Formal development of the theory and the properties of angular momenta, both orbital and spin
- To familiarize the students to the crucial concepts of scattering theory such as partial wave analysis and Born approximation.
- Time-dependent Perturbation theory and its application to study of interaction of an atom with the electromagnetic field
- To give the students a firm grounding in relativistic quantum mechanics, with emphasis on Dirac equation and related concepts
- To introduce the concept of covariance and the use of Feynman graphs for depicting different interactions

Course Outcome		Cognitive Skill
CO-01	Understand the concepts of the time dependent perturbation theory and their application to physical situations.	R,U, A,An,E,S
CO-02	Familiarize the concept of scattering theory such as partial wave analysis and Born approximation.	R,U, A,An,E,S
CO-03	Discuss the relativistic quantum mechanical equations namely, Klein-Gordon and Dirac equations and the phenomena accounted by them like electron spin and magnetic moment.	R,U, A,An,E,S
CO-04	Introduce the concept of covariance and the use of Feynman graphs for depicting different interactions.	R,U, A,An,E,S
CO-05	Demonstrate an understanding of field quantization and the explanation of the scattering matrix.	R,U, A,An,E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	M	S
CO-02	S	S	S	M
CO-03	S	M	S	S
CO-04	S	S	S	M
CO-05	M	M	S	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Time Dependent Perturbation Theory **9**

Time dependent perturbation theory – Constant and harmonic perturbations – Fermi Golden rule – Transition probability Einstein's A and B Coefficients – Adiabatic approximation – Sudden approximation – Semi – classical treatment of an atom with electromagnetic radiation – Selection rules for dipole radiation

Unit II: Scattering Theory **9**

Scattering amplitude – Cross sections – Born approximation and its validity – Scattering by a screened coulomb potential – Gaussian potential – Partial wave analysis – Scattering length and Effective range theory for S wave – Optical theorem – Transformation from centre of mass to laboratory frame.

Unit III: Relativistic Quantum Mechanics **9**

Klein – Gordon Equation – Charge and Current Densities – Dirac Matrices – Dirac Equation – Plane Wave Solutions – Interpretation of Negative Energy States – Spin of Electron – Magnetic Moment Of An Electron Due To Spin.

Unit IV: Dirac Equation **9**

Covariant form of Dirac Equation – Properties of the gamma matrices – Traces – Relativistic invariance of Dirac equation – Probability Density – Current four vector – Bilinear covariant – Feynman's theory of positron (Elementary ideas only without propagation formalism)

Unit V: Classical Fields and Second Quantization **9**

Classical fields – Euler Lagrange equation – Hamiltonian formulation – Noether's theorem – Quantization of real and complex scalar fields – Creation, Annihilation and Number operators – Fock states – Second Quantization of K-G field.

TOTAL: 45 HOURS

TEXT BOOKS

1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics,2nd Edition,Tata McGraw-Hill, New Delhi, 2010.
2. G. Aruldhas, Quantum Mechanics, 2nd Edition, Prentice-Hall of India, NewDelhi,2009
3. L. I. Schiff, Quantum Mechanics, 3rd Edition, International Student Edition, McGraw-Hill Kogakusha, Tokyo, 1968
4. V. Devanathan, Quantum Mechanics, 1st Edition, Narosa Publishing House, New Delhi, 2005.
5. NouredineZettili, Quantum mechanics concepts and applications, 2nd Edition, Wiley, 2017.

REFERENCE

1. P. A. M. Dirac, The Principles of Quantum Mechanics, 4th Edition,Oxford University Press, London, 1981.
2. B.K.Agarwal&HariPrakash, Quantum Mechanics, 7th reprint, PHI Learning Pvt. Ltd., New Delhi, 2009.
3. Deep Chandra Joshi, Quantum Electrodynamics and Particle Physics,1stedition,I.K.International Publishing house Pvt.Ltd., 2006
4. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 4th Edition, Macmillan India, New Delhi 2004.
5. E. Merzbacher, Quantum Mechanics, 2nd edition, John Wiley and Sons, New York, 1970.
6. Sl,GuptaV.Kumar, Hv.Sharma, QuantumMechanics, 37th edition Jai Prakash Nath Publications, 2017.

PH4708	CONDENSED MATTER PHYSICS	L	T	P	C
		4	1	0	4

OBJECTIVES

- To understand basic ideas about band structure and the electrical and magnetic properties of solids.
- To provide basic understanding of the complex properties of matter and materials.
- To provide a valuable theoretical introduction and an overview of the fundamental applications of the physics of solids.

Course Outcome		Cognitive Skill
CO-01	List out the crystal systems, symmetries allowed in a system and also the diffraction techniques to find the crystal structure	R,U, A, An, E, S
CO-02	Understand lattice vibrations and thermal properties in solids, in particular heat capacity.	R,U, A, An, E,S
CO-03	Generalize the electronic nature of solids from band theories.	R,U, A, An, E, S
CO-04	Describe the fundamental principles of dielectrics, superconductors and magnetic materials.	R,U, A, An, E, S
CO-05	Analyse the significance of various types of defects in crystals and understand the meaning of phase boundary and phase transformation.	R,U, A, An, E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	M	S	S
CO-02	S	S	M	S
CO-03	S	M	M	S
CO-04	S	M	M	S
CO-05	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Crystallography And Crystal Binding **9**

Types of lattices - Miller indices – Symmetry elements and allowed rotations - Simple crystal structures – Atomic Packing Factor - Reciprocal Lattice (SC, BCC, FCC) - Brillouin zone – Diffraction – Bragg's law - Structure factor - Atomic form factor - Inert gas crystals - quasi crystals - Cohesive energy of ionic crystals - Madelung constant - Types of crystal binding (general ideas).

Unit III: Phonons and Thermal Properties **9**

Vibrations of crystals with mono atomic basis – two atoms per primitive basis –quantization of elastic waves – phonon momentum – inelastic scattering by phonons – density of states in 3 dimension – Einstein model of specific heat - Debye model of specific heat – Debye T3law – thermal conductivity – thermal resistivity of phonon gas.

Unit III: Theory of Metals And Semiconductors **9**

Free electron theory: Bloch theorem - classification of solids, Electron motion in a periodic potential - Kronig-Penney model - effective mass - Fermi surfaces, Semiconductors – Conductivity of Semiconductor - Intrinsic carrier concentration – Temperature Dependence - Mobility - Photoconductivity- Fermi level, Hall effect .

Unit IV: Dielectrics, Superconductors & Magnetic Materials **9**

Dielectrics - Macroscopic electric field – local field at an atom – dielectric constant and polarizability.

Superconductivity- Meissner effect - BCS Theory –Electron Phonon Interaction-Cooper Pairs-coherence length - Type I and type II - Josephson Effect.

Diamagnetism- Quantum Theory of paramagnetism - Curie temperature- Ferromagnetism-magnons - Spin Waves - Domain Theory - magnetic anisotropy energy, hysteresis-antiferromagnetism - Neel temperature - ferrimagnetism and ferrites.

Unit V: Defects in Solids And Phase Transition **9**

Defects: Classification - Point Defects - Schottky Defect - Frenkel Defect – Equilibrium concentration of Schottky and Frenkel defects - Colour Centers - F Centre - Other in alkali halides-Dislocations: Edge Dislocation - Screw Dislocation – Surface defects : grain boundary, twin boundary, stacking fault – Volume defects - Ordered phases of matter, translational and orientational order, Structure and properties of liquid crystals.

TOTAL: 45 HOURS

TEXT BOOKS

1. C. Kittel, Introduction to Solid State Physics, 8th Edition, Wiley Eastern-New Delhi, 2012.
2. S.O Pillai, Solid State Physics, 10th edition, New Age International Publishers, 2022.
3. M. Ali Omar, Elementary Solid State Physics: Principles and Applications, Pearson, India, 2002.
4. A.J. Dekker, Solid State Physics, Laxmi Publications, 2008.
5. R.J. Elliot & A.P. Gibson, An Introduction to Solid State Physics & Its Applications, ELBS & Macmillan, 1974

REFERENCES

1. B.S. Saxena, R.C. Gupta , P.N. Saxena and Dr. J. N. Mandal, Solid State Physics, 8th edition, Pragati Prakashan- Meerut, 2001.
2. L. Kahani& C. Hemaranjani, Solid State Physics : Theory, Applications and Problems, Sultan Chand & Sons, New Delhi, India, 2014.
3. M.A.Wahab, Solid State Physics-Structure and properties of materials, Third edition, Narosa Publishing House, New Delhi, 2021.
4. H.V. Keer, Principles of Solid State, Wiley Eastern, 1994.
5. J. Richard Christman, Fundamentals of Solid State Physics, John Wiley & Sons, 1988.
6. R. Asokamani, Solid State Physics: Principles and Applications, Anshan Ltd, 2007.
7. Rita John, Solid State Physics, McGraw Hill Education, 2014.

		L	T	P	C
PH4709	**SPECTROSCOPY**	**4**	**1**	**0**	**4**

OBJECTIVES

- To comprehend the theory behind different spectroscopic methods.
- To know the working principles along with an overview of construction of different types of spectrometers involved.
- To explore various applications of these techniques in R & D.
- Apply spectroscopic techniques for the qualitative and quantitative analysis of various chemical compounds.
- Understand this important analytical tool.

Course Outcome		**Cognitive Skill**
CO-01	To describe the theories explaining the structure of the atoms and the origin of the observed spectra and to identify atomic effect such as space quantization and Zeeman effect	R,U, A, An, E
CO-02	Understand the working principles of spectroscopic instruments and theoretical background of IR spectroscopy. Able to interpret vibrational spectrum of small molecules.	R,U, A, E
CO-03	To get knowledge of main sample handling methods of electronic and fiuorescence spectroscopy and capability to design proper spectroscopic measurements	R,U, A, E
CO-04	Use these resonance spectroscopic techniques for quantitative and qualitative estimation of a substances	R,U, A, An, E, S
CO-05	Learn the electronic transitions caused by absorption of radiation in the UV/Vis region of the electromagnetic spectrum and be able to analyze a simple UV spectrum.	R,U, A, An, E

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	S	S
CO-02	S	S	S	M
CO-03	S	M	S	M
CO-04	S	S	S	S
CO-05	S	S	S	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Microwave Spectroscopy **9**

Quantum states of an electron in an atom; Electron spin; Stern-Gerlach experiment; Normal Zeeman Effect- Anomalous Zeeman Effect- Magnetic Moment of Atom and the G Factor-Lande‟s g' Formula-Paschen Back Effect -stark effect, Rotational spectra of diatomic molecules-Hyperfine structure and quadrupole moment of linear molecules, Microwave Spectroscopy-Experimental Method-Theory of Microwave Spectra of Linear, Symmetric Top Molecules-Hyperfine Structure.

Unit II: Infrared & Raman Spectroscopy **9**

IR Spectroscopy: Practical Aspects-Theory of IR Rotation Vibration Spectra of Gaseous Diatomic Molecules-Applications-Basic Principles of FTIR Spectroscopy. Raman Spectroscopy: Classical and Quantum Theory of Raman Effect-Rotational Raman Spectra of linear Molecule- symmetric top molecule - Stokes and anti-stokes line- SR branch- Applications.

Unit III: Electronic & Fluorescence Spectroscopy **9**

Electronic Excitation of Diatomic Species-Vibrational Analysis of Band Systems of Diatomic Molecules- Deslandre‟s Table-Intensity Distribution-Franck Condon Principle-Rotational Structure of Electronic Bands-Resonance and Normal Fluorescence-Experimental Methods-Applications of Fluorescence.

Unit IV: Resonance Spectroscopy **9**

NMR Spectroscopy- Theory-resonance condition-Bloch Equation-Relaxation Processes-Experimental Technique- MRI Scan, Electron Spin Resonance: Basic principle - Total Hamiltonian (Direct Dipole-Dipole interaction and Fermi Contact Interaction) – Hyperfine Structure (Hydrogen atom) – ESR Spectra of Free radicals – Instrumentation - Medical applications of ESR.

Unit V: UV Spectroscopy **9**

Origin of UV spectra - Laws of absorption – Lambert Bouguer law – Lambert Beer law - molar absorptivity – transmittance and absorbance - Color in organic compounds- Absorption by organic Molecule -Chromophores -Effect of conjugation on chromophores - Choice of Solvent and Solvent effect - Absorption by inorganic systems - Instrumentation - double beam UV-Spectrophotometer -Simple applications.

TOTAL: 45 HOURS

TEXT BOOKS

1. Colin N Banwell and Elaine M McCash, Fundamentals of Molecular Spectroscopy, 4th Edition, T McGraw Hill Education, 2017.
2. G. Aruldhas, Molecular structure and spectroscopy, 2nd edition, PHI Learning Pvt.Ltd, New Delhi, 2007.
3. D.N. Satyanarayana, Vibrational Spectroscopy: Theory and Applications, 3rd Edition, New Age International Publishers, 2021.
4. B.K. Sharma, Spectroscopy, Goel Publishing House Meerut, 2015.
5. P.S. Kalsi, Spectroscopy of Organic Compounds, 7th Edition, New Age International Publishers, 2016.

REFERENCES

1. Jeanne L. McHale, Molecular Spectroscopy, 2nd Edition, CRC Press, 2017.
2. J. Michael Hollas, Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, Cambridge, 2002.
3. B. P. Straughan and S. Walker, Spectroscopy Vol. I, Chapman and Hall, New York, 1976.
4. A.K. Chandra, Introductory Quantum Chemistry, 4th Edition, McGraw Hill Education, 2017.

		L	T	P	C
PH4773	**CONDENSED MATTER PHYSICS and SPECTROSCOPY LABORATORY**	**0**	**0**	**4**	**2**

OBJECTIVES

- To analyze the electrical and magnetic properties of materials and their practical applications, fostering a deeper understanding of material behavior in various contexts.
- To synthesize acquired knowledge and skills to address real-world physical challenges creatively, promoting problem-solving abilities and innovation in material science.

