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 2021

NOORUL ISLAM CENTRE FOR HIGHER EDUCATION
Kumaracoil - 629 180, Kanyakumari District, Tamil Nadu, India
www.niuniv.com info@niuniv.com
+91-9486856101, 04651-250566

Regulation: 2021

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

Mapping of Graduate Attributes and Programme Outcome (PO)

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**

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.	PH3701	Mathematical Physics-I	3	1	0	4
2.	PH3702	Classical Mechanics	3	1	0	4
3.	PH3703	Quantum Mechanics-I	3	1	0	4
4.	PH3704	Electronics and Microprocessor	3	1	0	4
PRACTICAL						
5	PH3771	Electronics Laboratory	0	0	6	3
6	PH3772	Non- Electronics Laboratory	0	0	6	3
TOTAL			**12**	**4**	**12**	**22**

SEMESTER II

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	PH3705	Mathematical Physics-II	3	1	0	4
2.	PH3706	Quantum Mechanics-II	3	1	0	4
3.	PH3707	Electromagnetic Theory	3	1	0	4
4.	PH3708	Thermodynamics and StatisticalPhysics	3	1	0	4
5.	PH37S1	Basic Biophysics	3	1	0	4
PRACTICAL						
6	PH3773	Solid State Physics Laboratory	0	0	6	3
7	PH3774	Advanced Optics Laboratory	0	0	6	3
TOTAL			**15**	**5**	**12**	**26**

SEMESTER III

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	PH3709	Atomic and Molecular Physics	3	1	0	4
2.	PH3710	Nuclear and Particle Physics	3	1	0	4
3.	PH3711	Condensed Matter Physics	3	1	0	4
4.	PH37S2	Renewable Energy	3	1	0	4
PRACTICAL						
5	PH3775	Microprocessor and C++ programming Laboratory	0	0	6	3
6	PH37P1	Mini project	0	0	5	5
TOTAL			**12**	**5**	**11**	**24**

SEMESTER IV

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	PH37AX	Elective I	3	1	0	4
2.	PH37AX	Elective II	3	1	0	4
3.	PH3777	Problem Solving Skills	1	1	0	2
PROJECT						
1.	PH37P2	Project and Viva-Voce	0	0	12	8
TOTAL			**7**	**3**	**12**	**18**

Syllabus Format

SEMESTER I

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	PH3701	Mathematical Physics-I	3	1	0	4
2.	PH3702	Classical Mechanics	3	1	0	4
3.	PH3703	Quantum Mechanics-I	3	1	0	4
4.	PH3704	Electronics and Microprocessor	3	1	0	4
PRACTICAL						
5	PH3771	Electronics Laboratory	0	0	6	3
6	PH3772	Non- Electronics Laboratory	0	0	6	3
TOTAL			**12**	**4**	**12**	**22**

PH3701	MATHEMATICAL PHYSICS I	L	T	P	C
		3	**1**	**0**	**4**

OBJECTIVES

- To think logically and approach real life problems.
- To enhance problem solving skills.
- To develop knowledge in mathematical physics and its applications.

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	Understand different types of matrices and their role in physics.	R,U,A,E
CO-04	The role of groups in physics can be understood.	R,U,A,E
CO-05	Different types of differential equations and their importance in solvingproblems 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- Gradient of a scalar filed, point function, 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 -physical interpretation, Gauss theorem, Green theorem, Poisons equations and Laplace equation with solution- Stokes theorem- classification of vector fields, application of vectors (equation of continuity, Eulers equation of motion, Bernoulli's)

Unit III: Matrices and Tensor **9**

Matrix types – special matrices - properties – rank of matrix- solution of linear equations- characteristic roots and vectors of matrix (eigen values and eigen vectors), Cayley-Hamilton Theorem, matrixes in physics (rotation matrix, pauli spin matrices, dirac matrices).Tensors- Introduction-Algebric operations- tpes- Application of Tensors (dynamics of a particle, tensors in elasticity, tensors in rigid bodies)

Unit IV Special Functions **9**

Gamma and Beta functions-Legueree, Bessel, Hermite differential equations and their solutions – Generating functions – Orthogonality relations – Important recurrence relations.

Unit V: Ordinary Differential equations **9**

Solution for linear differential equation of first order, power series solution: frobenius method-linear independence of solution, Legendre differential equation, functions, generating function, Rodrigues formula, orthogonality properties.

TOTAL: 45 HOURS

TEXT BOOKS

1. Mathematical Physics by H K Dass & Ramavarma, S Chand 2014 ISBN 81 219 1469 8 Seventeenth Edition
2. B.D. Gupta, *Mathematical Physics* (Vikas, Publishing House Pvt Ltd., New Delhi, 2010). ISBN-13: 978-8125930969
3. SatyaPrakash, *Mathematical Physics* with Classical Mechanics 6th Revised Edition (Sultan Chand and Sons, New Delhi, 2014). ISBN-13: 978-8180549281
4. E. Butkov, *Mathematical Physics* (Addison Wesley, London, 1968) ISBN 13: 9780201007275
5. S.J. Guha I.C. Goyal Ajoy Ghatak Mathematical Physics (Macmillan, New Delhi, 2003). ISBN 13: 9780333925485
6. P.K. Chattopadhyay, *Mathematical Physics* (New Age International (P) Ltd, New Delhi, 2004) ISBN 81-224-0283-6
7. M.L.Jain,*Vector Spaces and Matrices in Physics*,*Alpha Science* International (2001) ISBN 0849309786

REFERENCES:

1. L.A. Pipes and L.R. Harvill, *Applied Mathematics for Engineering and Physicists* 3rd Edition (McGraw Hill, Singapore, 1971) ISBN 0-07-085577-3
2. George B. Arfken, Hans J. Weber, Frank E Harris *Mathematical Methods for Physicists: A Comprehensive Guide Seventh Edition (*Elsevier Publication, 2013) ISBN: 978-0-12-384654-9
3. G. B. Arfken and H. J. Weber, *Mathematical Methods for Physicists, 6th Edition: A Comprehensive Guide* (Academic Press, San Diego 2005). ISBN-13: 978-0120598762

PH3702	CLASSICAL MECHANICS	L	T	P	C
		3	1	0	4

OBJECTIVES

The course provides an understanding of Lagrangian and Hamiltonian formulation which enables solving of many complex problems in classical mechanics and provides the foundation for the modern understanding of dynamics

Course Outcome		Cognitive Skill
CO-01	Understand the basic concepts of Classical Mechanics	R,U, A, An
CO-02	Understand Lagrangian and Hamiltonian formalisms	U, A, An, E
CO-03	Reduce two body problem to a single body problem and constructenergy diagrams using the effective potential	R, U, A, An
CO-04	Understand the dynamics of rigid body and the basic principles ofspecial theory of relativity	U,A, An
CO-05	Solve the physical problems	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	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: Particle Dynamics **9**

Mechanics of a particle and system of particles - conservation laws – constraints –generalized coordinates –generalized velocity and force –virtual work – D‟Alembert‟s principle – Lagrange‟s equations –applications: simple pendulum and atwood‟s machine.

UNIT II: Lagrangian and Hamiltonian Formulation **9**

Techniques of the calculus of variations –Hamilton‟s principle of least action –Lagrange‟s equations from Hamilton‟s principle – conservation theorems and symmetry properties – Hamilton‟s equations of motion – generalised momentum and cyclic co-ordinates– canonical transformations – Poisson bracket: equation of motion in Poisson bracket form – Hamilton Jacobi theory – Harmonic oscillator problem as an example.

UNIT III: Two-body Central Force Problem **9**

Reduction to one body problem-Equations of motion and first integrals – classification of orbits – motion in a central force field – differential equation of the orbit – Kepler‟s problem –inverse square law of force– scattering in central force field – virial theorem- transformation of the scattering problem to laboratory frames.

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

Rigid body dynamics – angular momentum and inertia tensor –Euler‟s angles – Euler‟s equation of motion of a rigid body– force free motion of symmetrical top –non-inertial frames and pseudoforces. Theory of small oscillations – Normal modes - Linear triatomic molecules – forced vibrations and the effect of dissipative forces.

UNIT V: Special Theory of Relativity **9**

Postulates of relativity – Lorentz transformation – relativistic kinematics – E = mc2 – momentum four-vector for a particle – Lagrangian formulation of relativistic mechanics- relativistic invariance of physical laws.

