Kalasalingam Academy of Research and Education

(Deemed to be University)

Anand Nagar, Krishnankoil – 626 126

Curriculum and Syllabi
(2018 Regulation)

Department of Physics

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Curriculum and Syllabi

2018 Regulation

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DEPARTMENT OF PHYSICS

M.Sc. Physics Programme

University/ Department	VISION	MISSION
Kalasalingam Academy of Research and Education	**To be a Centre of Excellence of International repute in education and research**	**To produce technically competent, socially committed technocrats and administrators through quality education and research**
Department Of Physics	To achieve excellence in education and research in the field of Physics and other related areas through knowledge creation and dissemination.	• Impart quality education and promote scientific temper • Blend theoretical knowledge with practical skills • Motivate basic/academic and applied research in technically important fields • Provide access to all sections of the society to pursue higher education • Inculcate moral values and ethics among students • Prepare students as responsible citizens • Hasten the process of creating a knowledgeable society

PROGRAMME EDUCATIONAL OBJECTIVES

PEO1: Technical Proficiency

Succeed in obtaining employment appropriate to their interests, education and will become valuable physicist

PEO2: Professional Growth

Continue to develop professionally through life-long learning, higher education, research and other creative pursuits in their areas of specialization

PEO3: Management Skills

Improve leadership qualities in a technical and social response through innovative manner

PROGRAMME OUTCOMES

The Program Outcomes of PG Physics are:

At the end of the programme, the students will

PO1: Gain the Knowledge and Understanding of the fundamental laws and principles of a variety of areas of physics; along with their application in Research skills which include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing;

PO2: Be able to use advanced mathematical tools to describe the physical world; and to provide lucid summation of the scientific literature in a given topic of study;

PO3: Be able to plan, execute and report the results of an extended experimental or theoretical physics based project in a research environment.

PO4: Learn how to apply theoretical knowledge of physical principles and mathematical techniques to practical problems;

PO5: Demonstrate the ability to plan and report on a programme of original work; including the planning and execution of experiments, the analysis and interpretation of experimental results, and an assessment of the errors involved;

PO6: Plan and execute a series of experiments or computations, including the identification and use of specialist equipment; and to give technical presentations in a variety of styles and defend their work in a manner appropriate to a scientific conference;

PO7: Communicate effectively by listening carefully and presenting complex information in a clear and concise manner orally, on paper and using ICT and to appreciate the financial and organizational context they will encounter in a career in science and technology.

Kalasalingam Academy of Research and Education

Department of Physics

M.Sc. Physics-Curriculum Structure 2018 Onwards

Semester	Sub. Code	Subject name	Course Type	L	T	P	C
I	PHY18R4001	Mathematical Physics	T	4	1	0	4
	PHY18R4002	Classical Mechanics	T	4	0	0	4
	PHY18R4003	Electronics	TP	3	0	2	4
	PHY18R4004	Atomic and Molecular Spectroscopy	T	4	0	0	4
	PHY18R40XX	Elective Paper	T	4	0	0	4
	PHY18R4081	General Physics Laboratory	L	0	0	6	3
	PHY18R4083	Seminar and Comprehensive Viva	Viva	0	0	2	2
				19	**1**	**10**	**25**
II	PHY18R4005	Quantum Mechanics-I	T	4	0	0	4
	PHY18R4006	Thermodynamics and Statistical Mechanics	T	4	0	0	4
	PHY18R4007	Electromagnetic theory	T	4	0	0	4
	PHY18R40XX	Elective Paper	TP	3	0	2	4
	PHY18R40XX	Elective Paper	T	4	0	0	4
	PHY18R4082	Electronics Laboratory	L	0	0	6	3
	PHY18R4084	Seminar and Comprehensive Viva	Viva	0	0	2	2
	PHY18R4061	Skill development Course	L	-	-	-	2
				19	**0**	**10**	**27**
III	PHY18R5001	Quantum Mechanics-II	T	4	0	0	4
	PHY18R5002	Solid State Physics	TP	3	0	2	4
	PHY18R5003	Nuclear and particle physics	T	4	0	0	4
	PHY18R50XX	Elective Paper *	T	4	0	0	4
	PHY18R5041	Research Methodology	T	2	0	0	2
	PHY18R5081	Advanced Physics laboratory	L	0	0	6	3
	PHY18R5082	Seminar and Comprehensive Viva	Viva	0	0	2	2
	PHY18R5051	Project (Phase-I)	Project	0	0	6	3
				17	**0**	**16**	**26**
IV	PHY18R50XX	Elective Paper *	T	4	0	0	4
	PHY18R5052	Project and Viva Voce (Phase-II)	Project	0	0	16	8
				4	**0**	**16**	**12**
						Total credits	**90**

*Elective may be replaced if the students have completed the discipline specific online courses with exam other than offered courses. The courses should be approved by the department.

Elective Papers

Sl. No.	Sub. Code	Subject Name	Course Type
Group I			
1	PHY18R4031	Modern Optics	T
2	PHY18R4032	Quantum Field Theory	T
3	PHY18R4033	Electrical and Electronic Instrumentation	T
Group II			
4	PHY18R4034	Numerical methods and Programming in C++	TP
5	PHY18R4035	Microprocessors and microcontrollers	TP
6	PHY18R4036	Communication Systems	TP
Group III			
7	PHY18R4037	Energy Physics	T
8	PHY18R4038	Radiation Physics	T
9	PHY18R4039	Medical Physics	T
Group IV			
10	PHY18R5031	Astro Physics	T
11	PHY18R5032	Atmospheric Physics	T
12	PHY18R5033	Analytical Instrumentation	T
Group V			
13	PHY18R5034	Crystal growth and Crystallography	T
14	PHY18R5035	Materials Science	T
15	PHY18R5036	Nanoscience and Nanotechnology	T

The students can be permitted to choose elective paper in any group in any semester but they can be permitted to choose only one elective in each group.

List of Online Courses

Sl. No.	Online courses	Course offered by
1	Characterization of Materials	NPTEL
2	Fundamental concepts of semiconductors	NPTEL
3	Classical field theory	NPTEL
4	Introduction to Physics of Nanoparticles and Nanostructures	NPTEL
5	Fiber Optics	NPTEL
6	Advanced Condensed Matter Physics	NPTEL
7	Plasma Physics: Fundamentals and Applications	NPTEL
8	Non Linear Optics	NPTEL
9	Semiconductor Optoelectronics	NPTEL
10	Quantum Electronics	NPTEL
11	Relativistic Quantum Mechanics	NPTEL
12	Selected Topics in Mathematical Physics	NPTEL
13	Special Theory of Relativity	NPTEL
14	Superconductivity	NPTEL
15	Spintronics: Physics and Technology	NPTEL

Non-CGPA Courses

Sl. No.	Courses	Credit
1	NET/SET/JEST/GATE coaching classes*	1
	a) Pass in examination based on the coaching classes. Exam will be conducted by the department at the end of the third semester for coaching classes.	1
	b) Paper presentation in National/International Conferences/Seminars	1
	c) Participation in workshops (3 days)	1
	d) Participation in Guest Lecture (5 Nos.)	1
	e) Internship	1
	f) Foreign Language/National Language	1

*80% attendance is compulsory in this category even if the student earns Non-CGPA credit as mentioned in the table.

The students should score minimum 2 credits for completing the Non-CGPA courses.

Subject Code	MATHEMATICAL PHYSICS	L	T	P	C
PHY18R4001		**3**	**1**	**0**	**4**

Course Category: Program core
Course Type: *Theory*

Course Objective:

The aim of this course focuses to enable the students to apply the mathematical concepts in physics

Course Outcomes:

Upon successful completion of this course, Students will be able to

CO1: Analyse the concepts of vector calculus, Differentiation and Integration of vectors
CO2: Understand the basic concepts of matrices, inverse and Rank of matrix.
CO3: Understand the basic knowledge on differential equations and special functions
CO4: able to analyse the complex methods to solve real physical problems
CO5: Learn the basic concepts on Fourier series and Fourier transforms

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H	M	M	M		L
CO2	M	M	L	M	L	L	L
CO3	M	H	M	L		M	L
CO4	M	H	M	L	L	M	M
CO5	H	M	H			L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I: Vector Calculus **12 Hours**

Triple product of vectors - Differentiation of vectors - Rules -Gradient of scalar field- Divergence of vector function -orthogonal curvilinear coordinates- Gauss divergence theorem - stoke's theorem

Unit II: Matrix **12 Hours**

Matrix addition and multiplication by a scalar– multiplication of matrices– Inverse of a matrix - Rank of matrix -definitions and theorems of Rank matrix- cayley -Hamilton theorem-Diagonalisation of matrices.

Unit III: Special functions **12 Hours**

Power series solutions for second order ordinary differential equations –Legendre differential equation - Legendre polynomial–Bessel's equation, functions and polynomial –Gamma, beta and error functions.

Unit IV: Complex Variables **12 Hours**

Graphical representation –Argant digram -complex integration -Properties of Moduli and arguments -Geometry of Complex members-Cauchy's theorem-Cauchy's integral theorem-Taylor's expansion-Cauchy's Residue theorem

Unit IV: Fourier series **12 Hours**

Fourier series – The dirichlet conditions – The Fourier coefficients – Symmetry considerations – Discontinuous functions – Non periodic functions – Complex Fourier series – Parseval's theorem – Fourier transforms – Laplace transforms.

Text Book(s):

1. B. D. Gupta, Mathematical Physics, 4th Edition, Vikas publishing house pvt ltd. 2010.
2. Hans J. Weber and George B. Arfken, Essential mathematical methods for Physicists, 5th edition Elsevier - academic press, 2003.

Reference Books:

1. Satya Prakash, Mathematical physics with classical mechanics, Sultan chand & Sons Educational Publishers, New Delhi, 2015.
2. H.K.Dass Mathematical Physics, S.Chand & company Ltd. New Delhi, 2010.
3. K.F.Riley, M.P. Hobson and S.J. Bence, Mathematical methods for Physics and Engineering, Cambridge University Press (Cambridge low - priced Edition), 1999
4. L.A. Pipes and L.R. Harwell, Applied Mathematics for Engineers and Physicists, Mc Graw - Hill, (1995).