Course Outcome		Cognitive Skill
CO-01	The students will be able to get the practical knowledge of optical and thermal properties of various materials and their applications.	R, U, A, An, E
CO-02	The students will be able to analyze the electrical and magnetic properties of materials and their applications.	R, U, A, An, E
CO-03	The students will be able to understand crystal structures and also to find lattice parameters using different XRD techniques.	R, U, A, An, E
CO-04	The students will be able to to synthesize the acquired knowledge, understanding and experience for physical problems in nature and to create new skills and tools for their possible solutions.	R, U, A, An, E
CO-05	The students will be able to understand basic properties of materials and applying the techniques to calculate required values.	R, U, A, An, E

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	**S**	**S**	**S**	**S**
CO-02	**S**	**S**	**M**	**S**
CO-03	**S**	**S**	**M**	**S**
CO-04	**S**	**S**	**M**	**S**
CO-05	**S**	**S**	**M**	**S**

S-Strong, M-Medium,L-Low,N-Not relevant

List of experiments:

1. Hall effect- Determination of hall parameter
2. Guoy Balance
3. Four Probe Method
4. Measurement of lattice parameters and indexing of powder photograph
5. Quinck‟s Method
6. UV-Vis Spectrophotometer – Determination of absorption coefficient and bandgap
7. Hysteresis (B – H Curve)
8. FTIR Spectrometer – Determination of vibration levels in a compound

9. Crystal Structure
10. Characteristics of Thermistor
11. Characteristics of Zener diode
12. Newton's Law of Cooling
13. Black Body Radiation: Determination of Stefan's Constant
14. Ultracapacitor (Supercapacitor)
15. Li-ion Battery

PH47S2	GREEN ENERGY TECHNOLOGIES	L	T	P	C
		2	0	2	2

OBJECTIVES

- To introduce the concept of green technology and its importance in promoting sustainability and environmental conservation.
- To explore the factors that influence the development and implementation of green technology, including technological, economic, social, and policy aspects.
- To provide students with knowledge and practical skills in specific areas of green technology, such as green synthesis, cleaner development technologies, energy-efficient systems and processes, and biofuels.

Course Outcome		Cognitive Skill
CO-01	Students will develop a comprehensive understanding of green technology, its principles, and its significance in promoting sustainability and environmental stewardship.	R,U, A, An,
CO-02	Students will be able to analyze the factors that influence the development and adoption of green technology, and assess their impact on sustainability.	R,U, A, E
CO-03	Students will gain insights into the roles of industry, government, and institutions in driving green technology initiatives and implementing sustainable practices.	R,U, A An, E,
CO-04	Students will acquire knowledge and practical skills in specific areas of green technology, such as green synthesis, cleaner development technologies, energy-efficient systems and processes, and biofuels.	R,U, An, E,
CO-05	Students will be able to critically evaluate and propose sustainable solutions in various domains, including manufacturing, energy, and resource management, based on the principles and practices of green technology.	R,U, A, An, E,

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	M	S	S	S
CO-02	S	S	S	S
CO-03	S	S	S	S
CO-04	S	S	M	S
CO-05	S	S	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

Unit-I: Green technology

Green technology-definition, importance, factors affecting green technology. Role of industry, government and institutions; industrial ecology, role of industrial ecology in green technology.

Unit-II: Green synthesis

Green methods of synthesis- microwave assisted synthesis, solvent free techniques- Reaction on solid supports. Green synthesis of nano particles -application

Unit-III: Cleaner development technologies

Cleaner development mechanisms, role of industry; reuse, reduce and recycle, raw material substitution; wealth from waste; carbon credits, carbon trading, carbon sequestration, eco labelling.

Unit-IV: Energy efficient systems and processes

Energy efficient motors, energy efficient lighting, control and selection of luminaries; bio-fuels, fuel cells- working, selection of fuels, Green manufacturing systems, selection of recyclable and environment friendly materials in manufacturing, design and implementation of sustainable green production systems.

Unit-V: Biofuels

Biomass as energy resources -Bio-fuels, bioethanol, biodiesel, green diesel and gasoline, methanol, and comparison with petroleum-derived fuels – Biofuel production.

TOTAL: 15 HOURS

TEXT BOOKS

Rashmi Sanghi and M.M. Srivastava, Green Chemistry-Environment Friendly Alternatives, Narosa Publishing House, New Delhi 2009.

REFERENCES

1. Khan B.H, Non conventional energy resources, Tata McGraw-Hill, New Delhi 2006.
2. Paul L. Bishop, Pollution prevention –Fundamentals and Practices, McGraw-Hill-international
3. 2000.
4. N. Vinutha bai, R. Ravindra, Energy efficient and green technology concepts, International
5. Journal of Research in Engineering and Technology p 253-258, Volume: 03 Special Issue: 06, 2014, eISSN: 2319-1163 pISSN: 2321-7308.

SEMESTER IV

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	PH4710	Core 10 - Nuclear and Particle Physics	4	1	0	4
2.	PH4711	Core 11 -Numerical Methods and Computer Programming	4	1	0	4
3.	PH47xx	Elective - IV (Choose any one from the list I, II & III)	4	0	0	4
PRATICAL And PROJECT						
4.	PH4774	Core Practical – IV - Numerical Methods and Computer Programming	0	0	2	2
5.	PH47S3	Skill Enhancement Course III - Problem solving skills - A Training for CSIR-NET	2	1	0	2
6.	PH47P6	Ability Enhancement Compulsory Course - Extension Activity	0	0	2	2
7.	PH47P5	Core 12- Project and Viva-Voce	0	0	12	6
TOTAL			**14**	**3**	**16**	**24**

PH4710	NUCLEAR AND PARTICLE PHYSICS	L	T	P	C
		4	1	0	4

OBJECTIVES

- Introduces different models of the nucleus in a chronological order
- Imparts an in-depth knowledge on the nuclear force, experiments to study it and the types of nuclear reactions and their principles
- Provides students with details of nuclear decay with relevant theories
- Exposes students to the Standard Model of Elementary Particles and Higgs boson

Course Outcome		Cognitive Skill
CO-01	Gain knowledge about the concepts of helicity, parity, angular correlation and internal conversion.	R,U, A,An,E,S
CO-02	Demonstrate knowledge of fundamental aspects of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of radiation and matter.	R,U, A,An,E,S
CO-03	Use the different nuclear models to explain different nuclear phenomena and the concept of resonances through Briet-Weigner single level formula	R,U, A,An,E,S
CO-04	Analyze data from nuclear scattering experiments to identify different properties of the nuclear force.	R,U, A,An,E,S
CO-05	Summarize and identify allowed and forbidden nuclear reactions based on conservation laws of the elementary particles.	R,U, A,An,E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	S	S
CO-02	S	S	M	S
CO-03	S	M	S	M
CO-04	S	S	M	S
CO-05	S	S	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Nuclear Models **9**

Liquid drop model – Weizacker mass formula – Isobaric mass parabola –Mirror Pair - Bohr Wheeler theory of fission – shell model – spin-orbit coupling – magic numbers – angular momenta and parity of ground states – magnetic moment – Schmidt model – electric Quadrapole moment - Bohr and Mottelson collective model – rotational and vibrational bands

Unit Ii: Nuclear Forces **9**

Nucleon – nucleon interaction – Tensor forces – properties of nuclear forces – ground state of deuteron – Exchange Forces - Meson theory of nuclear forces – Yukawa potential – nucleon-

nucleon scattering – effective range theory – spin dependence of nuclear forces - charge independence and charge symmetry – isospin formalism.

Unit Iii: Nuclear Reactions **9**

Kinds of nuclear reactions – Reaction kinematics – Q-value – Partial wave analysis of scattering and reaction cross section – scattering length – Compound nuclear reactions – Reciprocity theorem – Resonances – Breit Wigner one level formula – Direct reactions - Nuclear Chain reaction – four factor formula.

Unit Iv: Nuclear Decay **9**

Beta decay – Continuous Beta spectrum – Fermi theory of beta decay - Comparative Half-life – Fermi Kurie Plot – mass of neutrino – allowed and forbidden decay — neutrino physics – Helicity - Parity violation - Gamma decay – multipole radiations – Angular Correlation - internal conversion – nuclear isomerism – angular momentum and parity selection rules.

Unit V: Elementary Particles **9**

Classification of Elementary Particles – Types of Interaction and conservation laws – Families of elementary particles – Isospin – Quantum Numbers – Strangeness – Hypercharge and Quarks –SU (2) and SU (3) groups-Gell Mann matrices– Gell Mann Okuba Mass formula-Quark Model. Standard model of particle physics – Higgs boson.

TOTAL: 45 HOURS

TEXT BOOKS

1. D. C. Tayal – Nuclear Physics – Himalaya Publishing House (2011)
2. K. S. Krane – Introductory Nuclear Physics – John Wiley & Sons (2008)
3. R. Roy and P. Nigam – Nuclear Physics – New Age Publishers (1996)
4. S. B. Patel – Nuclear Physics – An introduction – New Age International Pvt Ltd Publishers (2011)
5. S.L Kakani, Shubhra Kakani – Nuclear and Particle Physics,-Viva Books Pvt. Ltd. New Delhi.(2011)

REFERENCES

1. L. J. Tassie – The Physics of elementary particles – Prentice Hall Press (1973)
2. H. A. Enge – Introduction to Nuclear Physics – Addison Wesley, Publishing Company. Inc. Reading. New York, (1974).
3. Kaplan – Nuclear Physics – 1989 – 2nd Ed. – Narosa (2002)
4. Bernard L Cohen – Concepts of Nuclear Physics – McGraw Hill Education (India) Private Limited; 1 edition (2001)
5. B.L. Cohen, 1971, Concepts of Nuclear Physics, TMCH, New Delhi.

		L	T	P	C
PH4711	**NUMERICAL METHODS AND COMPUTER PROGRAMMING**	**4**	**1**	**0**	**4**

OBJECTIVES

- To enable the students to understand different numerical approaches in problem solving a problem.
- To understand the basics of programming

Course Outcome		**Cognitive Skill**
CO-01	Understand the basic concept involved in root finding procedure such as Newton Raphson and Bisection methods, their limitations.	R,U, A,An,E,S
CO-02	Distinguish between various methods in solving simultaneous linear equations.	R,U, A,An,E,S
CO-03	Understand, how interpolation will be used in various realms of physics and apply to some simple problems Analyze the newton forward and backward interpolation	R,U, A,An,E,S
CO-04	Recollect and apply different methods in numerical differentiation and integration.	R,U, A,An,E,S
CO-05	Understand the basics of C-programming and conditional statements.	R,U, A,An,E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / **CO**	PO-A	PO-B	PO-C	PO-D
CO-01	M	S	S	L
CO-02	S	M	S	M
CO-03	S	L	M	M
CO-04	S	S	S	S
CO-05	M	S	M	M

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Solutions of Non Linear Equations **9**

Zeros or Roots of an equation: Non-linear algebraic equation and transcendental equations –Roots of polynomials, nonlinear algebraic equations and transcendental equations using Regula falsi and Newton-Raphson methods – Convergence of solutions in Regula Falsi and Newton-Raphson methods – Limitations of Regula Falsi and Newton-Raphson methods.

Unit II: Direct Solutions of Linear Equations **9**

Solution of simultaneous equations by Matrix inversion method and its limitations – Gaussian elimination method – Gauss Jordan method – Inverse of a matrix by Gauss elimination method - Eigen values and eigenvectors of matrices – Direct method - Power method and Jacobi Method to find the Eigen values and Eigen vectors.

Unit III: Interpolation and Curve Fitting **9**

Interpolation with equally spaced points - Newton forward and backward interpolation - Interpolation with unevenly spaced points - Lagrange interpolation – Curve fitting – Method of least squares – Fitting a polynomial.

Unit IV: Differentiation, Integration and Solution of Differential Equations **9**

Numerical differentiation – Numerical integration – Trapezoidal rule – Simpson's rule – Error estimates – Gauss-Legendre, Gauss-Laguerre, and Gauss-Hermite – solution of ordinary differential equations – Euler and Runga Kutta methods.

UNIT V: Programming **9**

Flow-charts – Integer and floating point arithmetic expressions – Built-in functions – Executable and non-executable statements – Subroutines and functions – Programs for the following computational methods: (a) Zeros of polynomials by the Regla Falsi method, (b) Zeros of polynomials/non-linear equations by the Newton-Raphson method, (c) Newton's forward and backward interpolation, Lagrange Interpolation, (d) Trapezoidal and Simpson's Rules, (e) Solution of first order differential equations by Euler's method.

TOTAL: 45 HOURS

TEXT BOOKS

1. V. Rajaraman, 1993, Computer oriented Numerical Methods, 3rd Edition. PHI, New Delhi.
2. M. K .Jain, S. R. Iyengar and R. K. Jain, 1995, Numerical Methods for Scientific and Engineering Computation, 3rd Edition, New Age Intl., New Delhi.
3. S. S. Sastry, Introductory Methods of Numerical analysis, PHI, New Delhi.
4. F. Scheid, 1998, Numerical Analysis, 2nd Edition, Schaum's series, McGraw Hill, New York.

REFERENCES

1. S. D. Conte and C. de Boor, 1981, Elementary Numerical analysis-an algorithmic approach, 3rd Edition, McGraw Hill,)
2. B. F. Gerald, and P. O. Wheatley, 1994, Applied Numerical analysis, 5th Edition, Addison-Wesley, MA.
3. B. Carnagan, H. A. Luther and J. O. Wilkes, 1969, Applied Numerical Methods, Wiley NY
4. S. S. Kuo, 1996, Numerical Methods and Computers, Addison-Wesley.
5. V. Rajaraman, Programming in FORTRAN / Programming in C, PHI, New Delhi

PH4774	NUMERICAL METHODS AND OMPUTER PROGRAMMING LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES

- To enhance the problem-solving aptitudes of students using various numerical methods.
- To formulate or design a system, process, or program to meet desired needs.
- To use the techniques, skills, and modern scientific and technical tools necessary for professional practice.