TOTAL: 45 HOURS

TEXT BOOKS

1. Goldstein, H., (2011), Classical Mechanics, Pearson New
2. N.C. Rana and P.S. Joag (2001) Classical Mechanics - Tata McGraw-Hill
3. J.C.Upadyaya (2005), ClassicalMechanics ,RevisedEditon,Himalaya Publishing Company
4. G.Aruldas (2008 Print), ClassicalMechanics,Prentice Hall of India Pvt Ltd

REFERENCES:

1. R. G. Takwale and P. S. Puranik – Introduction to Classical Mechanics - Tata McGraw - Hill Publishing Company Ltd. (1989).
2. L.D. Landau and E.M. Lifshitz, Mechanics, Buttorworth-Heinemann (1976).
3. I.C. Percival and D. Richards, Introduction to Dynamics, Cambridge University Press (1983).
4. J.V. Jose and E.J. Saletan, Classical Dynamics: A Contemporary Approach, Cambridge University Press (1998).
5. E.T. Whittaker, A Treatise on the Analytical Dynamics of Particles and Rigid Bodies, 4th edition, Cambridge University Press (1989).
6. Sommerfeld - Mechanics – Academic Press, 1952

PH3703	QUANTUM MECHANICS I	L	T	P	C
		3	1	0	4

OBJECTIVES

The main aim is to teach basic quantum mechanical skills and to understand the various physical concepts of quantum mechanics.

Course Outcome		Cognitive Skill
CO-01	To apply the mathematical techniques and conceptual background required to understand the foundation of quantum mechanic	R,U,A, An
CO-02	To solve the Schrödinger equation to obtain wave functions for some physically important types of potential in one dimensional and three dimensional problems and estimate the shape of the wave function based on the shape of the potential.	U, A, An, E, S
CO-03	To interprets the wave function and apply operators to it to obtain information about a particles physical property such as position, momentum and energy	U, A, An
CO-04	Student calculates the different aspects of the angular momenta and spin	R, U, A, An ,E
CO-05	The student applies the perturbation theory, variational and approximation method to solve simple problems	R, U, A, 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: Foundation of Quantum Mechanics **9**

Inadequacy of classical mechanics, wave packets, uncertainty relations. Postulates of quantum mechanics. Schrodinger equations, probability interpretation, probability current density. Expectation values, Ehrenfest theorem, Stationary states. Hermitian operators and their properties, Eigen values and eigen functions .

UNIT II: One dimensional and three dimensional problems **9**

Particle in a box, potential step, square well potential, rectangular barrier potential, Harmonic oscillator. Three dimensional problems- Spherically symmetric potential, Harmonic oscillator, spherical harmonics, hydrogen atom.

UNIT III: General formalism of Quantum Mechanics **9**

Hilbert space, commutation relations, Representation of states and dynamic variables, Completeness of eigen functions. Dirac delta function, bra and ket notation, Time evolution, Schrodinger, Heisenberg and Interaction pictures. Unitary Transformation.

UNIT IV: Angular Momentum **9**

Angular momentum, commutation relations, spin angular momentum, Eigen values of J2 and Jz, Eigen values of J+ and J- ,Pauli‟s Matrices, Addition of angular momenta, Clebsch-Gordon coefficients.

UNIT V: Approximation Methods **9**

Time independent perturbation theory for degenerate and non- degenerate states. Applications: Stark effect in hydrogen atom, Helium atom, Anharmonic oscillator; Variation method: Helium atom, WKB approximation-connection formulae.

TOTAL: 45 HOURS

TEXT BOOKS

1. L.I. Schiff, Quantum Mechanics, Tata McGraw Hill 4thedition (2014).
2. P.M. Mathews and K. Venkatesan, A Text Book of Quantum Mechanics, Tata McGraw Hill 2nd edition (2010)

REFERENCES:

1. E. Merzbacher, Quantum Mechanics,.John Wiley & Sons 3rd edition (1998)
2. V.K. Thankappan, Quantum Mechanics, NEW AGE INTERNATIONAL(P) LIMITED, PUBLISHERS 2nd Edition(1993)
3. P.A.M. Dirac, The Principles of Quantum Mechanics 3rd Edition (1965)
4. J.L. Powell and B. Crasemann, Quantum Mechanics Addison-Wesley Pub (1967)
5. Sathya Prakash, Quantum Mechanics, PragathiPrakasan Pub. (2015)
6. Sl, Gupta V.Kumar, Hv. Sharma, Quantum Mechanics Jai Prakash Nath Publications (2014)

PH3704	ELECTRONICS AND MICROPROCESSOR	L	T	P	C
		3	1	0	4

OBJECTIVES

- To understand the characteristics of op-amp and its various applications.
- To appreciate methods of connecting common peripheral devices.
- To understand the ways in which microprocessors can be used in automated systems.

Course Outcome		Cognitive Skill
CO-01	Able to understand the basic op-amp characteristics and its application in constructing various circuits	R,U, A, An, E, S
CO-02	Able to gain knowledge on the converters, types, application and how to design various converters	R,U, A, An, E,S
CO-03	Provides the knowledge on counters, registers its types and application	R,U, A, An, E, S
CO-04	Able to understand the basics, architecture of Microprocessr 8085 and gains knowledge on programming using 8085	R,U, A, An, E, S
CO-05	Provides the knowledge on 8086 microprocessor and able to understand the architecture of 8085	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	S	S

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

UNIT I: Applications Op-amp **9**

Op-Amp Circuits: Characteristics of ideal and practical op-amp; Nonlinear amplifiers using op-amps- Instrumentation amplifier - V to I and I to V converter - Sample and Hold circuits – constant current source. Log and Antilog amplifiers - Multiplier and Divider - Schimitt Trigger - Operating modes and functioning of 555 timer, Astable and MonostableMultivibrator - Triangular wave generators - Sine wave generators.

UNIT II: Converters **9**

Basic Summing Amplifier technique, Weighted D to A, BCD D/A Converter, Ladder R-2R network. Flash ADC and successive approximation ADCs, Integrating ADC/Dual Slope A/D Converter. Voltage Controlled Oscillator - voltage to time conversion - voltage to frequency conversion - frequency to voltage conversion.

UNIT III: Counters and Registers **9**

Asynchronous and Synchronous (up and down), Mode-N-counters, ring counters, Johnson counter and counters as frequency dividers. Basic shift resisters, Left right shift resistor, serial in and parallel out, Parallel in and serial-out, Parallel-in and Parallel-out shift resistors.

UNIT IV: Microprocessor –architecture-8085 **9**

Internal architecture of 8085 microprocessor – microcomputer system – microprocessor operation – system bus – control and status signals– pin out configuration – pin description – functional description- architecture – ALU – flags – registers-Instruction set (elementary operations).

UNIT V: Microprocessor –architecture-8086 **9**

Intel 8086-Pins Description-Operation of 8086-Lock operation and interrupt processing-8086 Bus cycles-Typical configuration of 8086 system-Addressing modes of Intel 8086- Instructions-Introduction to microcontrollers.

TOTAL: 45 HOURS

TEXT BOOKS

1. Millman and Halkias, Integrated Electronics, McGraw-Hill, New Delhi. 2010
2. Ramesh S. Gaonkar. Microprocessor Architecture, Programming, and Applications with the 8085 5th Edition. 2003.
3. Wadhwa and Ajay,Microprocessor 8085:Architecture,Programming & interfacing, Prentice Hall India Learning Private limited, 2010
4. B.Ram,Fundamentals of Microprocessors and Microcomputers, Dhanpat Rai publications (p) LTD. 2006

REFERENCES:

1. Milman and Halkias, Fundamental of Electronics Devices, McGraw-Hill, New Delhi.2001
2. R P Jain, Modern digital electronics, Tata mac‟Hill. 2003
3. J.D.Ryder, Electronics fundamental and application. 2004

4. Sunil Mathur, Microprocessor Architecture, Programming and Applications with the 8085, 5 th Edition, 2003.
5. Robert Dueck and Ken Reid, Digital electronics, Delmar Cengage Learning-1st edition,2011.
6. Sunil Mathur, Microprocessor 8086: Architecture, Programming and Interfacing, PHI Publishing 2010.
7. Krishna Kant, Microprocessors and Microcontrollers: Architecture, Programming and System Design 8085, 8086, 8051, 8096 Prentice-Hall of India Pvt.Ltd; 2nd Revised edition 2014.