Subject Code	Classical Mechanics	L	T	P	C
PHY18R4002		4	0	0	4
Pre-requisite: Nil	Course Category: Program core Course Type: Theory				

Objective:

This course aims to focus on the thorough understanding of the classical mechanics to solve Physical system and statistical mechanics to solve physical systems

Course Outcomes:

Upon successful completion of this course, Students will be able to

CO1: To understand mechanics systems of particles and apply the Lagrangian for solving the macroscopic physical problems

CO2: Apply the Hamiltonian‘s formalism for solving the macroscopic physical problems

CO3: Understand the basic concepts of canonical transformations and Poisson‘s brackets

CO4: Understand the basic concepts in small oscillation

CO5: To gain the knowledge on rigid bodies

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H	M	L	M		M
CO2	H	M	M	L	M	L	L
CO3	H	M	L	L		M	M
CO4	H	H	M	L	L	M	M
CO5	H	M	H			L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I: Mechanics systems of particles and Lagrangian Formalism 12 Hours

Frame of reference- inertial frame of reference- Mechanics of particles- Conservation of momentum- Conservation of angular momentum- Conservation of energy- Mechanics system of particles-Conservation of linear momentum-conservation of angular momentum- conservation energy-work energy theorem-Conservative forces-examples- constraints- Degrees of freedom under constraints- Lagrangian Formalism-Lagrange's equations of motion-Application of Lagrange's equation-Linear Harmonic oscillator- Particle moving under central force- Single particle in space – Cartesian & plane polar coordinates - Atwood's machine

Unit-II: Hamiltonian Formalism 12 Hours

Hamilton's equations of motion – Lagrange's equation from Hamilton's principle-Legendre transformations-Hamilton's function and Hamilton's equation of motion- configuration space-phase space and state space. Application of Hamiltonian's equations of motion- Linear Harmonic oscillator-Particle moving under central force- A bead on a straight Wire-Principle of least action

Unit III: Canonical transformations and Poisson brackets 12 Hours

Canonical transformations and Poisson brackets - Canonical transformation – Generating function – Properties of canonical transformation– Poisson bracket – Properties of Poisson bracket – constant of motion using Poisson brackets – Poisson brackets of canonical variables – Poisson's Theorem –Invariance of Poisson bracket under canonical transformation – Motion as successive canonical transformation (Infinitesimal generators). Harmonic oscillator problem using infinitesimal generators.

Unit IV: Mechanics of Small oscillations 12 Hours

HJ equation, Central force & Small Oscillations - The Hamilton – Jacobi equation for Hamilton's principle function – Harmonic oscillator problem using Hamilton's – Jacobi method–

Lagrange’s equation for small oscillations-– Normal modes Normal frequencies and Normal coordinates – Two masses and three springs – Three coupled pendulums – Free vibrations of linear triatomic molecule.

Unit V: Central Force and Rigid Bodies 12 Hours

Central force–definition and characteristics–Two body problem – Equation of the orbit – Classification of orbits – Stable & unstable equilibrium- Reduction to one-body problem-Motion in a central force field – general solution- Inverse Square Law force- Generalised co-ordinates for rigid body motion- Euler’s Theorem- Chasles’ theorem-Euler angles-Angular velocity of a rigid body-Angular momentum-Angular momentum of Rigid body-Moments and products of inertia- Equation of motion for a rigid body –Euler’s equations.

Text Books:

1. H. Goldstein, “Classical Mechanics”, Narosa Publishing House, 1996
2. Gupta kumar Sharma, “ Classical mechanics” PRAGATI PRAKASHAN Eductaional publishers, 2006

Reference Books:

1. John R. Taylor, “Classical Mechanics”, University Science books, 2005.
2. R. G. Takwale and R. S. Puranik, “Introduction to “Classical Mechanics” Tata McGraw Hill Publishing Company Limited, 2006.
3. P. V. Panat, “Classical Mechanics”, Narosa Publishing House, 2005.

Subject Code	Electronics	L	T	P	C
PHY18R4003		3	0	2	4

Pre-requisite: Nil **Course Category: Program core**

Course Type: Theory with Practical Component

Objective:

This course aims to give exposure to the students on basic analog and digital electronic components, devices and their applications

Course Outcomes:

Upon successful completion of this course, Students will be able to

CO1: Understand the characteristics field effect transistors

CO2: Analyze the characteristics of oscillators and wave shaping circuits

CO3: Understand the basic concepts of amplifiers and operational amplifiers

CO4: Apply the digital logic gates and design the different types of logic devices

CO5: Understand the basic knowledge on microprocessor

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H	M	H	M		L
CO2	M	L	H	H	H	L	L
CO3	H	L	L	H		M	L
CO4	H	M	M	L	L	M	M
CO5	H	M	H			L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I: Field Effect Transistor **12 Hours**

Circuit analysis-Circuit elements-Circuit laws-Network theorems–Two port networks – Semiconductor diodes – Rectifier applications - Bipolar junction transistors – current relationships – Bias and DC load lines – Capacitors and AC load lines – Field effect transistors – JFET bias line and load line – MOSFET construction and Symbols – MOSFET bias and load lines.

Unit II: Oscillator and Wave shaping circuits **12 Hours**

Oscillators and Wave Shaping Circuits - Oscillator Principle - Oscillator types - Frequency stability, response - The Phase shift oscillator, Wein bridge oscillator, LC tunable oscillators - Multivibrators – Monostable and Astable – Comparators - Square wave and Triangle wave generation - Clamping and Clipping - Voltage regulators- fixed regulators, Adjustable voltage regulators, Switching regulators.

Unit III: OPAMP **12 Hours**

Basic operational amplifier applications- Differential DC amplifier- instrumentation amplifier-integrators and differentiators – Analog computation- Active filters comparators- sample and holed circuit- precesion AC/DC converters- Logarithmic amplifiers- waveform generators-Regenerative comparator- voltage regulators.

Unit IV: Digital electronics **12 Hours**

Binary adders- Decoder & encoder- multiplexer & demultiplexer- JK flip flop- shift registers-Ripple counter- synchronous counter- A/D and D/A converters- 555 timer phase locked loop.

Unit V: Microprocessors **12 Hours**

Architecture of 8085 microprocessor- instruction set of 8085- simple programs using 8085-interfacing memory & I/O devices- 8085 interrupts-8255 programmable peripheral interfaces-operating modes of 8255- interfacing using 8255

List of Experiments

1. FET Characteristics
2. FET Amplifiers
3. Wein bridge oscillator
4. Adjustable voltage regulators
5. Integrators and Differentiators using OPAMP
6. Triangle wave generator
7. 4 bit multiplexer
8. Ring counter
9. Program for ascending order using 8085 µP.
10. Program for finding the largest number in a given array using 8085 µP.

Text Books:

1. Millman and Halkias - Integrated Electronics, 2^{nd}edition, McGraw Hill Education, 2017.
2. A.P.Malvino, D.P.Leach – Digital Principles and Applications, 7^{th}edition, McGraw Hill Education, 2010.
3. Ryder - Electronic Fundamentals and applications, 4^{th} edition, Prentice-Hall,1970

Reference Books:

1. Jimmie J Cathey, Electronic Devices and Circuits, 2^{nd}edition, McGraw Hill Education, 2002
2. Millman and Thub - Pulse, Digital and Switching waveforms,3^{rd}edition, McGraw Hill Education, 2017
3. Stan Gibilisco - Electronics Demystified, 2^{nd}edition, McGraw Hill Education, 2012
4. Bapat – Electonics Devices and Circuits, 1^{st}edition, McGraw Hill Education, 1978

Subject Code	Atomic and Molecular Spectroscopy	L	T	P	C
PHY18R4004		4	0	0	4
Pre-requisite: Nil	**Course Category:** Program core ***Course Type:*** *Theory*				

Objective:

The aim of this course is to acquire the knowledge of interaction of electromagnetic radiation with atoms and molecules and get exposure on different spectroscopic techniques and their applications

Course Outcomes:

Upon successful completion of this course, Students will be able to

CO1: Understand the basic principles and different schemes of atomic spectra.

CO2: Acquire the fundamental knowledge on the interaction of atoms with external fields and basics of Resonance spectroscopy

CO3: Understand the knowledge on interaction of molecules with Microwave and IR radiation.

CO4: Learn the therories and concepts of Raman and Electronic Spectroscopy.

CO5: Apply the Laser technology and its applications in different fields.

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H	M	M	M		L
CO2	H	M	L	L	M	L	L
CO3	H	M	L	L		M	L
CO4	H	H	M	L	L	M	M
CO5	H	M	H			L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I: Atomic Spectra 12 Hours

Investigation of spectra – Theoretical principles – quantum states of an electron in an atom- Hydrogen atom spectrum – electron spin and Stern-Gerlach experiment – spin –orbit coupling- fine structure- spectroscopic terms and selection rules- Hyperfine structure- Pauli exclusion principle - Alkali type spectra- LS & JJ coupling

Unit II: Atoms in External Fields and Resonance Spectroscopy 12 Hours

Zeeman and Paschen Back Effect of one and two electron systems – selection rules – Stark effect – inner shell vacancy – NMR – basic principles – classical and quantum mechanical description – spin-spin and spin-lattice relaxation times –chemical shift – ESR – basic principles – nuclear interaction and hyperfine structure – g-factor

Unit III: Microwave Spectroscopy and IR Spectroscopy 12 Hours

Microwave - classification of molecules - rigid rotor model - intensity of spectral lines - effect of isotopic substitution- Infrared - Review of harmonic oscillator - selection rules - vibrational energy of diatomic molecules - anharmonicity - vibration-rotation spectroscopy - vibration of polyatomic molecules - group frequencies.

Unit IV: Raman and Electronic Spectroscopy **12 Hours**

Raman effect - Classical and quantum theories of Raman effect – pure rotational - vibrational Raman spectra- mutual exclusion principle - Electronic spectra of diatomic molecules – Frank-Condon principle – dissociation energy – rotational fine structure of electronic vibration transitions – Fortrat Diagram.

Unit V: Laser and Holography **12 Hours**

Introduction – Spontaneous and stimulated emission- Einstein A and B coefficients- Basic Principles of Laser- Population Inversion- - optical pumping –Ruby Laser- He- Ne Laser- CO_2 Laser- Semi conductor Laser- Principle of Holography- Theory – Practical applications including data storage and security.

Text Books:

1. C.N. Banwell, Fundamentals of Molecular Spectroscopy, 4^{th} edition, McGraw-Hill, New York, 2004.
2. G. Aruldhas, Molecular Structure and Spectroscopy, Prientice Hall of India, New Delhi, 2002.
3. B.B. Laud, Lasers and Non-Linear Optics, New Age International Ltd, Revised 2nd Edition 2007.

Reference Books:

1. S.L. Gupta, V. Kumar & R.C. Sharma, Elements of Spectroscopy, Prakashan Publications, 9th Edition, 2006.
2. K. Thyagarajan & A.K. Ghatak, Lasers – Theory and Applications, Macmillan India Ltd, New Delhi 1997.
3. Manas Chanda, Atomic Structure and Chemical Bond, Tata McGraw-Hill, New Delhi 2003.

Subject Code	General Physics Laboratory	L	T	P	C
PHY18R4081		0	0	6	3
Pre-requisite: Nil	**Course Category:** Program core **Course Type:** Laboratory Course				

Course Objective:

The aim of this laboratory course is to develop an ability to identify, formulate and solve problems using experimental physics.