Course Outcome		Cognitive Skill
CO-01	Use various numerical methods in describing/solving physics problems.	R,U, A, An, E,S
CO-02	Solve problem, critical thinking and analytical reasoning as applied to scientific problems.	R,U, A, An, E,S
CO-03	To enhance the problem-solving aptitudes of students using various numerical methods.	R,U, A, An, E,S
CO-04	Apply various interpolation methods and finite difference concepts.	R,U, A, An, E,S
CO-05	The students will be able to implement programming techniques to solve problems in the C++ programming language.	R,U, A, An, E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	M	S	S
CO-02	S	S	M	S
CO-03	S	M	M	S
CO-04	S	M	M	S
CO-05	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

List of experiments:

1. Matrix Addition
2. Matrix Subtraction
3. Inverse of matrix
4. Transpose of matrix
5. Eigen values of a given matrix
6. Roots of Algebric equation – Newton Rapson method
7. Evaluation of area under the curve using Simpson‟s (1/3) rule
8. Evaluation of area under the curve using Simpson‟s (3/8) rule
9. Evaluation of area under the curve using Monte Carlo Method
10. Evaluation of the Q factor and Bandwidth using LCR series
11. Solution of Radioactive decay problem using Runga-Kutta Method
12. Current in a network
13. Solution of simultaneous linear algebraic equation – Gauss Seidal method
14. Least-squares curve fitting – Straight-line fit

TEXT BOOKS

1. E. Balagurusamy Object oriented Programming in C++ 4th Edition Tata Mc Graw Hill Publishing Pvt Ltd, New Delhi 2008 ISBN: 978 -0-07-066907-7
2. Steve Oualline Practical C++ Programming Second Edition OReilly Media Inc, United States of America 2003 ISBN: 978-0-596-00419-4

REFERENCES

1. James Roberge, Mathew Bauer, George K Smith Engaged Learning for programming in C++ - A Laboratory Course Second Edition (2001) Jones and Bartleft Publisher London ISBN 0-7637- 1423-2.
2. Harvey M. Deitel, Paul J. Deitel, Tem R. Nieto C++ in the Lab: Lab Manual to Accompany C++ how to Program (3rd Ed.) Prentice Hall, 2002 ISBN: 97801308957

LIST OF ELECTIVES

Sl. No	Course Code	Course Title	L	T	P	C
LIST I						
1.	PH47A1	Laser and its application	4	0	0	4
2.	PH47A2	Energy Physics	4	0	0	4
3.	PH47A3	Crystal Growth and Thin Films	4	0	0	4
4.	PH47A4	Materials Science	4	0	0	4
5.	PH47A5	Physics of Nanomaterials	4	0	0	4
LIST II						
6.	PH47A6	Alternate fuels	4	0	0	4
7.	PH47A7	Radiation Physics	4	0	0	4
8.	PH47A8	Bio Physics	4	0	0	4
9.	PH47A9	Advanced Optics	4	0	0	4
10	PH47B1	Advanced Mathematical Physics	4	0	0	4
LIST III						
11	PH47B2	Solid Waste Management	4	0	0	4
12	PH47B3	Sewage and Waste Water Treatment	4	0	0	4
13	PH47B4	Microprocessor 8086 and Microcontroller	4	0	0	4
14	PH47B5	Characterization of Materials	4	0	0	4
15	PH47B6	Medical Physics	4	0	0	4
16	PH47B7	Intellectual Property Rights	4	0	0	4
17	PH47B8	Astronomy and Astrophysics	4	0	0	4

PH47A1	LASER AND ITS APPLICATION	L	T	P	C
		4	0	0	4

OBJECTIVES

- To understand the basic concepts of lasers and their characteristics and to apply these concepts in real-world environment.
- To expose the students to the optical fiber communication systems and to explain the importance and advantages of optical fiber communications, basic problems and possible mitigations

Course Outcome		Cognitive Skill
CO-01	Students will be able to understand the basic principles of lasers and the operation of most common laser types	R,U, A, An, E, S
CO-02	Student will gain knowledge on the application of Lasers in Holograghy and its application.	R,U, A, An, E,S
CO-03	Students will be able to distinguish various types of fibres, splicing techniques, optical components etc	R,U, A, An, E, S
CO-04	Students will equip knowledge on how a coherent light is generated, and amplified and the techniques behind different lasers design and applications in spectroscopy, medicine etc	R,U, A, An, E, S
CO-05	Students will understand the concept of a product design specification and be able to gain knowledge about the lasers in industry	R,U, A, An, E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	**S**	**S**	**S**	**S**
CO-02	**S**	**M**	**S**	**S**
CO-03	**S**	**S**	**S**	**M**
CO-04	**S**	**S**	**S**	**S**
CO-05	**S**	**S**	**S**	**S**

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Principles and Types Of Lasers **9**

Introduction: spontaneous and stimulated emission, Einstein Relations, population inversion – Pumping threshold condition, Properties: temporal and spatial coherence, directionality – Types of lasers: ruby laser, helium-neon laser, Nd-YAG laser, CO2 laser, dye lasers, semiconductor lasers - Edge-Emitting Lasers - Quantum Well Lasers.

Unit II: Holography **9**

Basic principle of holography – Recording and reconstruction of a hologram– Types of Holograms: - applications of holography - Digital Holography – Holographic Non-Destructive Testing – Optical data storage using compact disk storage –Non-Linear Optics – Harmonic generation - Second harmonic generation.

Unit III: Fibre Optics **9**

Optical fibre principle – principle of light ray propagation through optical fibres – types of fibres –properties – fiber optical communication – Emerging Trends in Fiber Optic Communication:- Advantages of fibre optic communication system – Losses in fibers – Splicing – Fiber optic sensor: phase and polarization fibre sensor-Laser Doppler velocimeter sensor

Unit IV: Lasers In Science **9**

Saturation spectroscopy – Free electron Laser (FEL) – working principles and unique characteristics of FELs, such as tunability, high power, and ultrashort pulse duration - Photoacoustic Raman Spectroscopy – stimulated Raman emission – laser fusion – plasma-absolute rotation of the earth – medical applications-Laser in defence

Unit V: Lasers In Industry **9**

Materials processing – drilling, welding, Comparison between laser beam and electron beam welding – cutting - Advantages of laser cutting - Laser instrumentation for cutting and drilling – alloying –annealing- ablation – Comparison between laser beam and electron beam welding - laser chemical vapour deposition (LCVD) – Pulsed Laser Deposition – laser tracking – LIDAR.

TOTAL: 45 HOURS

TEXT BOOKS

1. P.Das,Lasers and Optical Engineering,Narosa publishing house 1992.
2. G.Senthil kumar,Engineering Physics –I,VRB publishers 2005.

REFERENCES

1. K. Thyagarajan and A.K. Ghatak, Lasers Theory and Applications, Mcmillan (1981).
2. Lasers and Non-Linear optics – B.B. Laud Wiley Eastern
3. K. Koebner (ed.), Industrial Applications of Lasers, Wiley (1984).
4. J.T. Cuxon and D.E. Parker, Industrial Lasers and their Applications, Prentice Hall (1985)
5. B. Culshaw, Optical Fiber Sensing and Signal Processing, Peter Peregrinus Ltd.(1984).
6. F.C. Appard, Fiber Optics Handbook, McGraw-Hill (1989).
7. William.M.Steen,Jyotirmoy Mazeemder,,Laser in materialprocessing,edition IV ,Springer science &Business Media,2010.
8. D.R.Vij,K.Mahesh,Medical application of Laser, Springer science &Business media 2013.

PH47A2	ENERGY PHYSICS	L	T	P	C
		4	0	0	4

OBJECTIVES

- To learn about various renewable energy sources.
- To know the ways of effectively utilizing the oceanic energy.
- To study the method of harnessing wind energy and its advantages.
- To learn the techniques useful for the conversion of biomass into useful energy.
- To know about utilization of solar energy

Course Outcome		Cognitive Skill
CO-01	To identify various forms of renewable and non-renewable energy sources.	R,U, A, An, E, S
CO-02	Understand the principle of utilizing the oceanic energy and apply it for practical applications.	R,U, A, An, E,S
CO-03	Discuss the working of a windmill and analyze the advantages of wind energy.	R,U, A, An, E, S
CO-04	Distinguish aerobic digestion process from anaerobic digestion.	R,U, A, An, E, S
CO-05	Understand the components of solar radiation, their measurement and apply them to utilize solar energy.	R,U, A, An, E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	S	M
CO-02	S	S	S	S
CO-03	S	S	M	S
CO-04	M	S	S	S
CO-05	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Introduction To Energy Sources **9**

Conventional and non-conventional energy sources and their availability–prospects of Renewable energy sources– Energy from other sources–chemical energy–Nuclear energy– Energy storage and distribution.

Unit II: Energy From The Oceans **9**

Energy utilization–Energy from tides–Basic principle of tidal power–utilization of tidal energy – Principle of ocean thermal energy conversion systems.

Unit III: Wind Energy Sources **9**

Basic principles of wind energy conversion–power in the wind–forces in the Blades– Wind energy conversion–Advantages and disadvantages of wind energy conversion systems (WECS) - Energy storage–Applications of wind energy.

Unit IV: Energy From Biomass **9**

Biomass conversion Technologies– wet and dry process– Photosynthesis -Biogas Generation: Introduction–basic process: Aerobic and anaerobic digestion – Advantages of anaerobic digestion– factors affecting bio digestion and generation of gas- bio gas from waste fuel– properties of biogas- utilization of biogas.

Unit V: Solar Energy Sources **9**

Solar radiation and its measurements–solar cells: Solar cells for direct conversion of solar energy to electric powers–solar cell parameter–solar cell electrical characteristics– Efficiency–solar water Heater –solar distillation– solar cooking–solar greenhouse – Solar pond and its applications.

TOTAL: 45 HOURS

TEXT BOOKS

1. G. N. Tiwari, Rajeev Kumar Mishra. Advanced Renewable Energy Sources. Royal Society of Chemistry, 2011
2. D. Mukherjee. Fundamentals of Renewable Energy Systems. New Age International, 2007
3. S. A. Abbasi, Naseema Abbasi. Renewable Energy Sources and Their Environmental Impact. PHI Learning Pvt. Ltd., 2004G.D. Rai, Non – convention sources of, 4th edition, Khanna publishers, New Delhi. 1996
4. S. Rao and Dr. Paru Lekar, Energy technology, Khanna Publishers, 2014
5. M.P. Agarwal, Solar Energy, S. Chand and Co., New Delhi, 1983.
6. S. P. Sukhatme, Solar energy, principles of thermal collection and storage, 2nd edition, Tata McGraw-Hill Publishing Co. Lt., New Delhi, 1997.

REFERENCES

1. Tushar K. Ghosh, Mark A. Prelas. Energy Resources and Systems Volume 2: (2011), springerlink
2. Dr.Sathyajith Mathew Wind Energy Fundamentals, Resource Analysis and Economics springerlink, 2006
3. S.P. Sukhatme. Solar Energy Priciples of Thermal Collection and Storage, ,2nd Ed. TMH, 2010
4. G.T. Wrixon, A.M.E. Rooney & W. Palz, Renewable Energy. Springer Verlag 2000

5. Giovanni Riva, and Ester Foppapedretti, Handbook on renewable energysources, National Renewable energy Laboratory, 2015
6. V. Vishal and T.N. Singh, Geologic Carbon Sequestration, Springer International Publishing 2016.
7. Aldo da Rosa, Fundamentals of renewable energy processes, Elsevier, 2012
8. Bent Sorensen, Renewable Energy Conversion, Transmission, and Storage, Academic Press 2017
9. C.S. Solanki. Renewal Energy Technologies: A Practical Guide for Beginners -PHI Learning. 2008.

PH47A3	CRYSTAL GROWTH AND THIN FILMS	L	T	P	C
		4	0	0	4

OBJECTIVES

- To acquire the knowledge on Nucleation and Kinetics of crystal growth.
- To understand the Crystallization Principles and Growth techniques.
- To understand the thin film deposition methods

Course Outcome		Cognitive Skill
CO-01	Acquire the Basic Concepts, Nucleation and Kinetics of crystal growth.	R,U, A, An, E, S
CO-02	Understand the Crystallization Principles and Growth techniques.	R,U, A, An, E,S
CO-03	Study various methods of Crystal growth techniques.	R,U, A, An, E, S
CO-04	Understand the Thin film deposition methods.	R,U, A, An, E, S
CO-05	Apply the techniques of Thin Film Formation and thickness Measurement.	R,U, A, An, E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	M	S
CO-02	S	S	M	S
CO-03	S	M	M	M
CO-04	S	S	M	M
CO-05	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Crystal Growth Kinetics **9**

Basic Concepts, Nucleation And Kinetics Of Growth Ambient Phase Equilibrium - Super Saturation - Equilibrium Of Finite Phases Equation Of Thomson - Gibbs - Types Of Nucleation - Formation Of Critical Nucleus - Classical Theory Of Nucleation - Homo And Heterogeneous Formation Of 3d Nuclei - Rate Of Nucleation - Epitaxial Growth - Growth Mechanism And Classification - Kinetics Of Growth Of Epitaxial Films.