PH3771	ELECTRONICS LABORATORY	L	T	P	C
		0	0	6	3

OBJECTIVES

To familiarize the students with the various electronics instruments and componentswhich 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 up in the vast field 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

1. Saw tooth wave generator
2. Square wave and triangular wave generator
3. Digital to Analog conversion
4. Astable multivibrator – using IC 555 Timer and operational amplifier
5. Modulus N counter using IC-7490
6. Monostable multivibrator – op amp
7. Flip flops using NAND gates
8. Wein's bridge oscillator
9. BJT CE Input and output Characteristics
10. Half adder and Full adder using IC 7408,IC 7486 and IC 7432
11. RC Frequency Response
12. RC Differentiator and Integrator

PH3772	NON ELECTRONICS LABORATORY	L	T	P	C
		0	0	6	3

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 materials analysis 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.	PH3705	Mathematical Physics-II	3	1	0	4
2.	PH3706	Quantum Mechanics-II	3	1	0	4
3.	PH3707	Electromagnetic Theory	3	1	0	4
4.	PH3708	Thermodynamics and StatisticalPhysics	3	1	0	4
5.	PH37S1	Basic Biophysics	3	1	0	4
PRACTICAL						
6	PH3773	Solid State Physics Laboratory	0	0	6	3
7	PH3774	Advanced Optics Laboratory	0	0	6	3
TOTAL			**15**	**5**	**12**	**26**

PH3705	**MATHEMATICAL PHYSICS II**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

OBJECTIVES

- To approach real life problems logically.
- 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	Can Learn about Fourier series and Fourier integral	R,U,A,An,
CO-02	Can able to solve various real time problems using laplace equation	R,U,A,E

CO-03	Can solve various transformation and its applications	R,U,A,E
CO-04	Get an idea about groups and its importance to solve the physical problem	R,U,A,E
CO-05	The role of groups in physics 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	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: Fourier Series and integral **9**

Fourier series- Dirichlet‟s theorem, condition-complex form of Fourier series –uses of Fourier series-physical examples of Fourier series-Parseval‟s identity. Fourier integral.

Unit II: Partial Differential Equation in Physics **9**

Solution of Laplace equation in Cartesian coordinates- diffusion equation - two dimensional heat flow- three dimensional heat flow equation – the equation of motion for vibrating string-D‟ Alemberts solution (method of separating variable).

Unit III: Integral Transform **9**

Fourier Transform –properties-sine and cosine transform- finite Fourier Transform –Laplace transform-convolution or Faltung theorem- application of Laplace transform.

Unit IV: Complex variable **9**

Operations – Argand diagram –properties –functions –necessity and sufficient conditions-Cauchy-Reimann equation- Cauchy integral theorem and formula –residue and contour integration.

Unit V: Group theory **9**

Groups- types - properties- Lagrange's theory for finite group- Rearranging theorem –classes - coset, centre of a group, reducible and irreducible representation -permutations, homomorphism, isomorphism – point group - Cayle's theorem.

TOTAL: 45 HOURS

TEXT BOOKS

1. L.A. Pipes and L.R. Harvill, Applied Mathematics for Engineering and Physicists 3rd Edition (McGraw Hill, Singapore, 1971) ISBN 0-07-085577-3
2. G. B. Arfken and H. J. Weber, Mathematical Methods for Physicists, 6th Edition: A Comprehensive Guide (Academic Press, San Diego 2005). ISBN-13: 978-0120598762
3. H K Dass Mathematical Physics 7th Revised Edition (Sultan Chand and Sons, New Delhi, 2014) ISBN 81- 219-1469-8

REFERENCES:

1. B.D. Gupta, Mathematical Physics (Vikas, Publishing House Pvt Ltd., New Delhi, 2010). ISBN-13: 978-8125930969
2. SatyaPrakash, Mathematical Physics with Classical Mechanics 6th Revised Edition (Sultan Chand and Sons, New Delhi, 2014). ISBN-13: 978-8180549281
3. E. Butkov, Mathematical Physics (Addison Wesley, London, 1968) IS BN 13: 9780201007275
4. S.J. Guha I.C. Goyal Ajoy Ghatak Mathematical Physics (Macmillan, New Delhi, 2003). ISBN 13: 9780333925485
5. P.K. Chattopadhyay, Mathematical Physics (New Age International (P) Ltd, New Delhi, 2004) ISBN 81-224-0283-6
6. M.L.Jain,Vector Spaces and Matrices in Physics,Alpha Science International (
7. 2001) ISBN 0849309786
8. A.W.Joshi, Elements of Group Theory for Physicists, Fourth Edition (New Age International Pvt. Ltd, New Delhi), 2005. ISBN 81 224 0975-X
9. W.W.Bell,Special Functions for Scientists and Engineers,Dover Publications, New York (2013) ISBN: 0-486-43521-0
10. Ken F. Riley, Mike P. Hobson, Stephen J. Bence Mathematical Methods for Physics and Engineering Cambridge University Press; Third edition (2018) 978-0521139878
11. Rakesh Kumar Pandey Theory of Complex Variable Discovery Publishing House New Delhi ISBN 81 8356-295-7

PH3706	QUANTUM MECHANICS-II	L	T	P	C
		3	1	0	4

OBJECTIVES

The objective of this course is to consolidate and extend the knowledge of quantum mechanics by introducing more theoretical tools and some more advanced applications.

Course Outcome		Cognitive Skill
CO-01	To understand the concepts of the time dependent perturbation theory and their application to physical situations.	R,U,A, An
CO-02	To develop problem solving method that will include mathematical as well as numerical computations and solutions	U, A, An, E
CO-03	To enable the students to develop a knowledge and understanding of perturbation theory, level splitting and radiative transitions	U, A, An
CO-04	To familiarize the concepts of operators with their resulting eigen value equations	U, A, An ,E
CO-05	To deal with scattering problems by employing the basic principles of scattering theory	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	S	M	S	S
CO-02	S	M	S	S
CO-03	S	S	M	S
CO-04	S	S	S	S
CO-05	S	M	M	S

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

UNIT I: Perturbation Theory **9**

Time dependent perturbation theory - Constant and harmonic perturbations - Transition probabilities - Selection rules for dipole radiation - Adiabatic and Sudden approximation ,Fermi Golden rule, The density matrix - Spin density matrix and magnetic resonance .

UNIT II: Scattering Theory **9**

Scattering amplitude - Cross Sections - Born approximation - Partial wave analysis, Green‟s function ,scattering for different kind of potentials, applications.

UNIT III: Identical particles and spin **9**

Physical meaning of identity, Symmetric and asymmetric wave functions, Slater determinant, collision of identical particles, spin angular momentum, spin matrices and eigenfunctions, spin functions for many electron systems.

UNIT IV: Relativistic Quantum Mechanics **9**

Klein-Gordon equation - Plane-wave solutions –Interaction with electromagnetic fields- Hydrogen like atoms. Dirac equation - Interpretation of negative energy states- Spin of electron -
- Energyvalues in a Coulomb potential.

UNIT V: Special topics in Radiation Theory **9**

Semi-Classical theory of radiation, Einstein‟s coefficient- Transition probability for absorption and induced emission, Electric dipole and forbidden transitions, Selection rules- Introduction to quantization of fields.

TOTAL: 45 HOURS

TEXT BOOKS

1. L.I. Schiff, Quantum Mechanics, Tata McGraw Hill 4th edition (2014).
2. P.M. Mathews and K. Venkatesan, A Text Book of Quantum Mechanics, Tata McGraw Hill 2nd edition (2010)

REFERENCES:

1. Sathya Prakash, Quantum Mechanics, PragathiPrakasan Pub. (2015)
2. Sl, Gupta V.Kumar, Hv. Sharma, Quantum Mechanics Jai Prakash Nath Publications (2014)
3. E. Merzbacher, Quantum Mechanics,John Wiley & Sons 3rd edition (1998)

PH3707	**ELECTROMAGNETIC THEORY**	**L**	**T**	**P**	**C**
		3	**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	A
CO-02	Students will be able to explain fundamentals laws associated with electromagnetic fields	R, U

CO-03	Students will be able to solve potential problems in electrostatics, magnetostatics and electrodynamics	An
CO-04	Students will understand the importance of Maxwell's equations in electromagnetic theory and modifications of Maxwell's equations needed in a medium	U
CO-05	Students will be able to analyze radiation systems in which the electric dipole, magnetic dipole or electric quadrupole dominate	An

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**

Coulomb‟s law - Electric field – continuous charge distribution – Gauss‟s law – Applications of Gauss‟s law – electric potential - Poisson‟s equation - Laplace‟s equation – potential of a localized charge distribution- electrostatic boundary conditions – surface charge and force on a conductor – Cartesian coordinates – spherical coordinates – monopole and dipole terms - electric field of a couple.

UNIT II: Magnetostatics **9**

Lorentz force law– Biot-Savart's law and Ampere's law– Magnetic vector potential - Multipole Expansion of the vector potential – Effects of a magnetic field on atomic orbits – Magnetization - Bound current and its physical interpretations – Ampere's law in Magnetised Material – magnetic susceptibility and permeability in linear media and non linear media – ferromagnetism.

UNIT III: Electrodynamics **9**

Ohm‟s law – electromotive force - Electromagnetic induction – Faradays Laws – induced electric field – inductance - electrodynamics before Maxwell - Maxwell's Equation – Magnetic charge – Maxwell‟s equation in matter – the continuity equation – poynting‟s theorem – Newton‟s third law in electrodynamics - conservation of momentum – angular momentum.