Course Outcomes:

Upon successful completion of this course, Students will be able to

CO1: Acquire the knowledge, experimental physics etc. in physics

CO2: Improve the analytical and observation ability in physics experiments

CO3: Analyse the various physical properties such as optical, electrical and magnetic properties using experimental observation

CO4: Implement the experimental skills in solving advanced problems

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	L	L	H	M		M
CO2	H	L	L	L	L	L	L
CO3	H	L	L	L		L	L
CO4	H	H		L	L	L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

90 Hours

Sl. No.	Name of the Experiments
1	Determination of the coefficient of self inductance of the given coil by forming Owen's bridge
2	Determination of the refractive index of the given liquid using laser and verifying the result using hollow prism.
3	Determination of the susceptibility of the given paramagnetic salt by Quincke's method.
4	Determination of the value of the given capacitor by forming Wien bridge network.
5	Determination of wavelength of prominent lines using comparator.
6	Determination of velocity of ultrasonic waves in liquid using ultrasonic interferometer.
7	Study of the variation of coefficient of coupling between the given pair of coils using Anderson's bridge.
8	Determination of Cauchy's Constants.
9	Determination of young's modulus of the given material using elliptical fringes
10	Michelson's interferometer – determination of wavelength of the source of light.
11	Optic bench – determination of the wavelength of the source of light.
12	Determination of young's modulus of the given material using Hyperbolic fringes

Reference Book:

1. M.N.Srinivasan, S.Balasubramanian and R.Ranganathan, A Text Book of Practical Physics, Sultan Chand &Sons, 2007.
2. InduPrakash& Ramakrishna, A Text Book of Practical Physics, Kitab Mahal Agencies, New Delhi, 2011
3. S.R. GovindaRajan, T. Murugaiyan S. SundaraRajan, Practical Physics, Rochouse& Sons

<table>
<tr><td>Subject Code</td><td rowspan="2">Seminar and Comprehensive Viva</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>PHY18R4083</td><td>0</td><td>0</td><td>6</td><td>3</td></tr>
<tr><td colspan="6">Pre-requisite: Nil Course Category: Viva
Course Type: Comprehensive Viva Course</td></tr>
</table>

Course Objective:

The aim of this course is to institute the subject knowledge

Course Outcomes:

CO1: Presentation skills
CO2: Subject knowledge
CO3: Analytical skills
CO4: Communication skills

The students can take a seminar every week. At the end of the semester, a comprehensive viva-voce will be conducted in the following topics.

1. Vector Calculus
2. Matrix
3. Special functions
4. Complex Variables
5. Fourier series
6. Mechanics systems of particles and Lagrangian Formalism
7. Hamiltonian Formalism
8. Canonical transformations and Poisson brackets
9. Mechanics of Small oscillations
10. central Force and Rigid Bodies
11. Field Effect Transistor
12. Oscillator and Wave shaping circuits
13. OPAMP
14. Digital electronics
15. Microprocessors
16. Atomic Spectra
17. Atoms in External Fields and Resonance Spectroscopy
18. Microwave Spectroscopy and IR Spectroscopy
19. Raman and Electronic Spectroscopy
20. Laser and Holography

II SEMESTER

Subject Code	Quantum Mechanics– I	L	T	P	C
PHY18R4005		**4**	**0**	**0**	**4**
Pre-requisite: Nil	**Course Category:** Program core ***Course Type:*** *Theory Course*				

Course Objective:

The aim of this course is to make the students to understand the concepts of quantum physics and their applications in microscopic systems

Course Outcomes:

Upon successful completion of this course, Students will be able to

CO1: Understand the basic concepts of Schrodinger wave equation and its applications

CO2: Acquire the basic knowledge on eigen values and eigen functions

CO3: Apply the Schrodinger wave equation to get eigen values of bound systems

CO4: Understand the matrix formulation in quantum mechanics

CO5: Acquire the basic knowledge on angular momentum of quantum mechanical systems

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	M	H		M	H	L
CO2	H	M	L	L		L	L
CO3	H	L	L	M	L		L
CO4	H	L	L	L	L	L	L
CO5	H	L				L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I: The Schrödinger wave equation 12 Hours

Need for wave equation – The one dimensional wave equation – Extension to three dimension – Interpretation of the wave function – Statistical interpretation – Normalization of the wave function – Probability – Current density – Expectation values – Ehrenfest theorem. **Eigen energy function:** Separation of wave equation – Significance of separation constant E – Boundary conditions at large distances – Continuity conditions – One dimensional square well potential – Perfectly rigid walls – Finite potential step – Energy level parity.

Unit II: Eigen function and Eigen values 12 Hours

Postulates – Dynamical variables as operators – Expansion in Eigen function – Ortho normality of energy Eigen functions – Reality of energy eigen values - Probability function and expectation value – Momentum Eigen functions – Box normalization – Dirac normalization Schwartz inequality – Minimal uncertainty product – Form of the minimum wave packet – Schrödinger equation in momentum representation.

Unit III: Discrete Eigenvalues: Bound States 12 Hours

Discrete Eigen values: One dimensional and three dimensional linear harmonic oscillator – Energy levels – Degeneracy – Zero-point energy – Rigid rotor – Eigen values and Eigen functions – Spherically symmetric potential – Spherical harmonics – Solutions for l=0 and arbitrary l values - Interior and exterior solutions - Schrödinger equation for the hydrogen atom – Solution for s-state only and the ground state wave function.

Unit IV: Matrix formulation 12 Hours

Hilbert space – Dirac bra-ket notation – Projection operator – Equation of motion in Schrödinger and Heisenberg pictures – Evaluation of commutatorbrackets - Velocity of a particle in an EM field – Virial theorem – Matrix theory of harmonic oscillator.

Unit V: Angular momentum **12 Hours**

Commutation relations – Eigen values of J+ and J- - Addition angular moments – CG coefficients – Construction of resultant wave function (j1=1/2 and j2=1/2 only) – Angular momentum matrices – Spin – Angular momentum and Pauli's spin matrices.

Text Book:

1. Quantum mechanics, Schiff, IIIrd Edn., Mc Graw Hill India, 2014
2. Quantum Mechanics, Aruldhas, Prentice Hall India Learning Pvt Ltd, 2nd Edition, 2008.

Reference Books:

1. Quantum Mechanics, Merzbacher, John Wiley, 3rd Edition, 1988.
2. Quantum Mechanics, Mathews &Venkatesan, TMH, 1976.
3. Quantum Mechanics: Fundamentals, Kurt Gottfried &Tung-Mow Yan, Springer, 2003
4. The principles of quantum mechanics, P.A. M. Dirac, Oxford University Press, 1958

Subject Code	Thermodynamics and Statistical Mechanics	L	T	P	C
PHY18R4006		**4**	**0**	**0**	**4**
Pre-requisite: Nil	**Course Category: Elective** ***Course Type:*** *Theory*				

Course Objective:

The aim of this course focuses to enable the students to learn about thermodynamics and statistical Physics

Course Outcomes:

Upon successful completion of this course, Students will be able to

CO1: Understand the basic concepts of thermodynamics

CO2: Understand the basic concepts of classical statistical Physics

CO3: Understand the basic knowledge of quantum statistical Physics

CO4: Learn the behaviour of Bose and Fermi gases.

CO5: Apply knowledge of statistical Physics to solve real world physical problems

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H	H	M	M	L	L
CO2	M	H	L		L	L	
CO3	H	L		L	L		L
CO4	H	M	M	L	L	M	L
CO5	H	M	H			L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I: Thermodynamics **12 hours**

Equation of state for various thermodynamic systems; Laws of Thermodynamics; Consequences of equations of state and Thermodynamics laws; thermodynamics potentials; Maxwell's relations, Thermodynamic equilibrium conditions; Phase equilibrium; Gibbs' phase rule, phase transitions; Ehrenfest's classification.

Unit II: Classical Statistical Mechanics **12 hours**

Postulates; Liouville's theorem, microcanonical, canonical & grand canonical ensembles; Equipartition of Energy theorem in these ensembles; equivalence of these ensembles; expressions for entropy in terms of probabilitity in these ensembles; applications of these ensembles to classical ideal gas, Langevin's theory of paramagnetism.

Unit III: Quantum Statistical Mechanics **12 hours**

Postulates of Quantum Statistical Mechanics; Density operator and matrix; applications to electron in a magnetic field, free particle, harmonic oscillator; Ideal Bose and Fermi gases in micro-canonical and Grand canonical ensembles; Bose Einstein and Fermi-Dirac distributions.

Unit IV: Ideal Bose and Fermi gases **12 hours**

Thermodynamic behaviour; Expressions for equation of state, thermodynamic quantities in terms of Bose-Einstein & Fermi-Dirac functions and virial expansions.

Unit V: Applications **12 hours**

Bose-Einstein condensation; Fermi energy and Momentum; Black body radiation; Einstein & Debye theory for heat capacity (possibly Ising model)

Text Books:

1. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger, Narosa Book Distributors, 1998.

2. Statistical mechanics and properties of matter, E.S.R.Gopal, Halsted Press, Wiley-Interscience, New York, 1974.

Reference Books:

1. Statistical Mechanics, R K Pathria, P.D. Beale, Academic Press, 3rd edition, 2011.
2. Introduction to Statistical Physics, Kerson Huang, Taylor & Francis; 2nd edition, 2009.
3. Fundamentals of Statistical Mechanics, B.B.Laud, New Age International Private Limited, 2012.

Subject Code	Electromagnetic Theory	L	T	P	C
PHY18R4007		**4**	**0**	**0**	**4**

Pre-requisite: Nil — **Course Category:** Program core
Course Type: *Theory*

Course Objective:

This course focuses on the theories of Electrostatics, Magnetostatics, Electromagnetism and Electromagnetic waves.

Course outcomes:

Upon successful completion of this course, Students will be able to

CO1: Understand the theories and properties of electrostatics

CO2: Analyze the interaction of electrostatic properties with matter.

CO3: Acquire the fundamental knowledge in Magnetostatics

CO4: Understand the basic concepts of electrodynamics

CO5: Analyze the electromagnetic waves in vacuum and in matter.

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H	M	L	M		L
CO2	H	H	L	L	M	L	L
CO3	H	M	L		M	M	L
CO4	H	M	M	L		L	L
CO5	H	M	M	M	L	L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I: Electrostatics **12 Hours**

The Electric field-Divergence and curl of electrostatic fields- electric potential-Work and energy in electrostatics-conductors-Laplace's equation-Method of Images-separation of variables-Multipole expansion.

Unit II: Electric fields in matter **12 Hours**

Polarization-The field of polarized objects: Bound charges, Physical interpretation of bound charges, The field inside a dielectric-The electric displacement: Gauss's Law in the presence of dielectric, Boundary conditions- Linear dielectrics: Susceptibility, Permittivity, Dielectric constant, Boundary value problems with linear dielectrics, Energy in dielectric systems, Forces on dielectrics

Unit III: Magnetostatics and Magnetic fields in matter **12 Hours**

The Lorentz Force Law-The Biot-Savart Law-The Divergence and curl of B, Comparison of Magnetostatics and Electrostatics- Magnetic vector potential: The vector potential, Summary of magnetostatic boundary conditions, multipole expansion of the vector potential.

Magnetization-The field of a magnetized object, The Auxiliary field H-Linear and Nonlinear media.