Unit II: Crystallization Principles **9**

Crystallization Principles And Growth Techniques - Classes Of Crystal System - Crystal Symmetry - Solvents And Solutions - Solubility Diagram - Super Solubility - Expression For Super Saturation - Metastable Zone And Introduction Period - Miers Tc Diagram - Solution Growth - Low And High Temperatures Solution Growth - Slow Cooling And Solvent Evaporation Methods - Constant Temperature Bath As A Crystallizer.

Unit III: Gel, Melt And Vapour Growth **9**

Gel, Melt And Vapour Growth Techniques: Principle Of Gel Techniques - Various Types Of Gel - Structure And Importance Of Gel - Methods Of Gel Growth And Advantages - Melt Techniques - Czochralski Growth - Floating Zone - Bridgeman Method - Horizontal Gradient Freeze - Flux Growth - Hydrothermal Growth - Vapour Phase Growth - Physical Vapour Deposition - Chemical Vapour Deposition.

Unit IV: Thin Film Deposition Methods **9**

Thin Film Deposition Methods Of Thin Film Preparation, Thermal Evaporation, Electron Beam Evaporation, Pulsed Laser Deposition, Cathodic Sputtering, Rf Magnetron Sputtering, Mbe, Sol Gel Spin Coating, Spray Pyrolysis, Chemical Bath Deposition.

Unit V: Thin Film Formation **9**

Thin Film Formation And Thickness Measurement Nucleation, Film Growth And Structure - Various Stages In Thin Film Formation, Thermodynamics Of Nucleation, Nucleation Theories,

Capillarity Model And Atomistic Model And Their Comparison. Structure Of Thin Film, Roll Of Substrate, Roll Of Film Thickness, Film Thickness Measurement - Interferometry, Ellipsometry, Micro Balance, Quartz Crystal Oscillator Techniques.

TOTAL: 45 HOURS

TEXT BOOKS

1. V. Markov, Crystal growth for beginners: Fundamentals of Nucleation, Crystal Growth and Epitaxy, 2nd edition, 2003.
2. A. Goswami, Thin Film Fundamentals, 5th Edition, New Age International, New Delhi, 2005.
3. M. Ohora and R. C. Reid, Modeling Crystal Growth Rates from Solution, Prentice Hall, New Jersey, 1973.
4. D. Elwell, H. J. Scheel and Emanuel Kaldis, "Crystal Growth from High Temperature Solution", Journal of The Electrochemical Society, 1976.
5. Heinz K. Henish, Crystal Growth in Gels, Cambridge University Press, USA, 1973.

REFERENCES

1. J.C. Brice, Crystal Growth Process, John Wiley, New York, 1986.
2. P. Ramasamy and F. D. Gnanam, "UGC Summer School Notes", 1983.
3. P. Santhana Raghavan and P. Ramasamy, Crystal Growth Processes and Methods, KRU Publications, 2000.
4. H.E.Buckley, Crystal Growth, John Wiley and Sons, New York, 1951.
5. B.R. Pamplin, Crystal Growth, Pergman Press, London, 1980.

PH47A4	MATERIALS SCIENCE	L	T	P	C
		4	0	0	4

OBJECTIVES

- To gain knowledge on optoelectronic, polymeric and composite materials.
- To learn about ceramic processing and advanced ceramics.
- To learn about shape memory alloys, metallic glasses and nanomaterials.

Course Outcome		Cognitive Skill
CO-01	Acquire knowledge on optoelectronic materials.	R,U, A, An, E, S
CO-02	Be able to prepare ceramic materials.	R,U, A, An, E,S
CO-03	Be able to understand the processing and applications of polymeric materials.	R,U, A, An, E, S
CO-04	Be aware of the fabrication of composite materials.	R,U, A, An, E, S
CO-05	Be knowledgeable of shape memory alloys, metallic glasses and nanomaterials.	R,U, A, An, E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	L	M
CO-02	S	M	M	S
CO-03	S	M	M	S
CO-04	S	M	M	S
CO-05	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Optoelectronic Materials **9**

Importance Of Optical Materials – Properties: Band Gap And Lattice Matching – Optical Absorption And Emission – Charge Injection, Quasi - Fermi Levels And Recombination – Optical Absorption, Loss And Gain, Optical Processes In Quantum Structures: Inter-Band And Intra-Band Transitions, Organic Semiconductors, Light Propagation In Materials – Electro-Optic Effect And Modulation, Electro-Absorption Modulation – Exciton Quenching.

Unit II: Ceramic Materials **9**

Ceramic Processing: Powder Processing, Milling And Sintering – Structural Ceramics: Zirconia, Almina, Silicon Carbide, Tungsten Carbide – Electronic Ceramics – Refractories – Glass And Glass Ceramics.

Unit III: Polymeric Materials **9**

Polymers And Copolymers – Molecular Weight Measurement – Synthesis: Chain Growth Polymerization – Polymerization Techniques – Glass Transition Temperature And Its Measurement – Viscoelasticity – Polymer Processing Techniques – Applications: Conducting Polymers, Biopolymers And High Temperature Polymers.

Unit IV: Composite Materials **9**

Particle Reinforced Composites – Fiber Reinforced Composites – Mechanical Behavior – Fabrication Methods Of Polymer Matrix Composites And Metal Matrix Composites – Carbon/Carbon Composites: Fabrication And Applications.

Unit V: New Materials **9**

Shape Memory Alloys: Mechanisms Of One-Way And Two-Way Shape Memory Effect, Reverse Transformation, Thermo-Elasticity And Pseudo-Elasticity, Examples And Applications -Bulk Metallic Glass: Criteria For Glass Formation And Stability, Examples And Mechanical Behavior - Nanomaterials: Classification, Size Effect On Structural And Functional Properties, Processing

And Properties Of Nano Crystalline Materials, Single Walled And Multi Walled Carbon Nanotubes.

TOTAL: 45 HOURS

TEXT BOOKS

1. Jasprit Singh, Electronic and optoelectronic properties of semiconductor structures, Cambridge University Press, 2007.
2. P. K. Mallick. Fiber-Reinforced Composites. CRC Press, 2008.
3. V. Raghavan, Materials Science and Engineering, 4th Edition, Prentice- Hall India, New Delhi, 2003.
4. G.K. Narula, K.S. Narula and V.K. Gupta, Materials Science, Tata McGraw-Hill, 1988.
5. M. Arumugam, Materials Science, Anuratha Agencies, 2018.

REFERENCES

1. B. S. Murty, P. Shankar, B. Raj, B. B. Rath and J. Murday, Textbook of Nanoscience and Nanotechnology. Springer- Verlag, 2012.
2. K. Yamauchi, I. Ohkata, K. Tsuchiya and S. Miyazaki (Eds), Shape Memory and Super Elastic Alloys: Technologies and Applications. Wood head Publishing Limited, 2011.
3. Lawrence H. Van Vlack, Elements of Materials Science and Engineering, 6th Edition, Second ISE reprint, Addison-Wesley, 1998.
4. H. Iabch and H. Luth, Solid State Physics – An Introduction to Principles of Materials Science, 2nd Edition, Springer, 2002.
5. D. Hull & T. W. Clyne, An introduction to composite materials, Cambridge University Press, 2008

PH47A5	PHYSICS OF NANOMATERIALS	L	T	P	C
		4	0	0	4

OBJECTIVES

- To provide the basic knowledge about nanomaterials.
- To learn the structures and properties of nanomaterials.
- To acquire the knowledge about synthesis methods and characterization techniques and its applications.

Course Outcome		Cognitive Skill
CO-01	Understand the basics of nanoscience and explore the different types of nanomaterials.	R,U, A, An, E, S
CO-02	Explore various physical, mechanical, optical, electrical and magnetic properties nanomaterials.	R,U, A, An, E,S
CO-03	Understand the process and mechanism of synthesis and fabrication of nanomaterials.	R,U, A, An, E, S
CO-04	Analyze the various characterization of Nano-products through diffraction, spectroscopic, microscopic and other techniques.	R,U, A, An, E, S
CO-05	Apply the concepts of technology in the field of sensors, robotics, purification of air and water and in the energy devices.	R,U, A, An, E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	S	S
CO-02	S	M	S	S
CO-03	S	S	S	M
CO-04	S	S	S	M
CO-05	S	M	S	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Fundamentals Of Nanoscience And Technology 9

Fundamentals Of Nano – Historical Perspective On Nanomaterial And Nanotechnology -– Classification Of Nanomaterials – Metal And Semiconductor Nanomaterials - 2d, 1d, 0d Nanostructured Materials - Quantum Dots – Quantum Wires – Quantum Wells - Surface Effects Of Nanomaterials.

Unit II: Properties Of Nanomaterials 9

Physical Properties Of Nanomaterials: Melting Points, Specific Heat Capacity, And Lattice Constant - Mechanical Behavior: Elastic Properties – Strength - Ductility - Superplastic Behavior

- Optical Properties: - Surface Plasmon Resonance – Quantum Size Effects - Electrical Properties - Conductivity, Ferroelectrics And Dielectrics - Magnetic Properties – Super Para Magnetism – Diluted Magnetic Semiconductor (Dms).

Unit III: Synthesis And Fabrication **9**

Physical Vapour Deposition - Chemical Vapour Deposition - Sol-Gel – Wet Deposition Techniques - Electrochemical Deposition Method – Plasma Arching - Electrospinning Method - Ball Milling Technique - Pulsed Laser Deposition - Nanolithography: Photolithography – Nanomanipulator.

Unit IV: Characterization Techniques **9**

Powder X-Ray Diffraction – X-Ray Photoelectron Spectroscopy (Xps) - Uv-Visible Spectroscopy – Photoluminescence - Scanning Electron Microscopy (Sem) - Transmission Electron Microscopy (Tem) - Scanning Probe Microscopy (Spm) - Scanning Tunneling Microscopy (Stm) – Vibrating Sample Magnetometer.

Unit V: Applications Of Nanomaterials **9**

Sensors: Nanosensors Based On Optical And Physical Properties - Electrochemical Sensors – Nano-Biosensors. Nano Electronics: Nanobots - Display Screens - Gmr Read/Write Heads - Carbon Nanotube Emitters – Photocatalytic Application: Air Purification, Water Purification -Medicine: Imaging Of Cancer Cells – Biological Tags - Drug Delivery - Photodynamic Therapy - Energy: Fuel Cells - Rechargeable Batteries - Supercapacitors - Photovoltaics.

TOTAL: 45 HOURS

TEXT BOOKS

1. A textbook of Nanoscience and Nanotechnology, Pradeep T., Tata McGraw-Hill Publishing Co. (2012).
2. Principles of Nanoscience and Nanotechnology, M.A. Shah, Tokeer Ahmad, Narosa Publishing House Pvt Ltd., (2010).
3. Introduction to Nanoscience and Nanotechnology, K. K. Chattopadhyay and A.N. Banerjee, PHI Learning Pvt. Ltd., New Delhi, (2012).
4. Nanostructured Materials and Nanotechnology, Hari Singh Nalwa, Academic Press, (2002).
5. Nanotechnology and Nanoelectronics, D.P. Kothari,V. Velmurugan and Rajit Ram Singh, Narosa Publishing House Pvt. Ltd, New Delhi. (2018).

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1. Nanostructures and Nanomaterials – Huozhong Gao – Imperial College Press (2004).
2. Richard Booker and Earl Boysen, (2005) Nanotechnology, Wiley Publishing Inc. USA
3. Nano particles and Nano structured films; Preparation, Characterization and Applications, J. H. Fendler John Wiley and Sons. (2007)
4. Textbook of Nanoscience and Nanotechnology, B. S. Murty, et al., Universities Press. (2012)
5. The Nanoscope (Encyclopedia of Nanoscience and Nanotechnology), Dr. Parag Diwan and Ashish Bharadwaj (2005) Vol. IV - Nanoelectronics Pentagon Press, New Delhi.

PH47A6	ALTERNATE FUELS	L	T	P	C
		4	0	0	4

OBJECTIVES

- To provide students with the knowledge on the properties, applications, limitations of alternative fuels

Course Outcome		Cognitive Skill
CO-01	Able to understand biogas, types of small scale and industrial digester.	R,U, A, An, E, S
CO-02	Gains knowledge on the need for alternate fuel and the effectiveness of using ethanol as alternate fuel	R,U, A, An, E,S
CO-03	Able to gain knowledge on biofuel, types and various methods on the production of biofuel from various resources.	R,U, A, An, E, S
CO-04	Able to gain knowledge on the production and usage of hydrogen fuel.	R,U, A, An, E, S
CO-05	Gains knowledge on the working principle of fuel cells, types and its application.	R,U, A, An, E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	M	M	S	S
CO-02	S	S	S	S
CO-03	S	S	S	M
CO-04	S	S	M	S
CO-05	M	S	S	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I :Biogas **9**

Introduction - Biogas - Types Of Biogas Digesters And Plants- Types Of Small-Scale Digesters – Types Of Industrial Digester- Wet And Dry Fermentation Plants – Advantages And Disadvantages – Biogas And Its Properties As A Fuel For Engines.

Unit II: Ethanolic Fuels **9**

Introduction To Alternative Fuels. – Need For Alternative Fuels – Sources. Alcohols As Fuels – Properties – Alcohol Production- Alcohol In Ci Engines. Ethanol Blends - E85 Flex Fuel Specification - Ethanol Benefits And Considerations - Performance Emission And Combustion Characteristics In Ci Engines.

Unit III: Biofuels **9**

Biofuels- Types Of Biofuels – Various Biofuel Standards -Various Sources Of Biofuels - Different Methods Of Using Vegetable Oils Engines – Blending, Preheating Transesterification And Emulsification Of Vegetable Oils – Performance In Engines – Performance, Emission And Combustion Characteristics In Diesel Engines.

Unit IV: Hydrogen Fuels **9**

Hydrogen Fuel – Properties And Application- Sources Of Hydrogen - Production Methods Of Hydrogen – Storage Of Hydrogen. Combustive Properties Of Hydrogen. Advantages And Disadvantages Of Hydrogen Fuel. Different Methods Of Using Hydrogen In Ci Engine.