UNIT IV: Electromagnetic Waves **9**

Electromagnetic wave equations – sinusoidal waves – boundary conditions reflections and transmissions – polarization – wave equation for E and B – monochromatic plane waves - energy and momentum in electromagnetic waves – propagation through linear media - reflection and transmission at normal incidence – electromagnetic waves in conductors – reflection and transmission at a conducting surface – the frequency dependence of permittivity – wave guides.

UNIT V: Elecromagnetic Radiation **9**

Radiation – electric dipole radiation – magnetic dipole radiation – 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

PH3708	THERMODYNAMICS AND STATISTICAL PHYSICS	L	T	P	C
		3	1	0	4

OBJECTIVES

- To invoke Physical laws on the microscopic (atomic) level.
- To understand and make proper analyses of physical problems related to temperature and energy.
- To acquire the knowledge of various statistical distributions.

Course Outcome		Cognitive Skill
CO-01	Students will be able to understand the principles of thermodynamics and its significance and the various parameters involved in it	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	Provides the concept about B.E distribution, ideal B.E and B.E condensation and its various applications	R,U, A, An, E
CO-04	Gives the idea of F.D. distribution, degeneracy and its various levels. Also it explains the 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 its types and its applications.	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	M	S
CO-03	S	S	S	S
CO-04	S	M	S	M
CO-05	S	M	S	M

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

UNIT I: Thermodynamics **9**

Review of thermodynamics – thermodynamics laws and its consequences –Gibb‟s free energy and Helmholtz‟ free energy – Thermodynamical potential – significance of thermodynamic potential– Phase-space –Micro canonical, canonical and grand canonical ensembles – Chemical potential – chemical potential and Gibbs Duhem Equation.

UNIT II: Probability & Maxwell Boltzman's Distribution **9**

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

UNIT III: Bose Einstein Distribution &Specific heat capacity of solids 9

Quantum statistics of identical particles –Bose-Einstein distribution law – Black body radiation – Planck‟s radiation law – Specific heat of solids – Einstein theory – Debye‟s theory – Ideal Bose-Einstein gas – Degeneracy of Bose- Einstein gas – Bose-Einstein Condensation.

UNIT IV: Fermi-Dirac Distribution &Specific heat of gases 9

Fermi-Dirac distribution law – Ideal Fermi-Dirac gas – Fermi energy – degeneracy – Weak degeneracy, strong degeneracy – Electron gas in metals – Thermionic emission of electrons – Specific heat of gases – monoatomic, diatomic and polyatomic gases – variation with temperature.

UNIT V: Partition Function 9

Relation between statistical and thermodynamical quantities – 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.

TOTAL: 45 HOURS

TEXT BOOKS

1. F.W. Sears and G. L. Salinger, Thermodynamics, Kinetic theory, and statistical Thermodynamics - Third Edition,NarosaPublishong House (1986).
2. A.K. Agarwal and Melvin Eisner - Statistical Mechanics – New Age International (P) Limited, New Delhi, 1998.

REFERENCES:

1. Kerson Huang – Statistical Mechanics – John Wiley & Sons, Inc., New York, 1987, Second edition.
2. A.K.Dasgupta – Fundamentals of Statistical Mechanics – New Central Book Agency (P) Ltd., Calcutta, 2000.
3. Sears and Zymanski – Statistical Mechanics – McGraw Hill Book Company, New York, 1961.
4. Fundamentals of Statistical and thermal Physics – FederickReif. – McGraw Hill International Editions, Singapore, 1985.
5. F. Mandl - Statistical Physics – Second edition, ELBS & Wiley (1988).

PH37S1	BASIC BIOPHYSICS	L	T	P	C
		3	1	0	4

OBJECTIVES

- To study selected biological phenomena using physical principles
- To establish the relationship between structure and function at the molecular level

Course Outcome		Cognitive Skill
CO-01	Identifies the role of various bonds in biological molecules and estimates the type of isomerism	R,U,A, An
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 as well as identifies and differentiates the different forms of DNA	U, A, An
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	Uses databases, computational tools and other online resources effectively in sequence comparison of various biological; systems.	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	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: Basics of Biophysics **9**

Role of biomolecules in biological functions, Atoms bonds, types of bonds, molecular configuration and conformation, structural isomerism, geometrical isomerism, optical isomerism, optical activity, basis of molecular interactions, Lennard –Jones potential, various bonds involved in structural stabilization of biomolecules.

UNIT II: Proteins **9**

Structure and properties of amino acids, peptide unit, allowes conformation for a pair of links peptide units, Ramachandran contact criteria and Ramachandran map, Primary Secondary Tertiary and Quaternary structure of proteins stabilizing forces in proteins, globular and fibrous proteins.

UNIT III: Nucleic acids **9**

Nucleotides, Double helical structure of DNA, Watson and Crick model, base pairing and base stacking, Interactions stabilizing the structure of DNA, A,B and Z forms of DNA, structure of tRNA.

UNIT IV: Carbohydrates **9**

Structure and conformations of monosaccharide‟s chair and boaf conformations Disaccharides, glycosidic linkage and glycosidic torsional angles, conformational map for disaccharides , oligosaccharide and polysaccharide structure of cellulose and amylose glycoproteins and glycolipids.

UNIT V: Biological Databases **9**

Database in proteins, Sequence database, Structural database, sequence comparison methods Nucleic acid database, Human genome mapping project, carbohydrate database.

TOTAL: 45 Hours

TEXT BOOKS

1. Basic Biophysics, Vasantha Pattabhi and N. Goutham, Alpha Sceince International,2002
2. P.Narayanan Essentials of Biophysics New Age Interantional,2000
3. Jeremy M.Berg, John L.Tymoczko and Lubert Srryer W.H.Freeman. Biochemistry, 2002, 5th Edition

REFERENCES:

1. R.Chandrasekarans, P.V.Balaji, P.K.Qasba and V.S.R.Rao Conformations of Carbohydrates Harwood Academic Press, 1998

		L	T	P	C
PH3773	**SOLID STATE PHYSICS LABORATORY**	**0**	**0**	**6**	**3**

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 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

PH3774	ADVANCED OPTICS LABORATORY	L	T	P	C
		0	0	6	3

OBJECTIVES

To provide hands on experiments on advanced optics 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 youngs 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	S	S	M	S

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

SEMESTER III

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	PH3709	Atomic and Molecular Physics	3	1	0	4
2.	PH3710	Nuclear and Particle Physics	3	1	0	4
3.	PH3711	Condensed Matter Physics	3	1	0	4
4.	PH37S2	Renewable Energy	3	1	0	4
PRACTICAL						
5	PH3775	Microprocessor and C++ programming Laboratory	0	0	6	3
6	PH37P1	Mini project	0	0	5	5
TOTAL			**12**	**5**	**11**	**24**

PH3709	ATOMIC and MOLECULAR PHYSICS	L	T	P	C
		3	1	0	4

OBJECTIVES

- To impart knowledge and to show a broad spectrum of spectroscopy.
- To equip the students in methodology related to spectroscopy.

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	To understand the principles , Instrumentation and application of FTIR &Raman spectroscopy techniques	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	To describe the sample handling methods of NMR and NQR Spectroscopy and its applications in various fields and its comparision	R,U,A,E,S
CO-05	To equip the methodology related to spectroscopy and to impart the knowledge of ESR and Mossbauer spectroscopy	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	M

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

Unit I: Atomic & 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. Hyperfine structure and isotopic shift; width of spectral lines; LS & JJ coupling; 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-Rotation Vibration Raman Spectra of Diatomic and Polyatomic Molecules-Applications-Laser Raman Spectroscopy.

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: NMR & NQR Spectroscopy **9**

NMR Spectroscopy- Theory-resonance condition-Bloch Equation-Relaxation Processes-Experimental Technique-Principle and Working of High Resolution NMR Spectrometer Chemical Shift. NQR Spectroscopy: Fundamental Requirements-General Principle- Experimental techniques of NQR.

Unit V: ESR & Mossabauer Spectroscopy **9**

ESR Spectroscopy: Basic Principles-Experiments-ESR Spectrometer -Hyperfine Structure. Mossabauer Spectroscopy: Mossabauer Effect-Recoilless Emission and Absorption-Mossabauer Spectrum-Experimental Methods-Chemical Isomer Shift -Magnetic Hyperfine and Electric Quadrupole Interaction.

TOTAL: 45 HOURS

TEXT BOOKS

1. Colin B.Banwell , „Fundamental of molecular spectroscopy‟ ,Mc Graw- Hill publishing company, 1994.
2. G.Aruldhas , „Molecular structure and spectroscopy‟ 2nd edition, PHI learning Pvt.Ltd, New Delhi, 2007.