Unit IV: Electrodynamics **12 Hours**

Electromotive Force-Electromagnetic Induction: Faraday's law, The induced electric field, Inductance and energy stored in the field- Maxwell's equation: Electrodynamics before Maxwell,

How Maxwell fixed Ampere's Law, Maxwell's equation, Magnetic charge, Maxwell's equations in matter, Boundary conditions.
The continuity equation - Poynting Theorem.

Unit V: Electromagnetic waves 12 Hours

Waves in One dimension-Electromagnetic waves in Vacuum: The wave equation for E and B, Monochromatic Plane wave, Energy and Momentum in em waves-Electromagnetic waves in Matter: Propagation in Linear media, Reflection and Transmission at Normal Incidence, Reflection and Transmission at Oblique Incidence-Absorption and Dispersion-Guided waves.

Text Book:

1. D. J. Griffiths, Introduction to Electrodynamics, 3rd Edition, Prentice Hall, New Jersy, 1999.
2. J. Reitz, F. Milford, R. Christy, Foundation of Electromagnetic theory, 4th Edition, Addision-Wesley, 2008.

Reference Books:

1. Paul Lorrain, Dale R. Corson, Electromagnetic Fields and Waves, 3rd Edition, W.H.Freeman & Co., 1988.
2. Edward J Rothwell, Michael J Cloud, Electromagnetics, 2nd Edition, CRC Press, 2008.

Subject Code	Electronics Practical	L	T	P	C
PHY18R4082		0	0	6	3
Pre-requisite: Nil	**Course Category:** Program core ***Course Type:*** *Laboratory Course*				

Course Objective:

The aim of this laboratory course is to develop an ability to identify, formulate and solve problems in analog and digital electronics.

Course Outcomes:

Upon successful completion of this course, Students will be able to

CO1: Acquire the knowledge, experimental physics etc. in physics

CO2: Improve the analytical and observation ability in physics experiments

CO3: Analyse the various physical properties using analog and digital circuits

CO4: Implement the experimental skills in solving advanced problems

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H		L	M		H
CO2	H	M	L		L	L	L
CO3	H	L	L	L		L	L
CO4	H	L		L	L	L	
CO5	H	L	M			L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

90 Hours

No.	**Electronics Experiments**
1	Construction and study of voltage regulation of a dual power supply.
2	Study of the characteristics of the UJT.
3	Construction of Integrator and Differentiator using OPAMP and 555 Timer.
4	Half adder, Full adder, Half subtractor using multiplexer.
5	Construction of a phase shift oscillator for a given frequency.
6	Construction of a Wien bridge oscillator for a given frequency using OPAMP.
7	Solving Boolean equations using Karnaugh map and realization of simplified circuit.
8	Construction of a relaxation oscillator using UJT.
9	RS, D& JK- Flip Flop using logic gates.
10	Write and solve CPP program for given numerical methods
11	Divide by 16 counter-R/2R ladder
12	Shift Register
13	Construction of a Clipper and clamper circuits.

Reference Books:

1. M.N.Srinivasan, S.Balasubramanian, R.Ranganathan, A Text Book of Practical Physics, Sultan Chand &Sons, 2007
2. InduPrakash& Ramakrishna, A Text Book of Practical Physics, Kitab Mahal Agencies, New Delhi, 2011
3. S.R. GovindaRajan, T. Murugaiyan S. SundaraRajan, Practical Physics, Rochouse & Sons.

Subject Code	**Seminar and Comprehensive Viva**	**L**	**T**	**P**	**C**
PHY18R4084		**0**	**0**	**2**	**2**
Pre-requisite: Nil	**Course Category:** Viva **Course Type:** Comprehensive Viva Course				

Course Objective:
The aim of this course is to institute the subject knowledge
Course Outcomes:
CO1: Presentation skills
CO2: Subject knowledge
CO3: Analytical skills
CO4: Communication skills

The students can take a seminar every week. At the end of the semester, a comprehensive viva-voce will be conducted in the following topics.

1. Crystal Physics
2. Crystal binding, defects and dislocations
3. Dielectric and Ferroelectric materials
4. Magnetic materials
5. Superconductors
6. Electrostatics
7. Electric fields in matter
8. Magnetostatics and Magnetic fields in matter
9. Electrodynamics
10. Electromagnetic waves
11. The Schrödinger wave equation
12. Eigen function and Eigen values
13. Discrete Eigen values: Bound States
14. Matrix formulation in Quantum mechanics

Subject Code	Skill Development Course	L	T	P	C
PHY18R4061		**0**	**0**	**6**	**2**
Pre-requisite: Nil	**Course Category:** Special Course **Course Type:** Theory and Hand on training Course				

Course Objective:
The aim of this course is to develop the experimental and analytical skills through Hands on training

Course Outcomes:
CO1: Analytical skills
CO2: Subject knowledge
CO3: Experimental skills

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H		M	M		M
CO2	H	L	M	L	M	L	
CO3	H	L		L		L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

The analytical techniques as follows

1. Fourier Transform Infrared Spectrometer
2. UV-Visible Spectrophoto meter
3. X-Ray Diffractometer
4. Scanning Electron Microscopy.
5. Atomic Absorption Spectrometer
6. Conductivity Measurement

Semester III

Subject Code	Quantum Mechanics-II	L	T	P	C
PHY18R5001		4	0	0	4
Pre-requisite: Nil	**Course Category:** Program core ***Course Type:*** *Theory*				

Course Objectives

- *To understand the basic concepts of quantum mechanics and different approximation methods*
- *To acquire the knowledge in identical particles, its spin matrices and wave equations*

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1: Acquire the knowledge in Approximation methods for stationary problems
CO2: Apply the knowledge of Approximation methods for scattering problems
CO3: Analyze the difference between Variation method and Approximation methods
CO4: Gain the knowledge about identical particles and spin matrices
CO5: Understand the concepts of relativistic wave equations.

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H	M	M	M		L
CO2	H	L	L	H	H	L	L
CO3	H	M	L	L		M	L
CO4	H	H	M	L	L	M	M
CO5	H	M	H			L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I: Approximation methods for stationary problems **12 Hours**

Stationary perturbation theory – Non degenerate case – I order perturbation – 2nd order perturbation – Perturbation of an oscillator – Degenerate case – Removal of degeneracy in I order and II order – I order stark effect in Hydrogen – Perturbed energy levels- Occurrence of permanent electric-dipole moment-Zeeman effect.

Unit II: Methods of scattering problems **12 Hours**

The Born approximation – Perturbation approximation – Green's function – Green's function for a free particle – Scattering by a square well potential – Validity of Born approximation – Scattering by a screened Coulomb potential-WKB approximation.

Unit III: Variation method and Approximation methods **12 Hours**

Expectation value of the energy – Application to excited states – Ground state of Helium.Time dependent perturbation theory – Expansion in un perturbed Eigen functions – Physical interpretation – Transition probability – Scattering cross section – Harmonic perturbation Adiabatic and sudden approximations.

Unit IV: Identical particles and spin **12 Hours**

Identical particles – Physical meaning of identity – Symmetric and asymmetric wave functions – Construction from un symmetrized functions – Distinguishability of identical particles – The exclusion principle – Correction with statistical mechanics – Spin-angular momentum – Correction between spin and statistics – Spin matrices and Eigen functions. Semi classical treatment of radiation – absorption and induced emission – Transition probability – Interpretation in terms of absorption and emission – Electric dipole transition – Forbidden transitions –

Spontaneous emission – Classical radiation field – Asymptotic form – Dipole radiation – Conversion from classical to QM – Planck distribution formula.

Unit V. Relativistic wave equations 12 Hours

Schrodinger relativistic wave equation – Electromagnetic potential – Separation of the equation – Energy levels in a Coulomb field – Dirac's relativistic equation – Free particle equation – Matrices for α and β - Free particle solution – Charge and current density – Electromagnetic potentials – Spin-angular momentum – Spin-orbit energy – Negative energy states- Klein Garden equation.

Text Books:

1. Quantum mechanics, L.Schiff, McGraw Hill Education, 4th Edition, 2014.

Reference Books:

5. Quantum Mechanics, Merzbacher, John Wiley, 3rd Edition, 1988.
6. Quantum Mechanics, Mathews &Venkatesan, TMH, 1976.
7. Quantum Mechanics:Fundamentals, Kurt Gottfried &Tung-Mow Yan, Springer, 2003
8. The principles of quantum mechanics, P.A. M. Dirac, Oxford University Presss, 1958

Subject Code	Solid State Physics	L	T	P	C
PHY18R5002		3	0	2	4
Pre-requisite: Nil	**Course Category:** Program core ***Course Type:*** *Theory with Practical*				

Course Objectives:

- *To acquire the knowledge about Phonons and electrical transport based phenomena in solids*
- *To get the fundamentals of Semiconductor Crystals and Fermi Surfaces*

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1: Gain the knowledge about phonons and its importance in thermal physics

CO2: Acquire the theoretical concept behind electrical and thermal properties of metals

CO3: Understand the fundamentaltheoriesto describe the energy bands in metals

CO4: Gain the knowledge about Semiconductor Crystals and their properties

CO5: Get the basic ideas about the Fermi Surfaces and its importance in metals.

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H	M	M	M		L
CO2	M	M	L	M	L	L	L
CO3	M	H	M	L		M	L
CO4	M	H	M	L	L	M	M
CO5	H	M	H			L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I Crystal physics **12 Hours**

Lattice points and space lattice-basis and crystal structure-unit cells and lattice parameters-symmetry elements in crystals –space groups-Bravais lattice-density and lattice constant relation-crystal directions. planes and Miller indices-reciprocal lattice allotropy and polymorphism in crystals-imperfections in crystals

Unit II: Lattice vibrations and thermal properties **12 Hours**

Dynamics of identical atoms in crystal lattice-dynamics of linear chain-experimental measurement of dispersion relation-anharmonicity and thermal expansion-specific heat of solids-classical model-Einstein's model-Debye model-thermal conductivity of solids-role of electrons and phonons-thermal resistance of solids.

Unit III: Free electron and band theory **12 Hours**

Elecrons moving in one dimensional potential well-Fermi-Dirac statistics-effect of temparature on Fermi distribution-electronic specific heat-electrical conductivity of metals-Wiedmann-Franz- Lorentz law-electrical resistivity of metals-Hall effect- energy bands in solids-Kronig-Penny model-construction of Brillouin zones-nearly free electron model.

Semiconductors

Free carrier concentration in semiconductors-mobility of charge carriers-temperature effects electrical conductivity of semiconductors-Hall effect in semiconductors

Unit IV: Dielectric and magnetic properties of materials **12 Hours**

Dipole moment-polarisation-local electric field in an atom-dielectric constant and its measurement-polarizability-classical theory-Peizo,Pyro and Ferro electric properties of Crystals-

Ferro electric domains-classification of magnetic materials-atomic theory of magnetism-Langevins theory-paramagnetism and quantum theory-Weiss molecular exchange field-ferromagnetic domains-anti ferromagnetism-Ferrites

Unit V: Superconductors **12 Hours**

Super conductivity – superconducting materials – Meissner effect–Type I and Type II superconductors–thermal properties of superconductors – High frequency phenomenological properties – coherence length – London model – Ginzburg – Landau theory–flux quantisation–BCS theory–Josephson effect (AC and DC) – High temperature superconducting oxides – Technological applications.