Unit V: Fuel Cells **9**

Fuel Cell – Working Principle – Types Of Fuel Cells – Polymer Electrolyte Membrane Fuel Cells - Direct Methanol Fuel Cells - Alkaline Fuel Cells - Phosphoric Acid Fuel Cells - Molten Carbonate Fuel Cells - Solid Oxide Fuel Cells - Reversible Fuel Cells - Microbial Fuel Cells - Applications - Advantages And Disadvantages Of Fuel Cells.

TOTAL: 45 HOURS

TEXT BOOKS

1. Arthur Wellinger, Jerry Murphy and David Baxter, The Biogas Handbook: Science,Production and Applications, Woodhead Pub Limited, 2013
2. Sara Gaspard and Mohamed ChakerNcibi, Biomass for Sustainable Applications: Pollution Remediation and Energy, Royal Society of Chemistry, 2013
3. S. S. Thipse, Alternative Fuels : Concepts, Technologies And Developments, Jaico BookDistributors, 2010

REFERENCE

1. A S Ramadhas, Alternative Fuels for Transportation, CRC Press, 2016
2. M.K. GajendraBabu and K.A. Subramanian, Alternative Transportation Fuels: Utilisationin Combustion Engines, CRC Press, 2013.
3. Frederick J. Barclay, Fuel Cells, Engines and Hydrogen: An Exergy Approach, JohnWiley & Sons, 2006.
4. Paul Breeze, Fuel Cells, Academic Press, Feb-2017
5. AnjuDahiya, Bioenergy: Biomass to Biofuels, Academic Press, 2014.
6. Sachin Kumar and Rajesh K. Sani. Biorefining of Biomass to Biofuels: Opportunities andPerception, Springer International Publishing, 2017
7. Andrew Bocarsly, David Michael P. Mingos, Fuel Cells and Hydrogen StorageSpringer Science & Business Media, 2011

PH47A7	RADIATION PHYSICS	L	T	P	C
		4	0	0	4

OBJECTIVES

- To provide students with an understanding of the fundamental concepts and principles related to the interaction of radiation with matter, the operation and characteristics of radiation detectors
- To measurement of radiation exposure and dose, the industrial applications of radiations, and the use of radiation in industrial processes.

Course Outcome		Cognitive Skill
CO-01	Demonstrate a comprehensive understanding of the interaction of radiation with matter, including the energy loss by collision, specific ionization	R,U, A, An, E, S
CO-02	Apply their knowledge of radiation detectors, such as scintillation counters and semiconductor devices, to select and operate appropriate detectors for specific radiation measurement purposes.	R,U, A, An, E,S
CO-03	Perform accurate measurements of radiation exposure and dose, utilizing principles such as particle flux and fluence, linear and mass absorption coefficients, and kerma, enabling them to assess radiation risks and ensure proper radiation safety protocols.	R,U, A, An, E, S
CO-04	Evaluate the industrial applications of radiations, including radiography, activation analysis, and radiation processing by understanding the techniques.	R,U, A, An, E, S
CO-05	Demonstrate an understanding of the principles and techniques of industrial radiation processing.	R,U, A, An, E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	S	M
CO-02	S	S	S	S
CO-03	S	S	M	S
CO-04	M	S	S	S
CO-05	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit 1: Interaction of Radiation With Matter **9**

Passage of heavy charged particles through matter : Energy loss by collision, maximum energy loss in a single collision, Bragg curve, Specific ionization, mean excitation energies, Bethe-Bloch formula collision stopping power, radiation stopping power. Interaction of neutrons : Neutron sources, General properties, energy classification, elastic and inelastic scattering, nuclear reaction, neutron activation and induced activity.

Unit II: Radiation Detectors **9**

Characteristics of organic and inorganic scintillation counters, Resolving time, Semiconductor devices - physics of semiconductors, diffused junction, surface barrier and ion-implanted detectors, Semiconductor. Neutron detectors : BF3 counters, fission chambers, activation methods, Neutron time of flight method. Preamplifier circuits, noise, linear pulse amplifier, pulse shaping, pulse stretching, operation amplifier, Pulse discriminators, coincidence and anti-coincidence circuits. Scalers, single and multichannel analyser, charge sensitive amplifier. Principles of measurement (collimation shielding, geometry, calibration),Radiation survey instruments.

Unit III: Measurement Of Radiation Exposure And Dose **9**

Particle flux and fluence, energy flux and fluence, cross section, linear and mass absorption coefficient, stopping power and LET. Exposures and its measurement, absorbed dose and its relation to exposure. Electronic equilibrium, Bragg-Gray principle and air wall chamber, Kerma, Kerma rate constant. Biological effectiveness, Equivalent dose, effective dose, Committed equivalent dose, Ambient and directional equivalent dose.

Unit IV: Industrial Applications Of Radiations **9**

Industrial radiography: X-ray and isotope radiography. Radiographic exposure devices, design, operation and accessories. Activation analysis : Basic principles, advantages and limitations. Time of irradiation Vs half life. Choice of detectors and irradiation. Method of estimation. Decay and special characteristics.

Unit V: Industrial Radiation Processing **9**

Elements of radiation chemistry - production of free radicals, radical diffusion and formation of molecular products, G-Values, Chemical transformation. Applications of radiation processing in irradiation design and food preservation, radiation sterilization and chemical processing. Radiopharmaceuticals, radiation sterilization of medical products. Polymerization - wood, vinyl monomers, fibre boards, vulcanization of rubber.

TOTAL: 45 HOURS

TEXT BOOKS

1. Knoll G F, „Radiation Detection and Measurements‟ (Wiley, New York, 1989)
2. Kapoor S S and Ramamurthy V S, „Nuclear Radiation Detectors‟ (Wiley Eastern Ltd.,
3. New Delhi, 1986)
4. Herman Cember, „Introduction to Health Physics‟ (Pergamon Press, 1983)
5. Attix F H et al, „Radiation Dosimetry‟, Vol. I, II and III (Academic Press, NY, 1968)

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1. Glasstone S, „Source book on Atomic Energy‟ (East West Press, New Delhi, 1975
2. Greening J R, Bristol, Adam Hilger, „Fundamentals of Radiation Dosimetry‟ (Medical
3. Physics Hand Book 6, 1981)
4. Morgan K Z and Turner J E, „Health Physics‟ , Wiley, NY, 1978
5. Horowitx Y S, Boca Raton (eds.), „Thermoluminescence and TL Dosimetry‟, Vol. I, II
6. and III, (CRC Press, 1984)
6. Mann W B, Et al, „Radioactivity and its Measurements‟ (Pergamon Oxford, 1980)
7. Dillman L T, et al, „Radionuclide Decay Scheme and Dose Estimation‟ Society of
7. Nuclear Medicine, NY, MIRD Pamphlet No. 10, 1975
8. Taylor L S, „Radiation Protection Standards‟ (CRC Press, Cleveland, Ohio, 1971)
9. Richard F. Mould, „Radiation Protection in Hospitals Medical Sciences Series‟ (Adam
10. Hilger Ltd, Bristol and Boston, 1985)
8. Kenneth R Kase, Bjarngard B E and Attix F H, „The Dosimetry of ionising radiation‟,
11. Vol I & II (Academic Press, 1985 & 1987)
9. Ronald L. Kathren, „Radiation Protection‟ (Adam Hilger Ltd. International Publishers
12. Services, 1985)
10. Merril Eisenbud, „Environmental Radioactivity‟ (Academic Press, Orlando, 1987)
11. James E Turner, „Atoms, Radiation & Radiation Protection‟ (Pergamon Press, 1986)

PH47A8	BIO PHYSICS	L	T	P	C
		4	0	0	4

OBJECTIVES

- To understand the fundamentals of macromolecular structures involved in propagation of life.
- To understand the biophysical function of membrane and neuron.
- To understand the physical principles behind the various techniques available for interrogating biological macromolecules.
- To understand the physical principles involved in cell function maintenance.

Course Outcome		Cognitive Skill
CO-01	Identifies the role of various bonds in biological molecules and also to understanding of the function of biological membranes	R,U, A, An, E
CO-02	Describes the different levels of protein structure and their independence	R,U, A, An, E
CO-03	Understands the different composition of nucleic acids and also to understand the functioning of nervous system.	U, A, An, E
CO-04	Describes and formulates the structure of different carbohydrates and explains their properties and functions in living organisms.	U, A, An, E

CO-05	Understand the structural organization and function of living cells and should able to apply the cell signaling mechanism and its electrical activities.	R,U, A, An, E

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	S	S
CO-02	S	M	S	S
CO-03	S	S	S	S
CO-04	S	S	S	S
CO-05	S	M	S	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Basics Of Biophysics **9**

Role of biomolecules in biological functions, types of bonds, structural isomerism, geometrical isomerism, optical isomerism, optical activity, basis of molecular interactions, Lennard –Jones potential, Biological membranes and dynamics - Membrane Capacitors – Transport across cell and organelle membranes

Unit II: Proteins **9**

Macromolecular structure: Protein structure – structure and properties of amino acids, peptide bond, primary, secondary,tertiary and quaternary structures of proteins, Ramachandran map, Special Bio-macromolecules: Metalloproteins, nucleoproteins, ribozymes, chaperons and prions.

Unit III: Nucleic Acids And Neuro Biophysics **9**

Nucleic acid structure: nucleosides and nucleotides, Watson and Crick model, A,B and Z forms of DNA, structure of tRNA. Nervous system: Organization of the nervous system –Membrane potential – Origins of membrane potential - Electrochemical potentials – Nernst equation – Goldman equation.

Unit IV: Carbohydrates **9**

Structure and conformations of monosaccharides, properties, disaccharides – biomedical impedance, glycosidic linkage, oligosaccharides and polysaccharides – Homopolysaccharides, Heteropolysaccharide, structure of cellulose and amylose- glycoproteins and glycolipids.

Unit V: Cellular Biophysics **9**

Architecture and Life Cycle of cells – Organelles of Prokaryotic and Eukaryotic cell – Cell size and shape – Fine structure of Prokaryotic and Eukaryotic cell organization – Compartment & assemblies membrane system – Extracellular matrix - Molecular mechanisms of Vesicular traffic - Electrical activities of cardiac and neuronal cells.

TOTAL: 45 HOURS

TEXT BOOKS

1. Geoffrey M. Cooper The cell: A molecular approach, , ASM Press, 2013.
2. Vasantha Pattabhi, N. Gautham Biophysics, , Narosa Publishing, 2009
3. P.Narayanan, Essentials of Biophysics New Age Interantional,2000
4. P. S. Mishra Biophysics, VK Enterprises, 2010.
5. M. A Subramanian Biophysics, , MJP Publishers, 2005.
6. L. Veerakumari Bioinstrumentation, MJP Publishers, 2006.

REFERENCE

1. Daniel A Beard, Chemical Biophysics Cambridge University Press, 2008.
2. Bruce Albert et al, Essential cell biology, Garland Science
3. W. Hoppe, W. Lohmann, H. Markl and H. Ziegler. Biophysics Springer Verlag, Berlin 1983.
4. Mohammad Ashrafuzzaman, Jack A. Tuszynski, Membrane Biophysics, Springer science & business media.
5. Iain D. Campbell, Raymond A. Dwek, Biological spectroscopy.

PH47A9	ADVANCED OPTICS	L	T	P	C
		4	0	0	4

OBJECTIVES

- To know the concepts behind polarization and double refraction.
- To impart an extensive understanding of laser, fiber and non-linear optics.
- To learn the principles of magneto-optic and electro-optic effects and its applications.

Course Outcome		Cognitive Skill
CO-01	Discuss the transverse character of light waves and different polarization phenomenon.	R,U, A, An, E, S
CO-02	Discriminate all the fundamental processes involved in laser devices and to analyze the design and operation of the devices.	R,U, A, An, E,S
CO-03	Demonstrate the basic configuration of a fiber optic – communication system and advantages.	R,U, A, An, E, S
CO-04	Identify the properties of nonlinear interactions of light and matter.	R,U, A, An, E, S
CO-05	Interpret the group of experiments which depend for their action on an applied magnetics and electric field.	R,U, A, An, E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	M	M	S
CO-02	S	M	M	M
CO-03	S	M	M	S
CO-04	S	M	S	S
CO-05	S	M	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit 1: Polarization And Double Refraction **9**

Classification of polarization – Transverse character of light waves – Polarizer and analyzer – Production of polarized light – Wire grid polarizer and the polaroid – Polarization by reflection – Polarization by double refraction – Polarization by scattering – The phenomenon of double refraction – Normal and oblique incidence – Interference of polarized light: Quarter and half wave plates – Analysis of polarized light – Optical activity

Unit II: Lasers **9**

Basic principles – Spontaneous and stimulated emissions – Einstein's Coefficients - Components of the laser – Resonator and lasing action – Types of lasers and its applications – Solid state lasers – Ruby laser – Nd:YAG laser – gas lasers – He-Ne laser – CO_2 laser – Semiconductor laser.

Unit III: Fiber Optics **9**

Introduction – Total internal reflection – The optical fiber – Glass fibers – The coherent bundle – The numerical aperture – Attenuation in optical fibers – Single and multi-mode fibers – Pulse dispersion in multimode optical fibers – Ray dispersion in multimode step index fibers – Parabolic-index fibers – Fiber-optic sensors: precision displacement sensor – Precision vibration sensor.

Unit IV: Non-Linear Optics **9**

Basic principles – Harmonic generation – Second harmonic generation – Phase matching – Third harmonic generation – Optical mixing – Parametric generation of light – Self-focusing of light.