REFERENCES:

1. B.P. Straugham & S. Walker, „Spectroscopy: Volumes I, II and III, Chapman and Hall, 1976.
2. G.M.Barrow, „ Introduction to molecular spectroscopy‟, Mc Graw- Hill Inc, US, 1962.
3. J.B.Rajam, „Atomic Physics‟ 7th edition, S.Chand Publications, New Delhi, 1966.

PH3710	NUCLEAR AND PARTICLE PHYSICS	L	T	P	C
		3	1	0	4

OBJECTIVES

- To impart knowledge about basic nuclear physics properties and nuclear models for understandings.
- To study the nuclear interaction and nuclear forces.
- To know the fundamentals of conservation laws.

Course Outcome		Cognitive Skill
CO-01	To understand the basic properties of nucleus and nuclear models and also to gain the knowledge about the importance of nuclear models	R,U,A
CO-02	To understand the interaction of nuclear radiation with matter and also to gain knowledge about the elementary ideas about α,β,γ decay	R,U,A,E
CO-03	To equip the students with the knowledge about nuclear forces and their theories and to discuss about the basic properties and detection of neutron	R,U,A,An,, E
CO-04	To solve the problems related to safety aspect of nuclear radiation and to understand the process of nuclear fission &fusion reactions	R,U,A,E,S
CO-05	To gain knowledge about the elementary particles and to describe the properties of nuclei and nuclear collisions	R,U,A,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	S	S	S
CO-04	S	M	S	S
CO-05	S	S	M	M

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

UNIT I: Nuclear models **9**

Binding energy, semi-empirical mass formula, application, quantum numbering; Liquid drop model; Fission and fusion; nuclear stability Bohr-Wheeler theory of Nuclear Fission –Magic numbers – Evidence for magic numbers – Shell model – prediction of shell model-Evidence of shell structure, single-particle shell model, its validity and limitations- Collective nuclear model-Nuclear size, shape and charge distribution, spin and parity

UNIT II: Nuclear Radiations **9**

Introduction, Ionization chamber, Geiger-Muller counter, Scintillation Counters, Bubble chamber, Gamow‟s theory of alpha decay – Fermi theory of beta decay. Elementary ideas of alpha, beta and gamma decays and their selection rules. electron capture- selection rules – Neutrino hypothesis – Parity violation – helicity - Selection rules - Nuclear isomerism –classification of nuclear isomer - Internal conversion- coulomb excitation- resonance fluorescence.

UNIT III: Nuclear forces **9**

Introduction- Nature of the nuclear force –form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces -Deutron- n-p scattering at low energies– scattering length– phase shift analysis – spin dependence – shape independent effective range theory of n-p scattering – p-p scattering at low energies –similarity between nn and pp forces-Saturation of nuclear forces.Meson theory of nuclear forces.

UNIT IV: Nuclear Reaction **9**

Different stages of nuclear reaction –Types, Cross section– Compound nuclear theory – Nuclear Transmutations -Reciprocity theorem –Fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions. Resonance Scattering -– Breit-Wigner dispersion formula – Neutron Sources –Properties – Stripping reaction - – detection of neutron- Neutron Diffusion – Neutron current density –Classification of Nuclear reactors- Artificial element -Safety and precautions of nuclear reactions.

UNIT V: Elementary Particles **9**

Classification of fundamental forces-interaction- conservation laws- (quarks, baryons, mesons, leptons); Spin and parity assignments, isospin, strangeness, Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness).C, P, and T invariance and applications of symmetry arguments to particle reactions –Gell-Mann-Nishijima formula.Elementary Particle symmetry (SU(2), SU(3)) Gellmann-Nishijima formula. Quark model, Application of symmetry arguments to particle reactions. Parity non-conservation in weak interaction. Relativistic kinematics.

TOTAL: 45 HOURS

TEXT BOOKS

1. Tayal, D. C., Nuclear Physics, Himalaya Publication home, (2007).
2. S L Kakani and SubhraKakani, Nuclear and Particle Physics -Viva Books 2008
3. K.Ilangovan, Nuclear Physics-MJP Publishers,2012

REFERENCES:

1. Roy, R.R. and Nigam, B.P., Nuclear Physics, New Age International Ltd., (2001).
2. Martin B,Nuclear and Particle Physics: An Introduction, Wiley Blackwell, 2009.
3. Milner B, Nuclear and Particle Physics, Cambridge University Press, 2001.
4. Krane, K.S. Nuclear Physics, Wiley India Pvt. Ltd., 2008.

		L	T	P	C
PH3711	**CONDENSED MATTER PHYSICS**	**3**	**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	To understand the concept of reciprocal lattice and get an idea about how matter arises from interacting atoms and electrons	R,U,A,An, E
CO-02	To get knowledge about dispersive and thermal properties in solids, in particular heat capacity.	R,U,A,An, E
CO-03	To determine the thermal and electrical properties in the free electron model and account for what the Fermi surface is and how it can be measured.	R,U,A,An, E
CO-04	To describe the fundamental principles of superconductors and semiconductors and able to estimate the charge carrier mobility and density.	R,U,A,An, E
CO-05	To explain the significance of various types of defects in crystals and understand the meaning of phase boundary and phase transformation.	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: Crystal Structure & Diffraction 9

Lattice Constant-Symmetry operation-miller indices-Bravais lattice- Reciprocal lattice concept-Reciprocal Lattice to BCC, FCC Lattices-Construction of Brillouin zones– Bonding of solids-molecular crystals, repulsive interaction, cohesive energy, ionic, metallic and covalent crystals, Bragg and Laue diffraction.

UNIT II: Lattice Vibrations and Thermal Properties 9

Vibrations of One Dimensional Diatomic Linear Lattice- dispersion relations- Acoustic and Optical Branches-Quantisation of lattice vibrations - phonons - Density of states- Debye model of specific heat-Thermal expansion-Thermal conductivity -Ohm‟s law- Widemann-Franz law - Normal process-Umklapp process.

UNIT III: Band Theory in Solids 9

Free electron theory: Bloch theorem -nearly free electron model, classification ofsolids, Electron motion in a periodic potential -Origin of energy gap- effective mass-Fermi surface in metals,Semiconductors-Conductivity of Semiconductor- Photoconductivity- Fermi level, Hall effect .

UNIT IV: Superconductors &Magnetic Materials 9

Superconductivity-Meissner effect- BCS Theory -ElectronPhonon Interaction-Cooper Pairs- Type I and type II-Josephson Effect-High Temperature Superconductivity.

Diamagnetism- Hund‟s rules-Quantum Theory of paramagnetism -Curie temperature-Ferromagnetism-exchange interaction-Curie Weiss Molecular Field Theory-Domain Theory-magnons-Spin Waves- 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-Colour Centers-F Centre-Other in alkali halides- Dislocations: Elastic and Plastic Deformation-Shear Strength of Single Crystals-Edge Dislocation-Screw Dislocation-Energy of a Dislocation -Ordered phases of matter, translational and orientational order, kinds of liquid crystalline order.

TOTAL: 45 HOURS

TEXT BOOKS

1. Introduction to Solid State Physics-C. Kittel-Wiley Eastern-New Delhi 8th Edition 2012.
2. Solid State Physics- S.O Pillai – New Delhi 6th edition 2005.

REFERENCES:

1. Solid State Physics-B.S. Saxena, R.C. Gupta & P.N. Saxena-PragatiPrakashan- Meerut 8th edition 2001
2. Solid State Physics-A.J. Dekker-Macmillan India 2000.
3. Solid State Physics-S.L. Kahani& C. Hemaranjani-Sultan Chand & Sons,New Delhi, India, 4th edition, 2005.
4. Solid State Physics-Structure and properties of materials- M.A.Wahab- Narosa Publishing House, New Delhi 2nd edition, 2005.
5. An Introduction to Solid State Physics & Its Applications-R.J. Elliot & A.P. Gibson-ELBS & Macmillan 1974.
6. Principles of Solid State-H.V. Keer-Wiley Eastern 1994.
7. Fundamentals of Solid State Physics-J.R. Christmann- John Wiley & Sons 1988.
8. Solid State Physics: Principles and Applications-R. Asokamani,Anshan Ltd 2007.