List of Experiments

Virtual Lab can be utilized from Virtual Amrita Laboratories Universalizing Education, Amrita Vishwa Vidyapeetham.

1. Resistivity by Four Probe method.
2. B.H.Curve.
3. Hall Effect experiment: Determination of charge carrier density
4. Cornus Experiment.
5. Crystal structure.

Text Book:

1. Introduction to Solid State Physics, Charles Kittal, 7^{th} Edition, John Wiley & sons, Wiley India edition, 2009.

Reference Books:

2. Principles of theory of solids, J.M.Ziman, Cambridge University Press, 1979.
3. Solid State Physics – S.L.Gupta&Dr.V.Kumar.
4. Solid state physics, H.C. Gupta, Vikas publishing house, 2001
5. S. O. Pillai, Solid State Physics, New Age International (p) Ltd, New Delhi (1995).

Subject Code	Nuclear Physics And Particle Physics	L	T	P	C
PHY18R5003		4	0	0	4

Pre-requisite: Nil **Course Category:** Program core

Course Type: *Theory*

Course Objective:

The aim of this course focuses to enable the students to understand the structure and properties of atomic nuclei, and their energetics.

Course Outcomes:

Upon successful completion of this course, Students will be able to

CO1: Understand the basics of atomic nuclei, nuclear charge and mass, binding energy etc.

CO2: Understand radioactivity and related processes and their energetics.

CO3: Understand the nuclear models and their applications.

CO4: Learn the basic nuclear reactions and applications.

CO5: Understand the different elementary particles and their behaviour.

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H	M	M	M		L
CO2	M	M	L	M	L	L	L
CO3	M	H	M	L		M	L
CO4	M	H	M	L	L	M	M
CO5	H	M	H			L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

UNIT – I: Introduction to nucleus

Distribution of nuclear charge - Nuclear mass and binding energy of a nucleus - Mass spectroscopy-Bain bridge and Jordan mass spectroscope -Nier’s mass spectroscope - Theories of nuclear composition (proton-electron and proton – neutron) - Bound states of two nucleons-Ground state of Deuterium - Wave mechanics of ground state of Deuterium-Spin states –Pauli’s exclusion principle -Tensor force - Exchange force - Low energy Nucleon - Nucleon scattering

UNIT – II: Decays

Alpha decay: Properties of α particles - Velocity and energy of α particles - Gamow’s theory of α particles- Geiger - Nuttall law- α ray energies and fine structure of α rays - α disintegration energy-Low range α particles

Beta decay: Properties of β particles - General features of β ray spectrum – Pauli’s hypothesis - Fermi’s theory of β particles - Forms of interaction and selection rules - Fermi’s and Gamow teller transition

Gamma decay: The absorption of γ rays by matter - Interaction of γ rays with matter - Measurement of γ ray energies - Dumont bent crystal spectrometer method-internal conversion

UNIT –III: Nuclear Models

Liquid drop model - Bhor Wheeler theory of fission - Condition for spontaneous fission - Activation energy-Seaborg’s expression

Shell model: Explanation for magic numbers - Prediction of shell model -Prediction of spin and parity - Nuclear statistics - Magnetic moment of nuclei - Schmidt lines-Nuclear isomerism

Collective model: Explanation of Quadrupole moments - Prediction of sign of electric quadrupole moments. Optical model: Nilsson model - Elementary ideas

UNIT – IV: Nuclear Reactions

Kinds of reaction and conservation laws - energetics of nuclear reaction-Isospin - Reaction cross section-Continuum theory of nuclear reaction - Resonance - Briet Wigner Dispersion formula - Stages of nuclear reaction - Statistical theory of nuclear reaction - Evaporation probability and cross section – Kinematics of stopping and pickup reaction - Surface reaction

UNIT –V: Elementary particles

Leptons – Hardons –Mesons - Hyperons- Pion - Meson resonance -Strange meson and baryons - Gellmann Okuber mass formula for baryons -CP violation in K decay - Symmetry and conservation laws - Quark model - Reaction and decays - Quark structure of hardons.

Text Books:

1. Dayal. D.C., Nuclear Physics, Himalaya Publishing House, New Delhi, 1997
2. Pandya. M.L. and R. P. S. Yadav, Nuclear and Particle Physics, Kedar Nath Ram Nath, Meerut, 2004

Reference Books:

1. Kenneth S.Karne, Introducing Nuclear Physics, John Wiley and Sons, New York.
2. Sharma. D.C, Nuclear Physics, - K. Nath & Co, Meerut,1992
3. Bernard L. Cohen, Concept of Nuclear Physics, Tata Mc Graw Hill, New Delhi,1978.

Subject Code	Advanced Physics laboratory	L	T	P	C
PHY18R5081		0	0	6	3
Pre-requisite: Nil	**Course Category:** Program core ***Course Type:*** *Laboratory Course*				

Course Objectives:

To familiarise the students with X –Ray Crystallography, Low Temperature Physics, Elastic Constants, Ferroelectric Curie temperature, Magnetic Properties, Computer Simulations for Solid State Physics

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1: Acquire the knowledge, experimental procedure etc., in Advanced Physics

CO2: Improve the analytical and observation ability in Physics Experiments

CO3: Analyze the various properties of the materials using the experimental observation

CO4: Implement the experiment skills further to solve the Engineering problems.

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	L	M	L	L		M
CO2	H	M	L	H	H	M	L
CO3	H	L	H	L		M	L
CO4	H	H	M	L	L	L	L

H – High correlation; M – Medium Correlation; L – Low Correlation **90 Hours**

List of Experiments

1. Dielectric constant measurement with temperature and verification of curie Wiess law.
2. Indexing of a given XRD pattern and determination of lattice parameter and crystal structure.
3. Determination of the characteristics of G.M. tube.
4. Study the variation of magnetoresistance of a sample with applied magnetic field.
5. Determination of Rydberg constant.
6. e/m of an electron Thompson's method.
7. Band gap determination.
8. Ferromagnetic studies using Guoy's method.
9. Refractive index of liquids and liquid mixtures using Abbe's refractometer.
10. Optical activity studies using polarimeter.
11. Interpretation of vibration spectra of simple molecules using Raman and IR spectra.
12. Interpretation of UV-visible spectra of materials.

Reference Books:

1. R A Dunlop, Experimental Physics: Modern Methods, Oxford University Press, USA, 1 edition, 1988.
2. A Ghatak, K Thyagarajan, Introduction to fiber optics, Cambridge University Press, First Edition, 1999.
3. A C Melissinos, J Napolitano, Experiments with Modern Physics, Academic Press, Secod edition, 2003.
4. J Varma, Nuclear Physics Experiments, New Age Publishers, 2001.
5. Introduction to Solid State Physics, Charles Kittal, 7th Edition, John Wiley & sons, Wiley india edition, 2009.
6. Molecular spectroscopy, Jeanne L. McHale, Pearson Education, 1999.

Subject Code	Seminar and Comprehensive Viva	L	T	P	C
PHY18R5082		0	0	2	2
Pre-requisite: Nil	**Course Category:** Viva **Course Type:** Comprehensive Viva Course				

Course Objective:
The aim of this course is to institute the subject knowledge
Course Outcomes:
CO1: Presentation skills
CO2: Subject knowledge
CO3: Analytical skills
CO4: Communication skills

The students can take a seminar every week. At the end of the semester, a comprehensive viva-voce will be conducted in the following topics.

1. Variation method and Approximation methods
2. Identical particles and spin
3. Relativistic wave equations
4. Phonons
5. Free electron Fermi gas
6. Energy Bands
7. Semiconductor Crystals
8. Fermi Surfaces and metals
9. Nuclear Models
10. Decays
11. Introduction to nucleus
12. Nuclear Reactions
13. Elementary particles
14. X –Ray Crystallography
15. Elastic Constants in BCC and FCC crystals
16. Magnetic Properties

Subject Code	Phase I Project	L	T	P	C
PHY18R5051		0	0	6	3
Pre-requisite: Nil	**Course Category:** Project **Course Type:** Project Course				

Subject Code	Phase II Project	L	T	P	C
PHY18R5052		0	0	16	8
Pre-requisite: Nil	**Course Category:** Project **Course Type:** Project Course				

Elective Papers

Subject Code	MODERN OPTICS	L	T	P	C
PHY18R4031		4	0	0	4
Pre-requisite: Nil	**Course Category:** Elective ***Course Type:*** *Theory*				

Course Objective:

The aim of this course focuses to enable the students to understand optics and non-linear optics concepts in physics

Course Outcomes:

Upon successful completion of this course, Students will be able to

CO1: Acquire fundamentals and principles of Laser action

CO2: Understand the basic concepts of different types of lasers

CO3: Apply the knowledge of laser in holography

CO4: Gain the knowledge in Fourier optics and Fourier transforming properties of lenses

CO5: Understand the concepts of nonlinear optics and harmonic generations.

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H	M	M	L		L
CO2	H	M	L	H	H	L	L
CO3	M	M	L	L		M	L
CO4	H	H	M	L	L	M	M
CO5	H	M	H			L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I: Fundamentals of Laser **12 Hours**

Emission and absorption of Radiation – Einstein Relations – Population inversion - Pumping Mechanisms – Optical feedback – Threshold conditions laser losses-Line shape function-Pumping threshold conditions- Laser modes – Mode locking – Q Switching - Properties of Laser beams.

Unit II: Laser Systems **12 Hours**

Classification of laser systems- Atomic Gas laser: Helium Neon laser – Argon Ion laser – Copper vapor laser – Molecular laser: Carbon dioxide laser - Excimer lasers- Organic Dye laser - Solid State laser: Ruby laser, Neodymium YAG laser and Glass laser – Titanium Sapphire laser – Fiber laser – Semiconductor diode laser: Ga-As lasers - Applications.

Unit III: Fourier Optics **12 Hours**

Fourier analysis in two dimensions :Definition and Existence Conditions- Fourier Transform Theorems-Local spatial frequency and space-frequency localization- linear systems-Fresnel and Fraunhofer diffraction: The Intensity of a Wave Field- The Huygens-Fresnel Principle in Rectangular Coordinates- The fresnel approximation- The fraunhofer approximation-Wave-Optics Analysis of Coherent Optical Systems:Thin lens as phase transformation – Thickness function- Various types of lenses- Fourier transforming properties of lenses.

Unit IV: Holography **12 Hours**

Holography:Principles and techniques-Introduction-Characteristics of a hologram-Inline holography:Gabor holography-Hologram Aberrations-Classification of holograms: Amplitude and phase holograms-Classification based on hologram thickness:Thin or plane holograms-volume holograms – Classification based on direction of reconstructed image: Transmission hologram – Reflection hologram – Classification according to arrangement - Fresnel hologram-Fraunhofer hologram-Fourier transform hologram -Applications of Holograms.