Unit V: Magneto-Optics And Electro-Optics **9**

Magneto-optical effects – Zeeman effect – Inverse Zeeman effect – Faraday effect – Voigt effect – Cotton-mouton effect – Kerr magneto-optic effect – Electro-optical effects – Stark effect – Inverse stark effect – Electric double refraction – Kerr electro-optic effect – Pockels electro-optic effect.

TOTAL: 45 HOURS

TEXT BOOKS

1. B. B. Laud, Lasers and Non – Linear Optics, 3rd Edition, New Age International (P) Ltd, 2017.
2. Ajoy Ghatak, Optics, 6th Edition, McGraw – Hill Education Pvt. Ltd, 2017.
3. William T. Silfvast, Laser Fundamentals Cambridge University Press, New York, 1996.
4. Lipson, S. G. Lipson and H. Lipson, Optical Physics, 4th Edition, Cambridge University Press, New Delhi, 2011.
5. B. Saleh, and M. Teich, Fundamentals of Photonics, Wiley-Interscience,

REFERENCE

1. F. S. Jenkins and H. E. White, Fundamentals of Optics, (4th Edition), McGraw – Hill International Edition, 1981.
2. Dieter Meschede, Optics, Light and Lasers, Wiley – VCH, Varley GmbH, 2004.
3. Y. B. Band, Light and Matter, Wiley and Sons (2006)
4. R. Guenther, Modern Optics, Wiley and Sons (1990)

PH47B1	ADVANCED MATHEMATICAL PHYSICS	L	T	P	C
		4	0	0	4

OBJECTIVES

- To educate and involve students in the higher level of mathematics and mathematical methods relevant and applicable to Physics.
- To enhance problem solving skills using different equations and series.
- To gain knowledge in various function in mathematical physics.

Course Outcome		Cognitive Skill
CO-01	Gained knowledge of both discrete and continuous groups	R, U, A, An
CO-02	Apply various important theorems in group theory	R, A, E
CO-03	Construct group multiplication table, character table relevant to important branches of physics.	R, U, E
CO-04	Equipped to solve problems in tensors	An, E
CO-05	Developed skills to apply group theory and tensors to peruse research	R, U, A

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	M	S	S	S
CO-02	S	M	M	S
CO-03	M	S	M	M
CO-04	S	S	M	S
CO-05	S	S	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Discrete Groups **9**

Definition of a group, subgroup, class, Lagrange's theorem, invariant subgroup, Homomorphism and isomorphism between two groups. Representation of a group, unitary representations, reducible and irreducible representations Schur's lemmas, orthogonality theorem, character table, reduction of Kronecker product of representations, criterion for irreducibility of a representation.

Unit II: Continuous Groups **9**

Infinitesimal generators, Lie algebra; Rotation group, representations of the Lie algebra of the rotation group, representation of the rotation group, D-matrices and their basic properties. Addition of two angular momenta and C.G. coefficients, Wigner-Eckart theorem.

Unit III: Special Unitary Groups **9**

Definition of unitary, unimodular groups SU (2) and SU(3). Lie algebra of SU(2). Relation between SU(2) and rotation group. Lie algebra of SU(3)-Gellmann's matrices. Cartan form of the SU(3). Lie algebra, roots and root diagram for SU(3). Direct product of two SU(3) representations, SU(3) symmetry in elementary particle physics.

Unit Iv: Tensors **9**

Cartesian vectors and tensors illustration with moment of inertia, Vectors and tensors under general co-ordinate transformations, contravariant and covariant vectors and tensors, mixed tensors; tensor algebra, addition, subtraction, direct product of tensors, quotient theorem, symmetric and antisymmetric tensors.

Unit V: Tensor Calculus **9**

Parallel transport, covariant derivative, affine connection. Metric tensor, Expression for Christoffel symbols in terms of and its derivatives (assuming D g = 0. Curvature tensor, Ricci tensor and Einstein tensor. Bianchi identities, Schwarzschild solution to the Einstein equation G=0.

TOTAL: 45 HOURS

TEXT BOOKS:

1. D. B. Lichtenberg, Unitary Symmetry and Elementary Particles
2. E. Butkov, Mathematical Physics
3. J. V. Narlikar, General Relativity & Cosmology
4. R. Geroch, Mathematical Physics, The University of Chicago press (1985).
5. W. Joshi, Group Theory for Physicists

REFERENCE BOOKS:

1. M. Hamermesh Group Theory
2. M. E. Rose: Elementary Theory of Angular Momentum
3. Georgi : Lie Groups for Physicists
4. E. A. Lord: Tensors, Relativity & Cosmology
5. P. Szekeres, A course in modern mathematical physics: Groups, Hilbert spaces and differential geometry, Cambridge University Press.

PH47B2	SOLID WASTE MANAGEMENT	L	T	P	C
		4	0	0	4

OBJECTIVES

- To gain basic knowledge in solid waste management procedures
- To gain industry exposure and be equipped to take up a job.
- To harness entrepreneurial skills.
- To analyze the status of solid waste management in the nearby areas.
- To sensitize the importance of healthy practices in waste managements.

Course Outcome		Cognitive Skill
CO-01	Gained knowledge in solid waste management	R,U, A, An, E, S
CO-02	Equipped to take up related job by gaining industry exposure	R,U, A, An, E,S
CO-03	Develop entrepreneurial skills	R,U, A, An, E, S
CO-04	Will be able to analyze and manage the status of the solid wastes in the nearby areas	R,U, A, An, E, S
CO-05	Adequately sensitized in managing solid wastes in and around his/her locality	R,U, A, An, E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	S	M
CO-02	M	S	S	S
CO-03	S	S	M	S
CO-04	M	S	S	S
CO-05	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Solid Waste Management **9**

Introduction - Definition of solid waste - Types – Hazardous Waste: Resource conservation and Renewal act – Hazardous Waste: Municipal Solid waste and non-municipal solid waste.

Unit II: Solid Waste Characteristics **9**

Solid Waste Characteristics: Physical and chemical characteristics - SWM hierarchy - factors affecting SW generation

Unit III: Tools And Equipment **9**

Tools and equipment - Transportation - Disposal techniques - Composting and land filling technique

SWM for economic development and environmental protection

Unit IV: Economic Development **9**

Job Creation- Resource Recovery and Recycling- Waste-to-Energy Projects - Cost Savings - Environmental Protection and Tourism - Linking SWM and climate change and marine litter- Land-based Sources - Coastal Tourism and Fisheries - Environmental Impacts.

Unit V: Industrial Application **9**

Recycling and Resource Recovery - Waste-to-Energy Conversion - Composting and Organic Fertilizers -Industrial Symbiosis and Waste Exchange -Waste-derived Products and Materials - Industrial Waste Treatment and Remediation - Construction and Building Materials - Industrial Packaging - Solid waste - Industrial By-Product Utilization -Landfill Gas Recovery - Sustainable Packaging and Product Design

TOTAL: 45 HOURS

TEXT BOOKS

1. Handbook of Solid Waste Management /Second Edition, George Tchobanoglous, McGraw Hill 2002.
2. Prospects and Perspectives of Solid Waste Management, Prof. B BHosett, New Age International (P) Ltd (2006).
3. Solid and Hazardous Waste Management, Second Edition, M.N Rao, BS Publications / BSP Books, 2020.
4. Integrated Solid Waste Management Engineering Principles and Management, Tchobanoglous, McGraw Hill, 2014.
5. Solid Waste Management (SWM), Vasudevan Rajaram, PHI learning private limited, 2016

REFERENCE BOOKS

1. Municipal Solid Waste Management, Christian Ludwig, Samuel Stucki, Stefanie Hellweg, Springer Berlin Heisenberg, 2012
2. Solid Waste Management Bhide A. D Indian National Scientific Documentation Centre, New Delhi Edition 1983 ASIN: B0018MZ0C2
3. Solid Waste Techobanoglous George; Kreith, Frank McGraw Hill Publication, New Delhi 2002, ISBN 9780071356237

4. Environmental Studies Manjunath D. L. Pearson Education Publication, New Delhi, 20061SBN-I3: 978-8131709122
5. Solid Waste Management Sasikumar K. PHI learning, New Delhi, 2009 ISBN 8120338693

PH47B3	SEWAGE AND WASTE WATER TREATMENT	L	T	P	C
		4	0	0	4

OBJECTIVES

- To gain basic knowledge in sewage and waste water Treatment procedures
- To gain industry exposure and be equipped to take up job.
- To harness entrepreneurial skills.
- To analyze the status of sewage and waste water management in the nearby areas.
- To sensitize the importance of healthy practices in waste water management

Course Outcome		Cognitive Skill
CO-01	Gained knowledge in solid waste management	R,U, A, An, E, S
CO-02	Equipped to take up related job by gaining industry exposure	R,U, A, An, E,S
CO-03	Develop entrepreneurial skills	R,U, A, An, E, S
CO-04	Will be able to analyze and manage the status of the solid wastes in the nearby areas	R,U, A, An, E, S
CO-05	Adequately sensitized in managing solid wastes in and around his/her locality	R,U, A, An, E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	S	M
CO-02	S	S	S	S
CO-03	S	M	M	S
CO-04	M	S	S	S
CO-05	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Recovery & Reuse Of Water **9**

Recovery & Reuse of water from Sewage and Waste water: Methods of recovery: Flocculation - Sedimentation - sedimentation with coagulation - Filtration - sand filters - pressure filters - horizontal filters - vector control measures in industries - chemical and biological methods of vector eradication

Unit II: Disinfection **9**

Disinfection: Introduction to disinfection and sterilization: Disinfectant - UV radiation - Chlorination - Antisepsis - Sterilant - Aseptic and sterile -Bacteriostatic and Bactericidal - factors affecting disinfection.

Unit III: Chemical Disinfection **9**

Chemical Disinfection: Introduction - Theory of Chemical Disinfection - Chlorination Other Chemical Methods - Chemical Disinfection Treatments Requiring - Electricity - Coagulation/Flocculation Agents as Pretreatment - Disinfection By-Products(DBPs)

Unit Iv: Physical Disinfection **9**

Physical Disinfection: Introduction - Ultraviolet Radiation - Solar Disinfection - Heat Treatment - Filtration Methods - Distillation - Electrochemical Oxidation Water Disinfection by Microwave Heating.

Unit V: Industrial Application **9**

Compliance with Environmental Regulations - Water Conservation and Reuse - Pollution Prevention- Industrial Process Water Supply - Industrial Pre-Treatment - Industrial Effluent Monitoring - Water Resource Protection - Industrial Cooling Water - Odor and Pollution Control - Sustainable Agriculture- Sustainable Development Goals

TOTAL: 45 HOURS

TEXT BOOKS:

1. Anirudhha Balachandra. Drinking water and disinfection technique,. CRC press, 2013.
2. Shashi Bushan, Jain Bros. Design of Water and Wastewater Treatment Systems (CV-424/434), 2015
3. Sarbhukan M M, Integrated Water Resources Management. CBS PUBLICATION, 2013.
4. C.S. Rao, Environmental Pollution Control Engineering, New Age International, 2007
5. S.P. Mahajan, Pollution control in process industries, 27th Ed. Tata McGraw Hill Publishing Company Ltd., 2012.

REFERENCE BOOKS:

1. Handbook of Water and Wastewater Treatment Plant Operations, Frank. R Spellman, CRC Press, 2020
2. Wastewater Treatment Technologies, Mritunjay Chaubey, Wiley, 2021.
3. Metcalf and Eddy, Wastewater Engineering, 4th ed., McGraw Hill Higher Edu., 2002.

4. W. Wesley Eckenfelder, Jr., Industrial Water Pollution Control, 2nd Edn., McGraw Hill Inc., 1989
5. Lancaster, Green Chemistry: An Introductory Text, 2nd edition, RSC publishing, 2010.

PH47B4	MICROPROCESSOR AND MICROCONTROLLER	L	T	P	C
		4	0	0	4

OBJECTIVES

- To provide an understanding of the architecture and functioning of microprocessor 8085A and to the methods of interfacing I/O devices and memory to microprocessor
- To introduce 8085A programming and applications and the architecture and instruction sets of microcontroller 8051.

Course Outcome		Cognitive Skill
CO-01	Gain knowledge of architecture and working of 8085 microprocessor.	R,U, A, An, E, S
CO-02	Get knowledge of architecture and working of 8051 Microcontroller.	R,U, A, An, E,S
CO-03	Be able to write simple assembly language programs for 8085A microprocessor.	R,U, A, An, E, S
CO-04	Able to write simple assembly language programs for 8051 Microcontroller.	R,U, A, An, E, S
CO-05	Understand the different applications of microprocessor and microcontroller.	R,U, A, An, E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	S	M
CO-02	S	S	S	S
CO-03	S	S	M	S
CO-04	M	S	S	S
CO-05	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: 8085 Programming, Peripheral Devices and Their Interfacing 9

Instruction set - Addressing modes - Programming techniques - Memory mapped I/O scheme- I/O mapped I/O scheme - Memory and I/O interfacing- Data transfer schemes - Interrupts of 8085 - Programmable peripheral interface (PPI) - Control group and control word- Programmable DMA controller - Programmable interrupt controller – Programmable communication interface - Programmable counter /interval timer.

Unit II: 8085 Interfacing Applications 9

Seven segment display interface - Interfacing of Digital to Analog converter and Analog to Digital converter - Stepper motor interface - Measurement of electrical quantities –Voltage and current) Measurement of physical quantities (Temperature an strain).

Unit III: 8051 Microcontroller Hardware 9

Introduction – Features of 8051 – 8051 Microcontroller Hardware: Pin-out 8051, Central Processing Unit (CPU), internal RAM, Internal ROM, Register set of 8051 – Memory organization of 8051 – Input/ Output pins, Ports and Circuits – External data memory and program memory: External program memory, External data memory.