		L	T	P	C
PH37S2	**RENEWABLE ENERGY**	**3**	**1**	**0**	**4**

OBJECTIVES

- To learn the different types of alternative energy sources
- To contribute in the field of energy, renewable energy, energy conservation and energy management.
- To understand the sources and harvesting techniques

Course Outcome		**Cognitive Skill**
CO-01	Able to understand the energy, types and usage of various resources for the production of renewable energy.	R,U, A, An, E,S
CO-02	Gains knowledge on the usage of solar energy and geothermal energy and their harvesting techniques	R,U, A, An, E,S
CO-03	Able to gain knowledge on the principle and production of wind and tidal energy	R,U, A, An, E,S
CO-04	Able to gain knowledge on the on hydro energy production. Provides knowledge to select various biomass resources for energy production	R,U, A, An, E,S

CO-05	Gains knowledge on the production of hydrogen for energy application. Able to understand the working principle of fuel cells and its types.	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	S
CO-02	S	S	S	S
CO-03	S	S	S	M
CO-04	S	S	S	S
CO-05	M	S	S	S

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

UNIT I: Energy **9**

Energy – forms of energy – measurement - non-renewable energy – types and sources - renewable energy –types and sources. Energy conservation- sources and importance- carbon sequestration – importance – capture and storage – methods - sequestration strategies – biological and non biological.

UNIT II: Solar Energy and Geothermal Energy **9**

Solar thermal energy - various methods of using solar energy – photovoltaic cell, solar cooker and water heater - artificial photosynthesis - advantages and disadvantages of solar energy. Geothermal energy – Environmental benefits of geothermal energy- Geothermal temperature gradient - Geothermal Systems - Concept of Enthalpy - utilization of geothermal resources- Principles of heat pumps- Electricity generation- advantages and disadvantages of geothermal energy.

UNIT III: Wind Energy and Wave Energy **9**

Wind energy – wind turbine – types - factors affecting efficiency of wind turbines – capacity factor. Wave energy –wave devices - wave energy converters- WEC operations –Tidal devices- Ocean Thermal Energy Conversion (OTEC) – ocean wave energy devices -OTEC power generation.

UNIT IV: Hydro Energy and Biomass **9**

Hydro energy- Basic definitions and processes - Advantages of small-hydro- Power and Energy - Elements of a small hydro - Types of turbines in SHP- Turbine selection criteria - Turbine efficiency. Biomass -types of biomass -- Biomass by energy crops - Biomass by Residues and Wastes. Biofuels – types of biofuels.

UNIT V: Hydrogen Energy and Fuel Cell **9**

Hydrogen as a renewable energy source - sources of hydrogen - hydrogen production- Storage of hydrogen. Fuel cell – working principle – Types of fuel cells – applications - advantages and disadvantages of fuel cells.

TOTAL: 45 HOURS

TEXT BOOKS

1. D. Mukherjee. Fundamentals of Renewable Energy Systems. New Age International, 2007
2. S. A. Abbasi, NaseemaAbbasi. Renewable Energy Sources and Their Environmental Impact. PHI Learning Pvt. Ltd., 2004

REFERENCES:

1. G. N. Tiwari, Rajeev Kumar Mishra. Advanced Renewable Energy Sources. Royal Society of Chemistry, 2011
2. Tushar K. Ghosh, Mark A. Prelas. Energy Resources and Systems Volume 2: (2011), springerlink
3. Dr.Sathyajith Mathew Wind Energy Fundamentals, Resource Analysis and Economics springerlink(2006),
4. S.P. Sukhatme. Solar Energy Priciples of Thermal Collection and Storage, ,2nd Ed. TMH
5. G.T. Wrixon, A.M.E. Rooney & W. Palz, Renewable Energy. Springer Verlag 2000
6. Giovanni Riva, and Ester Foppapedretti, Handbook on renewable energysources, National Renewable energy Laboratory, 2015
7. V. Vishal and T.N. Singh, Geologic Carbon Sequestration, Springer International Publishing 2016.
8. Aldo da Rosa, Fundamentals of renewable energy processes, Elsevier, 2012
9. Bent Sorensen, Renewable Energy Conversion, Transmission, and Storage, Academic Press 2017.

PH3775	MICROPROCESSOR AND C++ LABORATORY	L	T	P	C
		0	0	6	3

OBJECTIVES

- To become familiar with the architecture and Instruction set of Intel 8085 microprocessor.
- To provide practical hands on experience with Assembly Language Programming.
- 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	The students will be able to design and implement programs on 8085 microprocessor.	R,U, A, An, E,S
CO-02	The students will be able to understand and apply the fundamentals of assembly level programming of microprocessors.	R,U, A, An, E,S
CO-03	The students will be able to demonstrate ability to handle arithmetic operations using assembly language programming.	R,U, A, An, E,S

CO-04	The students will be able to demonstrate basic object oriented and structured programming 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 for Microprocessor

1. 8 bit addition
2. 8 bit subtraction
3. 8 bit multiplication
4. 8 bit division
5. Ascending order
6. Descending order
7. Biggest number
8. Smallest number
9. Display of any character
10. Rolling Display
11. Square root of the equation

List of Experiments for C++ laboratory

12. Matrix Addition
13. Matrix Subtraction

14. Inverse of matrix
15. Transpose of matrix
16. Eigen values of a given matrix
17. Roots of Algebric equation – Newton Rapson method
18. Evaluation of area under the curve using Simpson‟s (1/3) rule
19. Evaluation of area under the curve using Simpson‟s (3/8) rule
20. Evaluation of area under the curve using Monte Carlo Method
21. Evaluation of the Q factor and Bandwidth using LCR series
22. Solution of Radioactive decay problem using Runga-Kutta Method
23. Current in a network
24. Solution of simultaneous linear algebraic equation – Gauss Seidal method
25. Least-squares curve fitting – Straight-line fit

TEXT BOOK:

1. Yu-Cheng Liu, Glenn A.Gibson, “Microcomputer Systems: The 8086 / 8088 Family - Architecture, Programming and Design”, Second Edition, Prentice Hall of India, 2007. ISBN: 0- 13-580499-X
2. Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, “The 8051 Microcontroller and Embedded Systems: Using Assembly and C”, Second Edition, Pearson Education, 2011 ISBN: 013119402X
3. 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
4. Steve Oualline Practical C++ Programming Second Edition OReilly Media Inc, United States of America 2003 ISBN: 978-0-596-00419-4

REFERENCE:

1. Doughlas V.Hall, “Microprocessors and Interfacing, Programming and Hardware:,TMH, 2012.ISBN: 978-0-07-060167-3
2. Wen C. Lin Microprocessors: fundamentals & applications IEEE Press, Wiley, 1977 ISBN: 9780879420949
3. A K. Mukhopadhyay Textbook on Microprocessor-Based Laboratory Experiments and Projects 3rd Edition I.K. International Publishing House Pvt. Limited, 2013 ISBN 9380578040
4. 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.
5. 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

SEMESTER IV

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	PH37AX	Elective I	3	1	0	4
2.	PH37AX	Elective II	3	1	0	4
3.	PH3777	Problem Solving Skills	1	1	0	2
PROJECT						
1.	PH37P2	Project and Viva-Voce	0	0	12	8
TOTAL			**7**	**3**	**12**	**18**

List of Electives

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1. .	PH37A1	Physics of Nanomaterials	3	1	0	4
2.	PH37A2	Alternate Fuels	3	1	0	4
3.	PH37A3	Astronomy And Astrophysics	3	1	0	4
4.	PH37A4	Crystal Growth and Characterization Techniques	3	1	0	4
5.	PH37A5	Laser and its Applications	3	1	0	4
6.	PH37A6	Molecular Biophysics and Biophysical Methods	3	1	0	4
7.	PH37A7	Solar Photovoltaics	3	1	0	4
8.	PH37A8	Intellectual Property Rights	3	1	0	4

PH37A1	PHYSICS OF NANOMATERIALS	L	T	P	C
		3	1	0	4

OBJECTIVES

To know the fundamentals of nanotechnology, synthesis of nanomaterials and composites, characterization and properties

Course Outcome		Cognitive Skill
CO-01	The student will develop a fundamental knowledge of nanomaterials.	R, U, A, An,
CO-02	The student will understand the properties of materials with strong dependence on size	R,U, A, An, E
CO-03	The student will demonstrate an understanding of approaches to nanomaterials Characterization.	R,U, A, An, E
CO-04	The student will gain knowledge on the fundamentals, fabrication, characterization, and applications of nanomaterials	R,U, A, An, E
CO-05	The student will demonstrate an understanding of approaches to engineering Nanomaterials and nanostructures.	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: Introduction to Synthesis of Nanostructured Materials 9

Conceptual development of nanoscience - Free electron theory (qualitative idea)- Idea of band structure extended to nanostructured materials- 0D nanostructures (quantum dots)- 1D nanostructures (quantum wires) -2D nanostructures (quantum wells) - Bottom-up approach and Top-down approach- Carbon nanomaterials, Fullerene, CNT, Graphene.