Unit V: Non-Linear Optics **12 Hours**

Wave propagation in an anisotropic crystal- Polarization response of materials of light-Second order Non linear optical processes:Second harmonic generation-Sum and Difference frequency generation-Optical parametric oscillation – Third order Non-linear optical processes:Third harmonic generation-Intensity dependent refractive index-Self focussing-Non-linear optical materials-Phase matching-Saturable Absorption-Two photo Absorption-Stimulated Raman scattering- Harmonic generation in gases.

Text Book(s):

1. Opto Electronics- An Introduction, Wilson & JFB Hawkes 2^{nd} Ed., 1998.
2. Introduction to Fourier optics, J.W. Goodman, McGraw Hill, 1988.
3. Lasers and Holography, Prakash Chandra Mehta, Dr V V Rampal, World Scientific Publishing, 1998
4. Lasers and Non-Linear optics ,B.B. Laud, Wiley, 1991.

Reference Books:

1. Lasers, Peter W MIlonni & Joseph H .Eberly, Wiley, 2008.
2. Non-linear optics, Robert W Boyd, Academic Press, 1992.
3. Laser Fundamentals by William T. Silfvast; Second Edition, Cambridge, 2004.

Subject Code	Quantum Field Theory	L	T	P	C
PHY18R4032		4	0	0	4
Pre-requisite: Nil	**Course Category:** Elective ***Course Type:*** *Theory*				

Course Objectives:

- *To understand the basic concepts in quantum field theory and its importance in electromagnetic fields.*

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1: Acquire fundamentals and principles of Klein-Gordon equation as relativistic wave equation, Noether's theorem and Poincare symmetry and internal symmetry.

CO2: Understand the canonical quantization of KG field, and find the solution of KG field in Schrodinger and Heisenberg pictures.

CO3: Gain the knowledge about the use of anti-commutators.

CO4: Gain the knowledge in quantization of electromagnetic fields.

CO5: To gain the concepts in interacting quantum fields, Wick's theorem and Feynman Diagram.

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H	M	L	H	M	L
CO2	H	M	L	L	L	M	L
CO3	H	M	L		M	L	L
CO4	H	M	L	L	L		L
CO5	H	M	H	L		L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I: Symmetry Principles **12 Hours**

Relativistic kinematics, relativistic waves, Klein-Gordon (KG) equation as a relativistic wave equation, treatment of the KG equation as a classical wave equation: its Lagrangian and Hamiltonian, Noether's theorem and derivation of energy-momentum and angular momentum tensors as consequence of Poincaré symmetry, internal symmetry and theassociatedconserved current.

Unit I: Quantization of Klein-Gordan Field **12 Hours**

Canonical quantization of the KG field, solution of KG theory in Schrödinger and Heisenberg pictures, expansion in terms of creation and annihilation operators, definition of the vacuum and N-particle eigen states of the Hamiltonian, vacuum expectation values, propagators, spin and statistics of the KG quantum.

Unit III: Quantization of Dirac Field **12 Hours**

Review of Dirac equation and its quantization, use of anti-commutators, creation anddestruction operators of particles and antiparticles, Dirac propagator, energy, momentum and angular momentum, spin and statistics of Dirac quanta.

Unit IV: Quantization of Electromagnetic Fields **12 Hours**

Review of free Maxwell's equations, Lagrangian, gauge transformation and gauge fixing, Hamiltonian, quantization in terms of transverse delta functions, expansion in terms of creation operators, spin, statistics and propagator of the photon.

Unit V: Perturbative Interaction at Tree Level **12 Hours**

Introduction to interacting quantum fields, Wick's Theorem, Feynman Diagram, Examples from quantum electrodynamics at the tree level: positron-electron and electron-electron scattering.

Text Book:

1. Quantum Field Theory, C. Itzykson and J.B. Zuber, McGraw Hill Publications, 1980
2. Quantum Field Theory, L. Ryder, Cambridge University Press, 2003.

Reference Books:

1. Relativistic Quantum Fields,J.D. Bjorken and S.D. Drell, McGraw Hill Publications, 1965.
2. Quantum Electrodynamics, V.B. Berestetskii, E.M. Lifshitz and L.P. Pitaevskii,Elesvier, 2010.
3. An Introduction to Quantum Field Theory, M.E. Peskin and D.V. Schroeder, West view Press, 2015.

Subject Code	Electrical and Electronic Instrumentation	L	T	P	C
PHY18R4033		4	0	0	4
Pre-requisite: Nil	Course Category: Elective *Course Type: Theory*				

Course Objective:

- *To acquire the knowledge about different Electrical and Electronic Instrumentation*
- *To get the fundamentals of signal generation, recording, processing and analysis.*

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1: Understand different aspects of measurement and errors involved

CO2: Design and develop amplifiers, other signal processing instruments.

CO3: Design and develop signal generators, frequency dividers, lock-in amplifiers etc.

CO4: Understand and use different electronic measuring devices.

CO5: Understand the working and use of output devices like printers etc.

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H	M	M	M		L
CO2	M	M	L	M	L	L	L
CO3	M	H	M	L		M	L
CO4	M	H	M	L	L	M	M
CO5	H	M	H			L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I: Measurement and Error **12 Hours**

Measurements and methods- Accuracy and Precision – Significance of Measurement – Error in measurements and their types – Statistical analysis- Probability of errors – Limiting errors.

Dynamic characteristics of an instrumentation system: Zero, First and Second Order systems – Response of first and second order systems –Time Domine specifications- Frequency Domine analysis- Frequency response of first and second order systems.

Unit II: Amplifiers and Signal Conditioning **12 Hours**

Operational amplifier- Isolation amplifiers- Chopper amplifiers- Voltage to frequency and frequency to voltage converters-Frequency multipliers - Logarithmic amplifiers,- Buffer amplifier- Attenuators.

Types of filters – Low pass, High pass, Band pass, and Band stop filters- Filter with cascade Section, LC filters and All pass filters. General consideration of A/D and D/A Conversion-Sampling-Diode Clipping and Clamper Circuit.

Unit III: Signal Generation **12 Hours**

Frequency synthesized signal generator- Frequency divider generator- RF signal generator-Signal generator modulation- Sweep frequency generator- Function generator – Noise generator.

Signal Analysis: Wave Analyzer- Frequency Selective wave analyzer- Heterodyne wave analyzer- Total harmonic Distortion. Application of wave analysers. Harmonic distortion analyzer- Fundamental suppression harmonic distortion analyzer- Spectrum analyzer- Spectra of CW, AM, FM and PM waves.

Unit IV: Electronic Measuring Instruments **12 Hours**

Electronics Voltmeter and their advantages- Digital Millimetres- Digital frequency meter – Digital voltmeter – Phase meter – RF power and voltage measurement – Power factor meter – Vector volt meter. Diode sensor based instruments.

Unit V: Display and Recording **12 Hours**

X-t, X-Y Recorders – Magnetic tape Recorders- Laser printers – Ink jet printers. - Storage oscilloscope.Characteristics of digital displays: LED- LCD – Dot matrix and seven segment display systems.

Text Book(s):

1. A. K. Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation, Eighteenth revised and enlarged edition, Dhanpath Rai & Co, 2007.
2. Modern Electronic Instrumentation and Measurement Techniques – A.O. Helfrick and W.D.Cooper, Prentice Hall India Publications, 2011.

Reference Books:

1. Instrumentation Devices and Systems – C.S Rangan, G.R. Sharma and VSV Mani, Tata McGraw Hill Publications.
2. Introduction to Instrumentation and Control – A.K Ghosh – Prentice Hall India Publications, 2012.
3. Transducers and Instrumentation- D.V.S Murty PHI Publications, 2008.

Subject Code	Numerical Methods and Programming in C++	L	T	P	C
PHY18R4034		3	0	2	4
Pre-requisite: Nil		**Course Category:** Elective ***Course Type:*** *Theory with Practical*			

Course Objectives:

- *To make the student capable of developing different programs in C++*
- *To make the student understand the importance of programming and their use.*

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1: Understand the basics of C++ programming language.

CO2: Understand and use functions, programming structures, arrays and pointers in C++.

CO3: Understand and use structures of array, fields, classes and objects in C++

CO4: Understand and use different types of inheritance and their applications in C++

CO5: Understand and use the importance of polymorphism, templates etc. in C++ programming.

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H		H	M		H
CO2	H	H	M	M	L	M	L
CO3	H	M	M	L		L	L
CO4	H	H	L	L	L	L	L
CO5	H	L	L			L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I: C++ Basics **12 Hours**

Identifiers and key words – String numeric and character constants – Operators – Type conversion–Declaration of variables–Types of statements–features of iostream.h- Keyboard and screen I/O – Predefined manipulators – Input and output stream flags - Control statements: Conditional expressions, loop statements and breaking control statements.

Unit II: Functions, program structures, arrays and pointers **12 Hours**

Defining a function – 'Return' statement – Types of functions – Actual and formal arguments – Local and global variables – Default arguments – Multifunction program – Storage class specifiers: Automatic register, Static and external variables – Recursive function – Simple macro definitions – Macro with parameters – Other pre-processing techniques – Conditional compilation – Header files – Standard functions – Array notation, declaration and initialization – Processing with array – Arrays and functions – Multidimensional arrays – Character array – Pointer operator – Address operator – Pointer expressions – Pointer arithmetic – Pointers and functions – Pointers and arrays - Pointers and strings – Arrays of pointers .

Unit III: Structures, Classes and objects **12 Hours**

Declaration of structure – Initialization – Functions and structures – Arrays of structures- Arrays within a structure – Nested structure – Pointers and structures - Structures and classes – Declaration of class – Member functions – Object of a class – Accessing a member of a class - Array of class objects – Pointers and classes – Unions and classes – Nested class – Copy constructors – Default constructors – Destructors – Inline member functions – Static data member – Static member functions – Friend functions – Dynamic memory allocations – ' this' pointer.

Unit IV: Inheritance, overloading and Polymorphism **12 Hours**

Single inheritance – Public, private and protected inheritance – Array of class objects and single inheritance – Multiple inheritance – Container classes – Member access control – Function overloading with various data types and arguments – Overloading assignment, arithmetic, comparison and Unary operators - Polymorphism – Early binding - Polymorphism with pointers – Virtual functions – Late binding – Pure virtual functions – Abstract base classes – Constructors and destructors under inheritance – Virtual destructors and base classes

Unit V: Numerical Methods **12 Hours**

Bisection and Newton-Raphson's method to find the roots of equations –Solution of simultaneous linear equation by Gauss elimination method– Solution of ordinary differential equation by Euler and Ruge-Kutta method (second and fourth order) – Trapezoidal rule – Simpson's one third rule – (no derivation for all methods).