Unit IV: 8051 Instruction Set And Assembly Language Programming 9

Addressing modes – Data moving (Data transfer) instructions: Instructions to Access external data memory, external ROM / program memory, PUSH and POP instructions, Data exchange instructions – Logical instructions: byte and bit level logical operations, Rotate and swap operations – Arithmetic instructions: Flags, Incrementing and decrementing, Addition, Subtraction, Multiplication and division, Decimal arithmetic – Jump and CALL instructions: Jump and Call program range, Jump, Call and subroutines – Programming.

Unit V: Interrupt Programming And Interfacing To External World 9

8051 Interrupts – Interrupt vector table – Enabling and disabling an interrupt – Timer interrupts and programming – Programming external hardware interrupts – Serial communication interrupts and programming – Interrupt priority in the 8051 : Nested interrupts , Software triggering of interrupt. LED Interface Seven segment display interface- Interfacing of Digital to Analog converter and Analog to Digital converter - Stepper motor interface - Measurement of electrical quantities – Voltage and current) Measurement of physical quantities(Temperature an strain).

TOTAL: 45 HOURS

TEXT BOOKS:

1. NagoorKani, Microprocessors & Microcontrollers, RBA Publications, 2009.
2. P. Godse and D. A. Godse, Microprocessors, Technical Publications, Pune, 2009.
3. Ramesh Gaonkar, Microprocessor Architecture, Programming and Applications with 8085, Penram International Publishing, 2013.
4. Ram, Fundamentals of Microprocessors & Microcontrollers, DhanpatRai publications New Delhi, 2016.
5. V. Vijayendran, Fundamentals of Microprocessor-8085", 3rd Edition S.Visvanathan Pvt, Ltd. 2005

REFERENCE BOOKS:

1. Douglas V. Hall, Microprocessors and Interfacing programming and Hardware, Tata Mc Graw Hill Publications, 2008.
2. Muhammad Ali Mazidi, Janice GillispieMazidi, Rolin D. Mckinlay, The 8051 Microcontroller and Embedded Systems, Pearson Education, 2008.
3. Barry B. Brey, The Intel Microprocessors 8086/8088, 80186, 80286, 80386 and 80486, 3rd Edition, Prentice- Hall of India, New Delhi. 1995
4. J. Uffrenbeck, "The 8086/8088 Family-Design, Programming and Interfacing, Software, Hardware and Applications", Prentice-Hall of India, New Delhi.
5. W. A. Tribel, Avtar Singh, "The 8086/8088 Microprocessors: Programming, Interfacing, Software, Hardware and Applications", Prentice-Hall of India, New Delhi.

PH47B5	CHARACTERIZATION OF MATERIALS	L	T	P	C
		4	0	0	4

OBJECTIVES

- To make the students learn some important thermal analysis techniques namely TGA, DTA, DSC and TMA.
- To make the students understand the theory of image formation in an optical microscope and to introduce other specialized microscopic techniques.
- To make the students learn and understand the principle of working of electron microscopes and scanning probe microscopes.
- To make the students understand some important electrical and optical characterization techniques for semiconducting materials.
- To introduce the students the basics of x-ray diffraction techniques and some important spectroscopic techniques.

Course Outcome		Cognitive Skill
CO-01	Describe various thermal analytic techniques and make interpretation of the results.	R,U, A, An, E, S
CO-02	Identify the concept of image formation in Optical microscope, developments in other specialized microscopes and their applications.	R,U, A, An, E,S
CO-03	Explain the working principle and operation of different types of microscopes	R,U, A, An, E, S
CO-04	Understand Hall measurement, four –probe resistivity measurement, C-V, I-V, Electrochemical, Photoluminescence and electroluminescence experimental techniques with necessary theory.	R,U, A, An, E, S
CO-05	Compare the theory and experimental procedure for x- ray diffraction and some important spectroscopic techniques and their applications	R,U, A, An, E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	S	S
CO-02	S	M	S	S
CO-03	S	S	M	M
CO-04	S	M	S	M
CO-05	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Thermal Analysis **9**

Introduction – thermogravimetric analysis (TGA) – instrumentation – determination of weight loss and decomposition products – differential thermal analysis (DTA)- cooling curves – differential scanning calorimetry (DSC) – instrumentation – specific heat capacity measurements – determination of thermo mechanical parameters.

Unit II: Microscopic Methods **9**

Optical Microscopy: optical microscopy techniques – Bright field optical microscopy – Dark field optical microscopy – Dispersion staining microscopy - phase contrast microscopy –differential interference contrast microscopy - fluorescence microscopy - confocal microscopy - - digital holographic microscopy - oil immersion objectives - quantitative metallography - image analyzer.

Unit III: Electron Microscopy And Scanning Probe Microscopy **9**

SEM, EDAX, EPMA, TEM: working principle and Instrumentation – sample preparation – Data collection, processing and analysis- Scanning tunneling microscopy (STEM) - Atomic force microscopy (AFM) - Scanning new field optical microscopy.

Unit IV: Electrical And Optical Characterization **9**

Two probe and four probe methods- van der Pauw method – Hall probe and measurement – scattering mechanism – C-V characteristics – Schottky barrier capacitance – impurity concentration – electrochemical C-V profiling – limitations. Photoluminescence – light – matter interaction – instrumentation – electroluminescence – instrumentation – Applications.

Unit V: X-Ray And Spectroscopic Methods **9**

Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy, Raman spectroscopy, ESR, NMR, NQR, XPS, AES and SIMS-proton induced X-ray Emission spectroscopy (PIXE) – Rutherford Back Scattering (RBS) analysis-application - Powder diffraction - Powder

diffractometer -interpretation of diffraction patterns - indexing - phase identification - residual stress analysis - Particle size, texture studies - X-ray fluorescence spectroscopy - uses.

TOTAL: 45 HOURS

TEXT BOOKS:

1. R. A. Stradling and P. C. Klipstain. Growth and Characterization of semiconductors. Adam Hilger, Bristol, 1990.
2. J. A. Belk. Electron microscopy and microanalysis of crystalline materials. Applied Science Publishers, London, 1979.
3. Lawrence E. Murr. Electron and Ion microscopy and Microanalysis principles and Applications. Marcel Dekker Inc., New York, 1991
4. D. Kealey and P. J. Haines. Analytical Chemistry. Viva Books Private Limited, New Delhi, 2002.
5. Li, Lin, Ashok Kumar Materials Characterization Techniques Sam Zhang; CRC Press, (2008).

REFERENCE BOOKS:

1. Cullity, B.D., and Stock, R.S., "Elements of X-Ray Diffraction", Prentice-Hall, (2001).
2. Murphy, Douglas B, Fundamentals of Light Microscopy and Electronic Imaging, Wiley-Liss, Inc. USA, (2001).
3. Tyagi, A.K., Roy, Mainak, Kulshreshtha, S.K., and Banerjee, S., Advanced Techniques for Materials Characterization, Materials Science Foundations (monograph series), Volumes 49 – 51, (2009).Volumes 49 – 51, (2009).
4. Wendlandt, W.W., Thermal Analysis, John Wiley & Sons, (1986).
5. Wachtman, J.B., Kalman, Z.H., Characterization of Materials, ButterworthHeinemann, (1993).

PH47B6	MEDICAL PHYSICS	L	T	P	C
		4	0	0	4

OBJECTIVES

- To understand the major applications of Physics to Medicine
- To study the aid of different medical devices such as X-ray machines, gamma camera, accelerator and nuclear magnetic resonance.
- To outline the principles of Physics of different medical radiation devices and their modern advances, especially in medical radiation therapy and different applications in medical physics.
- To introduce the ideas of Radiography.
- To form a good base for further studies like research.

Course Outcome		Cognitive Skill
CO-01	To learn the fundamentals, production and applications of X-rays.	R,U, A, An, E, S
CO-02	To understand the basics of blood pressure measurements.	R,U, A, An, E,S
CO-03	To apply knowledge on Radiation Physics	R,U, A, An, E, S
CO-04	To Analyze Radiological imaging and filters	R,U, A, An, E, S
CO-05	Assess the principles of radiation protection	R,U, A, An, E,S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	S	S	M
CO-02	S	S	S	S
CO-03	S	S	M	S
CO-04	S	S	M	S
CO-05	S	S	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: X-Rays And Transducers **9**

Electromagnetic Spectrum – Production of X-Rays – X-Ray Spectrum –Bremsstrahlung – Characteristic X-Ray – X-Ray Tubes – Coolidge Tube – X-Ray Tube Design – Thermistors – photo electric transducers – Photo voltaic cells – photo emissive cells –Photoconductive cells– piezoelectric transducer

Unit II: Blood Pressure Measurements **9**

Introduction –sphygmomanometer – Measurement of heart rate – basic principles of electrocardiogram (ECG) –Basic principles of electro-neurography (ENG) – Basic principles of magnetic resonance imaging (MRI).

Unit III: Radiation Physics **9**

Radiation Units – Exposure – Absorbed Dose – Rad to Gray – Kera Relative Biological Effectiveness –Effective Dose – Sievert (Sv) – Inverse Square Law – Interaction of radiation with Matter – Linear Attenuation Coefficient – Radiation Detectors –Thimble Chamber – Condenser Chambers – Geiger Counter – Scintillation Counter.

Unit IV: Medical Imaging Physics **9**

Radiological Imaging – Radiography – Filters – Grids – Cassette – X-Ray Film – Film processing – Fluoroscopy – Computed Tomography Scanner – Principal Function – Display – Mammography – Ultrasound Imaging – Magnetic Resonance Imaging – Thyroid Uptake System – Gamma Camera (Only Principle, Function and display).

Unit V: Radiation Protection **9**

Principles of Radiation Protection – Protective Materials – Radiation Effects – Somatic – Genetic Stochastic and Deterministic Effect – Personal Monitoring Devices – TLD Film Badge – Pocket Dosimeter.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Dr. K. Thayalan , Basic Radiological Physics, Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi, 2003.
2. Curry, Dowdey and Murry, Christensen's Physics of Diagnostic Radiology: - LippincotWilliams and Wilkins, 1990.
3. FM Khan, Physics of Radiation Therapy, William and Wilkins, 3rd ed, 2003.
4. D. J. Dewhurst, An Introduction to Biomedical Instrumentation, 1st ed, Elsevier Science, 2014.
5. R.S. Khandpur, Hand Book of Biomedical Instrumentations, 1st ed, TMG, New Delhi, 2005.

REFERENCE

1. Muhammad Maqbool, An Introduction to Medical Physics, 1st ed, Springer International Publishing, 2017.
2. Daniel Jirák, FrantišekVítek, Basics of Medical Physics, 1st ed, Charles University, Karolinum Press, 2018
3. Anders Brahme, Comprehensive Biomedical Physics, Volume 1, 1st ed, Elsevier Science, 2014.

4. K. Venkata Ram, Bio-Medical Electronics and Instrumentation, 1st ed, Galgotia Publications, New Delhi, 2001.
5. John R. Cameron and James G. Skofronick, 2009, Medical Physics, John Wiley Interscience Publication, Canada, 2nd edition.

PH47B7	INTELLECTUAL PROPERTY RIGHTS	L	T	P	C
		4	0	0	4

OBJECTIVES

- Understanding different types of intellectual properties (IPs) and their roles.
- To create an awareness of IP and its values
- Differentiate the patentable and non patentable items

Course Outcome		Cognitive Skill
CO-01	To give an idea about IPR and its various types	R,U,A,An,
CO-02	To learn about registration procedure of patents	R,U,A,E
CO-03	To gain knowledge about copyrights	R,U,A,E
CO-04	To acquire knowledge of different kinds of trade marks	R,U,A,An,E
CO-05	To know various opportunities for IPR	R,U,A,An,E

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	M	M	S	S
CO-02	S	S	M	S
CO-03	S	M	M	S
CO-04	S	M	M	S
CO-05	S	M	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Overview of Intellectual Property **9**

Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Patent Law, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - Trademark Law- IPR in India : Genesis and development – IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967, the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994. International Intellectual Property Framework

Unit II: Patents **9**

Patents - Elements of Patentability: Novelty , Non Obviousness (Inventive Steps), Industrial Application - Non - Patentable Subject Matter - Examining exceptions and limitations to patentability- Registration Procedure - Examination and evaluation of patent applications -Rights and Duties of Patentee - obligations and responsibilities of patentees, Assignment and licence , Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties - Patent office and Appellate Board

Unit III: Copyrights **9**

Nature of Copyright - rights granted under copyright law, including reproduction, distribution, public performance, and adaptation rights- Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings - Registration Procedure, Term of protection - duration of copyright protection, Ownership of copyright, Assignment and licence of copyright - Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights

Unit IV: Trademarks **9**

Concept of Trademarks - role of trademarks in brand recognition, consumer protection, and market competition. Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks - limitations and exceptions to trademark registration - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - Trademarks registry and appellate board

Unit V: Other forms of IP and Careers opportunities **9**

Design: meaning and concept of novel and original - criteria for determining the novelty and originality of designs.- Procedure for registration, effect of registration and term of protection

Geographical indication: meaning, and difference between GI and trademarks - Procedure for registration, effect of registration and term of protection Plant Variety Protection - term of protection for registered geographical indications and the possibility of renewal.

Plant variety protection: meaning and benefit sharing and farmers' rights – Procedure for registration - requirements, examination process, and documentation., effect of registration and term of protection

Layout Design Protection

Layout Design protection: meaning – Procedure for registration including the requirements, application process, and documentation. effect of registration and term of protection Career Opportunities in IP - IPR in current scenario with case studies.