UNIT II: Nanocomposites 9

Introduction to Nanocomposites, Composite material, Mechanical properties of Nano composite material: stress - strain relationship, toughness, strength, plasticity, Synthesis methods for various nanocomposite materials: sputtering, mechanical alloying, sol-gel synthesis, thermal spray synthesis. , Polymer nanocomposites - Nano composites for hard coatings, processing of polymer nanocomposites – Properties of polymer nanocomposites.

UNIT III: Nanomaterial Characterization 9

Principle and Applications- X-ray diffraction - Debye-Scherer formula – dislocation density – micro strain – FTIR –FT Raman Spectroscopy– UV – Vis Spectrophotometer - Photoluminescence (PL) Spectroscopy – SEM-TEM- Differential scanning calorimeter (DSC) – Thermogravimetric/Diffferential Thermal Analyzer (TG/DTA).

UNIT IV: Properties of Nanostructured Materials 9

Functionality of nanostructures and their characteristic evaluation - Mechanical properties - Thermophysical properties - Electric properties - Electrochemical properties - Magnetic properties - Optical properties - Catalytic property - Properties of gas permeation and separation membranes

UNIT V:Applications 9

Application of nanostructured materials in biotechnology, photonics, electronics, nano-electromechanical systems, defense, nanocatalysis - challenges in nanotechnology.

TOTAL: 45 HOURS

TEXT BOOKS

1. Introduction to Nanotechnology by Charles P. Poole Jr and Frank J.Owens Wiley India Pvt Ltd., (2003).
2. Nanostructures & Nanomaterials: Synthesis, Properties & Applications, Guozhong Gao, Imperial College Press (2004).

REFERENCES:

1. Nanocrystals: Synthesis, Properties and Applications, C. N. R. Rao, P. J. Thomas and G. U. Kulkarni, Springer (2007).
2. Physics of semiconductor nanostructures – K. P. Jain, Narosa 1997
3. Nanotechnology - Enabled Sensors, Kourosh Kalantar-zadeh and Benjamin Fry, Springer (2008).
4. Nanocomposite science and technology, Pulickel M.Ajayan, Linda S.Schadler, Paul V.Braun, Wiley-VCH Verlag, Weiheim (2003).
5. Encyclopedia of Materials Characterization, C. Richard Brundle, Charles A. Evans Jr., Shaun Wilson, Butterworth-Heinemann Publishers (1992).
6. Handbook of Microscopy for Nanotechnology, Ed. By Nan Yao and Zhong Lin Wang, Kluwer Academic Press (2005).

PH37A2	ALTERNATE FUELS	L	T	P	C
		3	1	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	S	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- Dry fermentation plants – advantages and disadvantages - Biogas and its Properties as a Fuel for Internal Combustion Engines - electricity generation from biogas

UNIT II: Ethanolic Fuels **9**

Introduction to alternative fuels. – Need for alternative fuels – sources. Alcohols as fuels – properties – alcohol production- alcohol in CI engines. Performance emission and combustion characteristics in CI engines.

UNIT III: Biofuels **9**

Biofuels- types of biofuels - 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

REFERENCES:

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

PH37A3	ASTRONOMY AND ASTROPHYSICS	L	T	P	C
		3	1	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 correctly draw 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 discoveries throughout 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
PH37A4	**CRYSTAL GROWTH AND CHARACTERIZATION TECHNIQUES**	**3**	**1**	**0**	**4**

OBJECTIVES

- To understand the different methods of growing good quality crystals.
- To provide basic knowledge about crystal imperfections and the methods for detecting imperfections.
- To provide knowledge about the characterization techniques involved in studying the structural, optical and thermal properties of crystals.

Course Outcome		**Cognitive Skill**
CO-01	The students will be able to describe the preparatory methods and growth process involved in crystal growth.	R,U,A,An
CO-02	The students will be able to identify the constituents of a solution and select a crystal growth method for a specific situation.	R,U,A,An,E,S
CO-03	The students will be able to explain the significance of various types of defects in crystals and the methods used for detecting the defects.	R,U,An,A,E
CO-04	The students will be able to choose appropriate electron microscopy technique to investigate the microstructure of materials at high resolution.	R,U,A,An,E,
CO-05	The students will be able to apply the principles of X-ray diffraction, various spectroscopic and thermal analysis techniques.	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	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 in Gel media **9**

Crystal growth in gel media – Advances in gel growth –Methods of gel growth – Theory of Nucleation – Homogeneous and heterogeneous nucleation – Nucleation control – Morphologies of gel grown crystals.

UNIT II: Crystallization from Solution **9**

Introduction – basic requirements – crystallization apparatus –crystal growth methods – the chemical physics of crystal growth – saturation and seeding – Solid growth techniques – Melt growth techniques – solution growth methods – low and high temperature solution growth – Vapour phase growth – Epitaxial growth techniques.

UNIT III: Crystalline Perfection **9**

Crystalline defects – volume, surface, line and point defects –Grain Size Determination– Stacking Faults –Threshold concentration of defects in crystals –Internal Stresses –Methods of detecting imperfections

UNIT IV: Electrical and Microscopic characterization **9**

Electrical properties: Two probe method, Four probe method; Microscopic properties– Magnification – resolution – Rayleigh criteria – optical microscope – scanning electron microscope – elemental analysis –transmission electron microscope – applications for each technique.

UNIT V: Spectroscopic Characteization Techniques **9**

Structural , Optical and Thermal Investigations- XRD,Fourier Transform Infrared spectrometer – Raman spectroscopy, UV-Vis-NIR spectrophotometer –thermogravimetric analysis – differential thermal analysis – differential scanning calorimetry – applications for each technique.

TOTAL: 45 HOURS

TEXT BOOKS

1. Fundamentals of Molecular Spectroscopy, C.N. Banwell, and E.M. McCash, TataMcGraw Hill, Fourth Edition (2008).
2. Thermal Analysis, B. Wunderlich, Academic Press Inc. (1990)
3. Materials Characterization Techniques, Sam Zhang, Lin Li and Ashok Kumar, CRCPress (2008).

REFERENCES:

1. Crystal growth edited by Brain R. Pamplin (II edn.)Pergman Press, Oxford, 1980.
2. Fundamentals of Molecular Spectroscopy, C.N. Banwell, and E.M. McCash, Tata McGraw Hill, Fourth Edition (2008).
3. Thermal Analysis, B. Wunderlich, Academic Press Inc. (1990)
4. Materials Characterization Techniques, Sam Zhang, Lin Li and Ashok Kumar, CRC Press (2008).
5. Electron and Ion Microscopy and Microanalysis Principles and Applications, Lawrence
   E. Murr, Marcel Dekker Inc., New York (1991).
6. Characterization of Materials, Shirley Jackson, Wiley Online Library, Second Edition (2003).

		L	T	P	C
PH37A5	**LASER AND ITS APPLICATIONS**	**3**	**1**	**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	The students understand the basic principles of lasers and to familiar with the operation of most common laser types	R,U,An,S
CO-02	The students extend the knowledge and experience of the student in the specialized area of Lasers and Holograghy and to illustrate the special interest in this area through individual study and presentation	R,U,A,An,E,S
CO-03	The students distinguish various types of fibres and to discuss splicing techniques, optical components etc	R,U,An,A,E

CO-04	The students equip the knowledge of how a coherent light is generated and amplified the techniques behind different lasers design and applications in spectroscopy, medicine etc	R,U,A,An,E,S
CO-05	The students understand the concept of a product design specification and be able to gain knowledge about the lasers in industry	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	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, CO_2 laser, dye lasers, semiconductor lasers.

UNIT II: Holography **9**

Basic principle of holography – Recording and reconstruction of a hologram– applications of 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 – 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) – 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, cutting, welding – alloying –annealing- ablation – 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.

		L	T	P	C
PH37A6	**MOLECULAR BIOPHYSICS AND BIOPHYSICAL METHODS**	**3**	**1**	**0**	**4**

OBJECTIVES

- To study selected biological phenomena using physical principles
- To establish the relationship between structure and function at the molecular level

Course Outcome		**Cognitive Skill**
CO-01	Explains the role of various bonds in biological molecules along with its geometry	R, U, A,An
CO-02	Describes the different protein structure and recognizes its structure	R, U, A, An, E
CO-03	Identifies and differentiates the different forms of DNA along with its chemical composition.	R, U, A, An, E
CO-04	Explains the properties and functions of various carbohydrates in living organisms	R, U, A, An, E
CO-05	Recognizes and explains the various biophysical methods available for the detection of biomolecules.	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	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: Basics of Biophysics **9**

Amino acids, nucleic acid bases, saccharides and lipids –Biomolecules in biological functions – Geometry of biomolecules – Conformation and Configuration – Lennord-Jones potential – Basis of molecular interactions – Various bonds involved in structural stabilization of biomolecules

UNIT II: Proteins **9**

Structure and properties of Amino acids - Structure and Conformation of proteins - Primary, secondary, tertiary and quaternary Structures - main chain and side chain torsion angles – Allowed conformations for a pair of linked peptide units – Ramachandran contact criteria and Ramachandran map – Alpha helix, beta sheet, turns – globular and fibrous proteins – Protein databases.