List of Experiments

1. Write a CPP Program for quadratic equation.
2. CPP Program for sine and cosine series.
3. CPP program for Ascending order using functions
4. CPP Program to find the largest number using pointer.
5. CPP program for adding to two complex variables.
6. CPP Program for arithmetic operations.
7. CPP program for newton-Rapshon method.
8. CPP program for Runge-kutta method.
9. CPP Program for Bi-section method.
10. CPP program for Gauss-elimination method.

Text Book:

1. Programming with C++ - By D. Ravichandran –Tata McGraw – Hill Pub. Co. Ltd., New Delhi, 2014
2. Computer oriented numerical methods, V. Rajaram, Prentice hall, 2004.

Reference Books:

1. Object oriented programming with C++, E.Balagurusamy, Tata McGraw – Hill Pub. Co. Ltd., New Delhi, 2013
2. Let us C++, Yashwant. P.Kanetkar, BPB Publications, New Delhi, 2010.
3. Object oriented programming in Turbo C++, Robert Lafore – Galgotia Publications Pvt. Ltd., New Delhi, 1991.

Subject Code	Microprocessors and microcontrollers	L	T	P	C
PHY18R4035		3	0	2	4

Pre-requisite: Nil **Course Category:** Elective
Course Type: *Theory with Practical*

Course Objectives:

- *To make student understand the theory and working of Microprocessor, Microcontroller and their applications*
- *To make the student able to use microprocessor and Microcontroller in different applications.*

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1: Understand the structure and working of 8085 microprocessor and apply it
CO2: Understand and working of different peripheral devices and use it in different applications
CO3: Acquire knowledge about the interfacing peripherals with 8085 microprocessor.
CO4: Understand the Architecture and working principle of 8051 microcontrollers with different operation modes.
CO5: Acquire knowledge about the interfacing 8051 microcontroller with various peripherals.

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H	H	M	L	M	L
CO2	H		M	L	M	M	L
CO3	H	L	M	L	L		L
CO4	H	L	M	L	L	L	L
CO5	H	L	H		L	L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I: The 8085 Microprocessor based system **12 Hours**

General Organization of a Microcomputer, Detailed Architecture of 8085, Instructions Set, Assembly Language Programming, -Ascii Code—High level Languages-Operating system. Programming Examples. The 8085-Based System Design -Pins and Signals,System Components, Interfacing Memory, I/O Devices.

Unit II: The 8085 Programming Model **12 Hours**

8085 instructions and classification – Data Transfer-Arithmetic and logical operators-Branch operations-Op code Fetch operation-Instruction & Data flow- Flags registers- Debugging a program- Looping-Counters and Time delays-Stacks operation and Subroutines-Restart-Interrupts-Code conversion- Memory read and memory write-Addressing Modes.

Unit III: Peripheral Interfaces and Interfacing with 8085 **12 Hours**

Parallel I/O Methods, Programmable Peripheral Interface (8155), Key board /Seven segment Display interface, Programmable Interval Timer 8254 (8253). Programmable Interrupt Controller (8259 A), DMA Controller (8237/8257), Programmable Interval Timer (8253).

Unit IV: INTEL 8051 Microcontrollers **12 Hours**

Intel 8051Architecture-Memory rganization-Internal RAM Structure- Special Function Registor-Processor Status word-Power control in 8051.Instruction set and Programming-Addressing modes-Parallel port in 8051-Programming memory and Data memory Interfacing-Timer operating modes-Intrrupts.

Unit V: 8051 Interfacing **12 Hours**

Interfacing with 8255with 8051- Interfacing of Push button switches and LEDs-Interfacing of Seven segment Displays-Interfacing with ADC and DAC Chip- Interfacing Stepper Motor with 8051.

List of Experiments

1. Write an assembly language program to add two 16 bit numbers.
2. Assembly language program to find the largest number in a given array.
3. Assembly language program for finding one's complement.
4. Write a program to multiplication of two 8 bit numbers.
5. Programs in 8051 controller.

Text Book:

1. Microprocessor Architechure, programming and Application with the 8085-By Gaonkar-Penram International Publishing (India)Pvt. Ltd.
2. Microprocessors and Microcontrollers-By Senthil Kumar, Saravanan, Jeevananthan, Oxford University Press, 2010 ,India.
3. Microprocessors, PC Hardware and Interfacing - By N. Mathivanan, PHI, 2003

Reference Books:

1. The 8086 Microprocessor : Programming & Interfacing the PC - By Kenneth J. Ayala Penram International Publishing, 1995
2. Advanced Microprocessors and Peripherals - Architecture, Programming and Interfacing - By A K Ray and K M Bhurchandi, TMH, 2000
3. Advanced Microprocessors and Interfacing - By Badri Ram, TMH, 2nd Reprint 2002

Subject Code	Communication Systems	L	T	P	C
PHY18R4036		3	0	2	4
Pre-requisite: Nil	Course Category: Elective *Course Type: Theory with Practical*				

Course Objective:

The aim of this course focuses to enable the students to apply the mathematical concepts in physics

- To make the student familiar with theory and importance of communication devices.
- To make the student capable of developing advanced communication devices

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1: Learn the basic concepts on the theory of analog signals and their modulations

CO2: Understand the principles of digital transmission systems and apply them.

CO3: Understand the theory of optical sources, various transmission lines.

CO4: Understand the theory of Microwave propagation and devices

CO5: Apply the Advanced Communication Techniques in communications systems

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H	M	M	M		L
CO2	M	M	L	M	L	L	L
CO3	M	H	M	L		M	L
CO4	M	H	M	L	L	M	M
CO5	H	M	H			L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I: Analog signal transmission **12 Hours**

Need for modulation, Amplitude modulation, Frequency spectrum for sinusoidal A.M, Average power for sinusoidal and non-sinusoidal A.M, Generation of A.M. waves- Collector modulator, Balanced modulator, A.M transmitter (Block diagram approach), Detection of A.M waves – Square law detector, Frequency and Phase modulation, Frequency spectrum for sinusoidal F.M, Average power for sinusoidal F.M, Varactor diode F.M modulator, Balanced slope F.M detector, Ratio F.M detectors.

Unit II: Digital transmission of analog signals **12 Hours**

Sampling theorem, Pulse amplitude modulation (PAM), Natural sampling, Flat-top sampling, Signal recovery through holding, Quantization of signals, Quantization error, Pulse Code Modulation (PCM), Companding, Multiplexing PCM signals, Differential PCM.**Digital modulation techniques:** Amplitude Shift Keying (ASK), Phase Shift Keying (PSK), Frequency Shift Keying (FSK) and Differential Phase Shift Keying (DPSK) and their generation and detection (qualitative).

Unit III: Transmission lines **12 Hours**

Introduction, Primary line constants, Phase velocity and line wavelength, Characteristic impedance, Propagation coefficient, Phase and group velocities, Standing waves, Lossless line at radio frequencies, VSWR, Slotted-line measurements at radio frequencies, Transmission lines as circuit elements, Smith chart.

Unit IV: Microwave propagation and devices **12 Hours**

Introduction to rectangular and circular wave guides, Solution of wave equations in cylindrical coordinates, TE and TM modes, Power transmission and loss in circular wave guides, Excitation of modes in circular wave guide, Microwave tunnel diode, Gun effect diode (GaAs), Microwave generation and amplification.

Unit V: Advanced Communication Techniques **12 Hours**

RADAR Systems- Principle of operation, radar frequencies, pulse considerations, Radar range equation, minimum detectable signal, signal to noise ratio, integration of RADAR pulses, radar cross section, pulse repetition frequency, system losses and propagation losses, RADAR transmitters, receivers, Antennas, Displays. Satellite Communication:, look angles, orbital spacing, satellite systems, link modules

List of Experiments

1. Amplitude Modulation.
2. Frequency Modulation.
3. Pulse Amplitude Modulation.
4. Pulse Width Modulation.
5. Pulse Code Modulation.

Text Books:

1. Dennis Roddy, Electronic Communications, Pearson Education India, 1977
2. R.P. Singh and S.D. Sapre, Communication Systems, Tata McGraw Hill, 2011.
3. G. Kennedy, Electronic Communication Systems, Tata McGraw Hill, New Delhi, 1995.
4. M. Schwarts, W. R. Bennet and S. Stein, Communication Systems and Techniques, McGraw Hill, New Delhi.
5. J. Millman and L. C. Halkias, Electronic Devices and Circuits, McGraw Hill, Singapore, 1972.
6. B. P. Lathi, Communication Sytems, BS Publication Hyderabad, 2008.

Reference Books:

1. Samuel Y Liao, Microwave devices and circuits –, Pearson Education, 2003.
2. H. Taub and D. L. Schilling Principles of Communication Systems – (2nd edition) TMH, 2014.
3. Simon Haykin An Introduction to Analog and Digital Communications –, 2nd Ed.,Wiley, 2006.
4. Wyane Tomasi, Electronic Communication Systems, Pearson Education, 2001

Subject Code	Energy Physics	L	T	P	C
PHY18R4037		4	0	0	4
Pre-requisite: Nil	Course Category: Elective *Course Type: Theory*				

Course Objectives:

- *To understand the basic concepts of energies produced from various energy sources, advantages and disadvantages*

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1: To gain the knowledge about different energy sources, energy storage and distribution

CO2: Understand the basic concepts related to ocean energy.

CO3: Understand the basic principles in wind energy conversion and advantage and disadvantage of wind energy conversion systems.

CO4: Gain the knowledge about the energy produced from biomass and biogas.

CO5: Understand the concepts of solar cell and solar energy.

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H		L	M	M	M
CO2	H		L	L	L	L	M
CO3	H	M	L	M		M	L
CO4	H	M	L	L	L	L	L
CO5	H	M	M		M	L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I: Energy Sources

Introduction to energy sources - Energy sources and their availability – prospects of renewable energy sources – Energy from other sources – chemical energy – Nuclear energy – Energy storage and distribution.

Unit II: Ocean Energy

Ocean Energy Resource-Introduction-Tides: Tidel energy to electric energy conversion, Tidal power, Advantage and disadvantage of Tidel power-Ocean currents: Currents Energy to Electric energy conversion, Ocean currents resource in Puerto Rico-ocean Thermal energy: OTEC-Ocean waves energy.

Unit III: Wind Energy

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

Unit IV: Energy from Biomass and Biogas

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

Unit V: Solar Energy

Solar radiation and its measurements – solar, cells : Solar cells for direct conversion of solar energy to electric powers – solar cell parameter – solar cell electrical characteristics -Efficiency – solar water Heater – solar distillation – solar cooking – solar green house.

Text Book:

1. Non-conventional sources of energy by G.D. Rai, 4th edition, Khanna Publishers, New Delhi, (1996)

Reference Books:

1. Energy Technology: Nonconventional, Renewable & Conventional, S. Rao, Khanna Publishers (2005)
2. John Twidell and Tony weir, Renewable energy resources, Taylor and Francis group, London and Newyork, 2005.
3. Solar energy, principles of thermal collection and storage by S.P. Sukhatme 2nd edition,Tata McGraw-Hill publishing co. Ltd., New Delhi, 1997.