TOTAL: 45 HOURS

TEXT BOOK:

1. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis. ISBN 9788131251652
2. V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India Pvt Ltd, 2016 978-8120352650

REFERENCE

1. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
2. Sople V (2016) Managing Intellectual Property: The Strategic Imperative PHI Learning PVT. LTD. 9788120352650
3. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
4. S. V. Satakar, - Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi, 2002
5. Deborah E. Bouchoux, ―Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets, Cengage Learning, Third Edition, 2012.
6. Prabuddha Ganguli,Intellectual Property Rights: Unleashing the Knowledge Economy, McGraw Hill Education, 2011.
7. Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.
8. Ganguli Prabuddha Gearing up for Patents…..The Indian Scenario", Universities Press (1998).
9. Ganguli Prabuddha "Intellectual Property Rights--Unleashing the Knowledge Economy", Tata McGrawHill (2001)

PH47B8	ASTRONOMY AND ASTROPHYSICS	L	T	P	C
		4	0	0	4

OBJECTIVES

- To have a solid grounding in the underlying principles and important conceptual models from core subject areas of astronomy and astrophysics and demonstrate their ability to correctlydraw logical conclusions from these principles and models, enabling them to make accurate quantitative predictions in astronomical contexts.
- Be inspired to continue and share their interest in astronomical advances and discoveriesthroughout their lives.

Course Outcome		Cognitive Skill
CO-01	The students will be able to define and use the terms star, planet, galaxy, universe and define light year, astronomical unit and relate these to the size of the above objects	R,U,A,An,E
CO-02	The students will be able to understand the significance of local thermodynamic equilibrium and non local thermodynamic equilibrium and the sources of opacity in stellar atmospheres.	R,U,A,An,E
CO-03	The students will be able to outline a broad model of stellar evolution based on the observed properties of large numbers of stars, and describe how stars of different initial mass might evolve.	R,U,A,An,E
CO-04	The students will be able to explain the physical principles and derive the equations governing the structure of stars.	R,U,A,An,E
CO-05	The students will be able to list and explain various nucleosynthesis processes in the context of stellar evolution.	R,U,A,An,E

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	M	S	S
CO-02	S	S	M	S
CO-03	S	M	M	S
CO-04	S	M	M	S
CO-05	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I: General Astronomy **9**

System of Coordinates – Time – Stellar Parallaxes – The Proper Motion – Stellar Magnitudes – Stellar Classification – Saha‟s ionization formula.

UNIT II: Stellar Atmosphere I **9**

Stellar Masses – Radiative Transfer – Local Thermodynamic Equilibrium – Detailed Balancing – Basic Definitions –Energy Density – Mass Emission Coefficient – Mass Absorption Coefficient – Equation of Transfer –Solution of Transfer – Chandrasekhar‟s Method.

UNIT III: Stellar Atmosphere II **9**

Model Atmosphere–Theory of Absorption Lines –Basic Theory – Line Formation –The Line Profile –Collisional Broadening –Doppler Broadening –Natural Broadening – Virial Theorem.

UNIT IV: Stellar Structure **9**

Hydrostatic Equilibrium–Thermodynamics of a Mixture of Gas and radiation –Radiative and Convective Transport of Energy –Standard Model –Convective Energy Transport –Mixing Length.

UNIT V: Stellar Energy and Nucleosynthesis **9**

Energy Sources –Helmholtz-Kelvin Hypothesis –Nuclear Reactions as a Possible Energy Source– Energetics of Nuclear Reactions –Reaction Cross-Section and Reaction Rates – The Neutrino Problem –Nucleosynthesis–Origin of Elements.

TOTAL: 45 HOURS

TEXT BOOKS

1. Text book of Astronomy and Astrophysics with elements of Cosmology, V. B.Bhatia, Narosa Publishing House, New Delhi, 2001.

REFERENCES

1. An Introduction to Astrophysics, Second Edition,BaidyanathBasu, TanukaChattopadhyay, SudhindraNathBiswas, PHI Learning Private Limited, New Delhi 2010.
2. An Introduction to Astrophysics, BaidyanathBasu, Prentice Hall of India Private Limited, New Delhi 2003.
3. Astrophysics for Physicists, ArnabRaiChoudhuri, Cambridge University Press, New Delhi 2010.
4. Particle Astrophysics, Donald Perkins, Oxford University Press, New York 2003.
5. Modern Astronomy, C. Sivaram, KenathArun, Ane Books Pvt. Ltd.,New Delhi 2009.

		L	T	P	C
PH47C1	**CERTIFICATE COURSE - SUSTAINABLE GREEN ENERGY PRODUCTION**	**2**	**0**	**0**	**2**

OBJECTIVES

- To provide an understanding of the various types of biofuels and their significance in the context of sustainable energy production.
- To explore the selection criteria for different biomass feedstocks and evaluate their characteristics, availability, and sustainability for biofuel production.
- To study the conversion processes and technologies involved in the production of biofuels, including transesterification, fermentation, pyrolysis, and gasification.
- To examine the property, reaction kinetics, and optimization of biofuel production processes.
- To delve into specific biofuel production methods such as biodiesel and bioethanol, including their respective production processes, quality control, and blending

Course Outcome		Cognitive Skill
CO-01	Students will be able to explain the significance of biofuels in the context of sustainable energy production and understand the different types of biofuels available.	R,U,A,An,E
CO-02	Students will develop the ability to evaluate and select appropriate biomass feedstocks for biofuel production based on their characteristics, availability, and sustainability.	R,U,A,An,E
CO-03	Students will acquire knowledge of the conversion processes involved in biofuel production, their underlying chemistry, and the factors affecting reaction kinetics and process optimization.	R,U,A,An,E
CO-04	Students will gain practical skills in the production of biodiesel, including the transesterification process, catalyst selection, purification techniques, and quality control measures.	R,U,A,An,E
CO-05	Students will gain practical skills in the production of bioethanol, including saccharification, fermentation, distillation, and purification processes, as well as an understanding of ethanol fuel quality, blending considerations, and its application in E85 vehicles.	R,U,A,An,E

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	M	S	S
CO-02	S	S	M	S
CO-03	S	M	M	S
CO-04	S	S	S	S
CO-05	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Introduction to Biofuels

Overview of biofuels, their significance, and role in sustainable energy production. Types of biofuels, including biodiesel, bioethanol, biogas, and advanced biofuels.

Unit II: Feedstock Selection

Evaluation of different biomass feedstocks for biofuel production. Characteristics, availability, and sustainability considerations. Crop-based feedstocks, algae, waste materials, and lignocellulosic

Unit III: Biomass
Introduction to biomass as a renewable energy source. Biofuel Production Technologies: Conversion processes for biofuel production, including transesterification, fermentation, pyrolysis, and gasification. Process chemistry, reaction kinetics, and optimization.

Unit IV: Biodiesel Production
Production of biodiesel from vegetable oils and animal fats. Transesterification process, catalyst selection, and reaction conditions. Purification, characterization, and quality control of biodiesel.

Unit V: Bioethanol Production
Production of bioethanol from starch-based and lignocellulosic feedstocks. Saccharification, fermentation, distillation, and purification processes. Ethanol fuel quality, blending, and E85 vehicle.

TEXT BOOKS

1. Introduction to Bioenergy by Vaughn Nelson and Kenneth Starcher (2019)
2. Biofuels Engineering and Technology: Concepts and Advances by Shibu Jose, Thallada Bhaskar, and Ashok Pandey (2010)
3. Biofuels: Alternative Feedstocks and Conversion Processes by Ashok Pandey, Christian Larroche, and Edgard Gnansounou (2011)

REFERENCES

1. Biofuels: Production, Applications, and Development by David M. Mousdale (2017)
2. Bioenergy: Biomass to Biofuels by Anju Dahiya (2019)
3. Biofuels Engineering Process Technology by Caye M. Drapcho, John Nghiem, and Terry H. Walker (2008)

PH XXXX	INDIAN KNOWLEDGE SYSTEM	L	T	P	C
		4	0	0	4

Objectives:
To explore ancient Indian scientific knowledge, Vedic cosmology, astronomy, Pancha Bhootas, Tamil inscriptions, and sustainable lifestyles, emphasizing their historical, philosophical, and practical significance.

Subject Code: PHxxxx	Subject Name: Indian Knowledge System	
Course Outcome -COs		**Cognitive Skill**
CO-01	Gain a comprehensive understanding of the Vedic period, ancient Indian scientific knowledge, and its impact on modern science.	R,U, A,An,
CO-02	Understand Vedic cosmological views, astronomical calculations, and the significance of Panchangam in maintaining Vedic calendars and linking festivals to astronomical events.	R,U, A, E
CO-03	Learn about the Pancha Bhootas' philosophical and cosmological significance, their role in rituals, Ayurveda, and Vastu Shastra, and their interpretation in Indian philosophical schools.	R,U, A An,E,
CO-04	Develop the ability to analyze Tamil inscriptions, understand the evolution of Tamil scripts, and appreciate the historical and cultural significance of different types of inscriptions.	R,U, An,E,
CO-05	Recognize ancient South Indian sustainable agricultural, water management, architectural techniques, and resource management practices, and their relevance to contemporary sustainability efforts.	R,U, A,An,E,

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	M	S	S	S
CO-02	S	S	S	S
CO-03	S	S	S	S
CO-04	S	S	M	S
CO-05	S	S	S	M

Unit I: Introduction to Vedic Physics

Historical Context and Foundations: Introduction to the Vedic period and literature - Overview of scientific knowledge in ancient India - Key texts related to Vedic physics (e.g., Rigveda, Samaveda).Vedic Cosmology: Vedic views on the creation and structure of the universe - Concepts of time and space in Vedic literature - Role of deities and divine forces in cosmology - Scientific methods used by Vedic scholars

Unit II: Astronomy and Panchangam

Basic astronomical concepts from the Vedic period: Nakshatras (lunar mansions), Tithis (lunar days), and planetary movements - Study of the Vedanga Jyotisha - Significance of this text in Vedic astronomy. Astronomical Calculations: Methods for calculating lunar months, solar years, and intercalary months (Adhika Masa). Importance of these calculations in maintaining the Vedic calendar. The Panchangam - Components of Panchangam - understanding of the five elements: Tithi (lunar day), Vara (weekday), Nakshatra (constellation), Yoga (auspicious period), and Karana (half of a Tithi). Types of Panchangam - Different types of Panchangam used in various regions of India. Lunar and Solar Calendars -Differences between lunar and solar calendars in the Vedic context- Festivals and Astronomy - festivals linked to astronomical events: solstices, equinoxes, and eclipses. Vedic understanding of solar and lunar eclipses.

Unit III: Pancha Bhootas

Pancha Bhootas: Earth (Prithvi), Water (Apas), Fire (Agni), Air (Vayu), and Ether (Akasha) -The philosophical and cosmological significance of these elements in Vedic literature -Symbolic representations and attributes associated with each element -Importance of the Pancha Bhootas in Vedic rituals (Yajnas) and ceremonies- Integration of the Pancha Bhootas in daily Vedic practices and lifestyle- Role of the Pancha Bhootas in Tridosha (Vata, Pitta, Kapha) in Siddha and Ayurveda -Role of the Pancha Bhootas in Vastu Shastra (traditional Indian architecture and traditional Tamil architecture and space planning) - Interpretations of the Pancha Bhootas in various Indian philosophical schools (Samkhya, Yoga, Vedanta).

Unit IV: Inscription

Evolution of writing systems in Tamil Nadu: from Tamil-Brahmi to Vatteluttu and Grantha - Importance of inscriptions as primary historical sources. Types of Inscriptions: Classification: Royal inscriptions, temple inscriptions, hero stones (Nadukal), and copper plate inscriptions. Materials used: Stone, metal, and other mediums. Scripts and Languages: Development of Tamil script from early Tamil-Brahmi to modern Tamil. Epigraphic Conventions: Analysis of common epigraphic terms and formulas used in Tamil inscriptions. Royal Inscriptions: Chola Inscriptions - Pandya and Pallava Inscriptions - Temple Inscriptions- Copper Plate Inscriptions –Palm leaf inscription

Unit V: Ancient sustainable life style

Introduction to various ancient South Indian civilizations and dynasties: Cholas, Pandyas, Cheras, and Pallavas. Agricultural Techniques: Traditional farming methods: mixed cropping, crop rotation, and use of natural fertilizers. Indigenous techniques like the use of cow dung and green manure. Food Preservation and Storage: Techniques for preserving food: sun drying, pickling, and fermentation - Community granaries and their role in food security. Ancient Irrigation Techniques: tanks (Eris), canals, and wells - Techniques of rainwater harvesting and the construction of check dams and percolation ponds - Role of sacred groves (Kavu) and temple tanks in water conservation. Sustainable Architecture and Urban Planning - Eco-friendly Building Materials – Usage of laterite, granite, bamboo, and clay. Traditional architectural techniques for maintaining thermal comfort, such as thatched roofs and lime plaster. Daily Life and Resource Management - Energy Use and Conservation: Use of renewable energy sources like biofuel and wind - Techniques for efficient energy use in cooking, heating, and lighting.

Text books:

1. Bhag Chand Chauhan. Textbook on The Knowledge System of Bhārata, Garuda Prakashan Pvt. Ltd. (2023)
2. Sibaji Raha, et al. Histrory of Science in India Volume-1, Part-I, Part-II, Volume VIII, bNational Academy of Sciences, India and The Ramkrishan Mission Institute of Culture, Kolkata (2014)
3. B. Mahadevan, Vinayak Rajat Bhat, and R.N. Nagendra Pavana, Introduction to Indian Knowledge System: Concepts and Applications, PHI Learning Private Limited, New Delhi (2022).

Reference Books:

1. Pradeep Kohle et al. Samskrit Bharati Pride of India- A Glimpse of India's Scientific Heritage (2006).
2. Keshav Dev Verma Vedic Physics, Motilal Banarsidass Publishers (2012).
3. Suresh Soni, India's Glorious Scientific Tradition, Ocean Books Pvt. Ltd. (2010)
4. S. N. Sen and K. S. Shukla, History of Astronomy in India, Indian National Science Academy, 2nd edition, New Delhi, (2000).