UNIT III: Nucleic acids **9**

Base pairs - nucleotides – Double helical Structure of DNA, Watson and Crick model - base pairing and base stacking, Interactions stabilizing the structure of DNA – DNA polymorphism - A, B and Z forms – DNA Supercoiling – circular DNA – Environmental effects on DNA – tRNA and ribosomal RNA

UNIT IV: Carbohydrates **9**

Structure and conformations of Monosaccharides, Disaccharides and oligosaccharides – chair, boat and other conformations of saccharides – Glycosidic torsional angles – Conformational map for disaccharides – Detailed structure of polysaccharides, cellulose, amylose, chitin, xylan – Glycosylation-Types of Glycosylation-Importance of Glycosylation-Carbohydrates as integral part of biological systems, glycoconjugates – Glycoproteins, glycolipids.

UNIT V: Biophysical Methods **9**

Fundamentals of X-ray diffraction – Protein Crystallography – X ray fibre diffraction in determining macromolecular structure – Basic principle of NMR spectroscopy, Experimental technique and Instrumentation, Chemical shift, Spin-Spin coupling, Relaxation process –

Nuclear Overhauser Effect – Applications of NMR spectroscopy – Electron Microscopy-TEM, SEM-CD and ORD.

TOTAL: 45 HOURS

TEXT BOOKS

1. Elementary crystallography by D. Velmurugan Edition 1, 2008, MJP Publications.
2. Essentials of Biophysics by P. Narayanan, New Age International Publishers,2000

REFERENCES:

1. Biophysics by VasanthaPattabhi, Gautham N, Narosa Publishing House, 2ndEdition,2011
2. Biophysics: An Introduction by Rodney Cotterill, John Wiley & Sons, 2003
3. Lehninger Principles of Biochemistry by David Lee Nelson, Albert L. Lehninger& Michael M. Cox, 5th Edition, W.H. Freeman,2008
4. J.M. Berg, J.L. Tymoczko and L. Stryer, Biochemistry, Edition: 5, 2002.

PH37A7	SOLAR PHOTOVOLTAICS	L	T	P	C
		3	1	0	4

OBJECTIVES

- To make the students understand the fundamental theory governing the photovoltaic device and make them carry out preliminary system design.
- To understand the basic concept of solar energy and performance of various type of solar cells

Course Outcome		Cognitive Skill
CO-01	The students describe and analyse the important concepts of solar radiation used in photovoltaics systems .	R,U,A,An,E
CO-02	The students gain an insight of the photovoltaic system ,PV cell circuit model etc with different approaches and able to advance photovoltaic systems	R,U,A,An,E,S
CO-03	The students gain deep knowledge in thin film technologies and the performance of silicon materials in market production	R,U,A,An,E
CO-04	Students understand the knowledge for the description, analysis and sizing the different components within PV system and their different configurations	R,U,A,An,E
CO-05	Students gain knowledge and skills necessary for a project of stand-alone and grid-connected systems as well as knowing some different applications	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	M
CO-04	S	S	S	S
CO-05	M	S	S	S

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

UNIT I: Solar Radiation **9**

The Sun as a source of radiation, Extra-terrestrial solar radiation, solar spectrum at the Earth‟s surface, Basic Sun-Earth angles, Depletion of solar radiation by atmosphere, Diffuse radiation at the ground, Estimating solar radiation empirically, Measurement of global, diffuse and direct solar radiation.

UNIT II: Physics of Solar Cells **9**

Photovoltaic effect, PV cell circuit model, P-N junctions, Depletion region, Enegry Band diagram, Charge movement and Current densities, I-V characteristics in dark and light, Irradiation and temperature on I-V characteristics, P-N junction under illumination, I-V equations of Solar Cells.

UNIT III: Solar cell types and Fabrication methods **9**

Types: Crystalline and Amorphous Silicon cells, II-VI cells, Thin film solar cells- CdTe and CIGS. Organic solar cells, Dye-sensitized solar cells

Fabrication Methods: Growth of crystalline silicon by Czochralski, Float-zone method, Thin film deposition by thermal evaporation, sputtering and spray pyrolisis. Epitaxial growth methods, MBE, MOCVD.

UNIT IV: Design and Analysis **9**

Solar cell parameters-short circuit current, open circuit voltage, fill factor, efficiency; Losses in a solar cell- effect of series and parallel resistance and temperature on efficiency, Solar cell design –design for high Isc,Voc and fill factor; quantum efficiency measurements.

UNIT V: PhotoVoltaic systems and Applications **9**

PV modules, PV systems- Stand-Alone PV systems, Grid-connected PV systems, PV applications- Grid-connected power plants, off grid system for rural electrification, battery charging, solar car, solar powered satellites.

TOTAL: 45 HOURS

TEXT BOOKS

1. J. Nelson, Physics of Solar Cells, Imperial college press,2003
2. H.P.Garg and J.Prakash, Solar Energy: Fundamentals and Applications

REFERENCES:

1. Chetan Shingh Solanki, Solar Photovoltaics Fundamentals,Technologies and Applications,PHI Learning Pvt Ltd,New Delhi,3rd Edition ,2015
2. J.Balfuor,M.Shaw,S.Jarasola, Introduction to Photovoltaics
3. G.N.Tiwari, Solar Energy, Narosa Publishing House,2002

PH37A8	INTELLECTUAL PROPERTY RIGHTS	L	T	P	C
		3	1	0	4

OBJECTIVES

- To understand different types of intellectual properties (IPs) and their roles.
- To create an awareness of IP and its values
- To 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, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - 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

Unit II: Patents **9**

Patents - Elements of Patentability: Novelty , Non Obviousness (Inventive Steps), Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, 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 - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings - Registration Procedure, Term of 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 - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks - 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 - 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
Plant variety protection: meaning and benefit sharing and farmers' rights – Procedure for registration, effect of registration and term of protection
Layout Design Protection
Layout Design protection: meaning – Procedure for registration, effect of registration and term of protection Career Opportunities in IP - IPR in current scenario with case studies.

TOTAL: 45 HOURS

TEXT BOOKS

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

REFERENCES:

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)

PH3777	PROBLEM SOLVING SKILLS	L	T	P	C
		2	1	0	2

OBJECTIVES

- To increase physics problem solving capabilities
- To motivate students for prospective career in lectureship/research
- To created an sense of awareness for competitive examination
- To increase the success rate of clearing CSIR NET examination

Course Outcome		Cognitive Skill
CO-01	Understand the problem, apply the proper formula and solve the problem	R,U,A,An,
CO-02	To enhance basic knowledge of physics	R,U,A,E
CO-03	To know the concept behind the problem	R,U,A,E
CO-04	To apply the knowledge of physics concepts	R,U,A,An,E
CO-05	Solve the problem in higher level	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	M	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

Objective type question of the following syllabus (latest CSIR NET syllabus) to be taught

Unit 1: Numerical Ability – I **6**

Number and Simplification, LCM and HCF Average, Quadratic Equations, Sequence and Series, Surds and Indices, Logarithms, Percentage, Profit and Loss, Simple Interest, Compound Interest.

Unit II: Numerical Ability – II **6**

Ratio, Proportion and Variation, Partnership, Alligation and Mixture. Time Speed and Distance, Time and Work, Permutations and Combinations, Probability, Geometry, Mensuration, Trigonometry

Unit III - Core (Part A) **6**

Mathematical Methods of Physics, Classical Mechanics, Electromagnetic Theory, Quantum Mechanics, Thermodynamic and Statistical Physics, Electronics and Experimental Methods

Unit IV - Advanced (Part B) – II **6**

Mathematical Methods of Physics, Classical Mechanics, Electromagnetic Theory, Quantum Mechanics

Unit V - Advanced (Part B) – II **6**

Thermodynamic and Statistical Physics, Electronics and Experimental Methods, Atomic & Molecular Physics, Condensed Matter Physics, Nuclear and Particle Physics.

TOTAL: 30 HOURS

TEXT BOOKS

1. Gu Yipeng. Solving Physics Problems. Jenny Stanford Publishing. ISBN: 9789814877411
2. Whitney Joshua F. A Handbook of Mathematical Methods and Problem-Solving Tools for Introductory Physics. Morgan & Claypool Publishers. ISBN: 9781681742809, 9781681742809

REFERENCE

1. Last three years questions to be discussed in the class room
2. University exam to be conducted in objective type and viva voce examination