Subject Code	Radiation Physics	L	T	P	C
PHY18R4038		**4**	**0**	**0**	**4**
Pre-requisite: Nil	**Course Category:** Elective ***Course Type:*** *Theory*				

Course Objectives:

- *To understand the types of radiation source, radiation quantities and interaction of radiation with matter and also to aware about the protection from the radiation.*

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1: know the radiation source

CO2: learn the knowledge on the interaction of radiation with matter.

CO3: understand the Radiation quantities, Units and Dosimeters

CO4: know about Biological effects

CO5: understand the basic information regarding Radiation protection, shielding and transport

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	M	L	M	L		L
CO2	H		L	L		L	
CO3	H	M	M	L	M	L	L
CO4	H	M		L	M	L	L
CO5	H	L	L		L		L

H – High correlation; M – Medium Correlation; L – Low Correlation

UNIT – I: Radiation source

Types of radiations - ionizing, non ionizing, electromagnetic, particles, neutral – gamma – neutrino neutron - charged alpha, beta, gamma, and heavy ion sources - radioactive sources – naturally occurring production of artificial isotopes – accelerators – cyclotrons

UNIT – II: Interaction of radiations with matter:

Electrons – classical theory of inelastic collisions with atomic electrons - energy loss per ion pair by primary and secondary ionization - specific energy loss – bremsstrahlung - range energy relation - energy and range straggling Heavy charged particles – stopping power - energy loss - range and range – energy relations - Bragg curve

UNIT – III: Radiation quantities, Units and Dosimeters:

Particle flux and fluence - calculation of energy flux and fluence – curie – Becquerel - exposure and its measurements - absorbed dose and its relation to exposure – KERMA - Biological effectiveness - wighting factors - (WR and WT) - Equivalent dose - Effective dose – Dosimeters - Primary and secondary dosimeters - Pocket dosimeter - Films and solid dosimeter (TLD and RPL) - Clinical and calorimetric devices – Radiation survey meter for area monitoring.

UNIT – IV: Biological effects :

Basic concepts of cell biology - Effects of ionizing radiations at molecular - sub molecular and cellular levels - secondary effects - free radicals - deterministic effects - stochastic effects. Effects on tissues and organs - genetic effects - Mutation and chromosomal aberrations - applications in cancer therapy- food preservation - radiation and sterilization.

UNIT – V: Radiation protection, shielding and transport :

Effective radiation protection - need to safeguard against continuing radiation exposure – justification and responsibility – ALARA - concept of radiologic practice - time distance and shielding - safety specifications - method of radiation control - Shielding factor for radiations - Choice of material - Primary and secondary radiations - Source geometry - Beta shielding - Gamma shielding - neutron shielding - Shielding requirements for 18 medical - industrial and research facilities - handling of the source – sealing - transport and storage of sealed and unsealed sources.

Text Books:

1. G.F.Knoll, Radiation detection and measurement, John Wiley & sons, Newyork, (2000)
2. K.Thayalan, Basic radiological physics, Jaypee brothers medical Publishers, New Delhi, (2003)
3. W.J. Meredith and J.B. Masse, Fundamental Physics of radiology, Varghese publishing house , Bombay (1992)

References Books:

1. M.A.S. Sherer, P.J.Visconti, E.R Ritenour, Radiation Protection in medical radiography, Mosbey Elsevier,(2006)
2. Lowenthal G.C and Airey P.L., Practical applications of radioactivity and nuclear radiation sources, Cambridge University Press (2005)

Subject Code	Medical Physics	L	T	P	C
PHY18R4039		4	0	0	4
Pre-requisite: Nil	**Course Category:** Elective ***Course Type:*** *Theory*				

Course Objectives:

- *To understand the basic concepts of physics in the medical field*

Course Outcomes:

Upon successful completion of this course, Students will be able to

CO1: Understand the basic concepts of Biosensor.

CO2: Understand working principles of Transducers, thermister and photo cells.

CO3: Learn the instrumentation techniques of ECG and ENG.

CO4: Learn the basic concepts of X-ray and its application.

CO5: Understand the concepts of thermography and endoscopy.

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H	M		L		L
CO2	H		M	L	L	L	
CO3	H	L	L	M		L	L
CO4	H	M	L	L	L	L	L
CO5	H	M	M			M	

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit – I

Bioelectric Signals – Electrodes – Surface, Needle and Micro Electrodes – Biosensors – Pulse Sensors.

Unit – II

Transducers: Thermistors: Photo electric type – transducer – photo voltaic cells – Photo emissive cells – Diode – Detectors – Optical fibers.

Unit – III

Blood Pressure measurements: Sphygmomanometer Measurement of heart rate – Basic Principles of ECG – Basic Principles of Electroneurography (ENG) – basic Principles of MRI.

Unit – IV:

Basic of X-ray – Production of X-ray – X-ray Image – Applications of X-ray Examinations – Basic Principles of X-ray Tomography.

Unit – V

Endoscopes – Thermography – Liquid Crystal thermography – Microwave thermography – Basic Principles of ultrasonography – Laser – Uses of Lasers in Medicine.

Text Books:

1. Biomedical Instrumentation – Dr. M. Arumugam, Anuratha Agencies Publishers (2002).
2. Handbook of Biomedical Instrumentations, TMG, New Delhi (2005) – R.S.Khandpur.

Reference Books:

1. Bio-Medical Electronics & Instrumentation – Prof. S.K.Venkata Ram – Galgotia Publications Pvt. Ltd.
2. H.E. Jones and J.R. Cunnigham, The Physics of Radiology, Charles C. Thomas. New York (1980).
3. B.H. Brown, R.H. Smallwood, D.C. Barber, P.V. Lawford and D.R. Hose, Medical Physics and Biomedical Engineering, Overseas Press India Private Limited, New Delhi (2005).

Subject Code	Astronomy and Astrophysics	L	T	P	C
PHY18R5031		**4**	**0**	**0**	**4**
Pre-requisite: Nil	**Course Category:** Program core ***Course Type:*** *Theory*				

Course Objective:

The aim of this course focuses to enable the students to understand the Universe and different astronomical objects.

Course Outcomes:

Upon successful completion of this course, Students will be able to

CO1: Understand the basic concepts of coordinate systems, coordinate system used in astronomy, and evolution and properties of stellar objects.

CO2: Understand different mechanisms of energy transfer in stellar objects.

CO3: Understand the nuclear reactions in stellar objects and their behaviour.

CO4: Learn the basic concepts of cosmology and astrophysics.

CO5: Understand the different types astronomy according to the wavelengths of emission.

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H	M	M	M		L
CO2	M	M	L	M	L	L	L
CO3	M	H	M	L		M	L
CO4	M	H	M	L	L	M	M
CO5	H	M	H			L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit –I: Introduction to stars and stellar properties 12 Hour

Ecliptic – equatorial – right ascension and declination – rotation and precession of stars – Solar system – overview – extra solar planets

d, L, M, R, g, T_e, abundances – Magnitudes and bolometric corrections – spectral classifications – colour-magnitude diagram – stellar populations

Unit –II: Energy Transport In Stars 12 Hour

Radiative transfer – interiors Vs atmospheres – opacity – scattering and absorption processes – Rosseland mean – conduction, convection – Schwarzschild criterion – mixing length theory – turbulence and dissipation

Unit – III: Nuclear Reactions In Astrophysics and Sequence Of Evolution 12 Hour

Binding energy per nucleon – isotopic abundances – H and He burning – non-resonant and resonant reactions

Equations of stellar structure – internal and gravitational energy – PP chains, CNO cycles, solar neutrinos – surface boundary conditions – Shell hydrogen burning – properties of giant stars – Core helium burning – properties of horizontal branch stars – adiabatic pulsations of a spherical star – nucleo-synthesis.

Unit – IV: The Observed Universe 12 Hour

The cosmological distance scale – The Cosmological Principle – The expansion of the Universe – Hubble’s law – The deceleration parameter – The cosmological constant – The large scale distribution of matter – Clustering properties – The age of the Universe – Relationship to the

Hubble's constant – Stellar evolution – Cosmic background radiations – Mass density of the Universe.

Unit V: Multicolour Astronomy And Instrumentation 12 Hour

Introduction to – Radio Astronomy - Infrared Astronomy – X-ray Astronomy – γ-ray Astronomy – Hubble's telescope – Chandra X-ray telescope – Spitze IR telescope – Spacecraft and Ground Based γ-ray telescopes (TACTIC, PACT etc.,).

Text Books:

1. Franklin Shu, Physical Universe, University Science Books; 1981 edition (17 January 1981)
2. Martin Harwit, Astrophysical Concepts, Springer; 4th ed. 2006

Reference:

1. V.B. Bhatia, Text Book of Astronomy and Astrophysics with elements of Cosmology, Alpha Science International Ltd (1 January 2001)

Subject Code	Atmospheric Physics	L	T	P	C
PHY18R5032		4	0	0	4
Pre-requisite: Nil	Course Category: Elective *Course Type: Theory*				

Course Objective:

The aim of this course focuses to enable the students to understand the nature and behaviour of earth's atmosphere.

Course Outcomes:

Upon successful completion of this course, Students will be able to

CO1: Understand the basic composition of earth's atmosphere and different processes going on in the atmosphere.

CO2: Understand the theory of atmosphere and its properties.

CO3: Understand and analyse the different processes going in the atmosphere in day to day basis as well as long term basis.

CO4: Learn the causes of pollution of atmosphere and the remedies..

CO5: Understand the different types of meteorological measurements and reporting.

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H	M	M	M		L
CO2	M	M	L	M	L	L	L
CO3	M	H	M	L		M	L
CO4	M	H	M	L	L	M	M
CO5	H	M	H			L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit – I **12 Hour**

Atmospheric composition - Laws of thermodynamics of the atmosphere - Adiabatic process - Potential temperature - The Clauses – Clapyeron equation - law of black body radiation - solar and terrestrial radiation - Albedo - Green house effect - Heat balance of earth atmosphere system.

Unit – II **12 Hour**

Fundamental force - Non-Inertial reference frames and apparent forces - Structure of static atmosphere.

Momentum - Continuity and energy equations - Thermodynamics of the dry atmosphere - Elementary applications of the basic equations.

The circulation theorem - Voracity, Potential Voracity, Voracity and potential Voracity equations.

Unit – III **12 Hour**

Wind - Temperature and pressure distribution over India in the lower - Middle and upper atmosphere during pre, post and mid-monsoon season - Monsoon circulation in the meridonal (Y-Z) and (X-Y) planes - Energy cycle monsoon - Dynamics of monsoon depressions and easterly waves - Intra-Seasonal and inter-annual variability of monsoon - Quasi-be weekly and 30-60 day oscillations - ENSO and dynamical mechanism for their existence.

Unit – IV **12 Hour**

Role of meteorology on atmospheric pollution - Atmospheric boundary layer, air stability, local wind structure, Ekman spiral, turbulence boundary layer scaling - Residence time and reaction rates of pollutants, sulphur compounds nitrogen compounds - carbon compounds, organic compounds, aerosols, toxic gases and radioactive particles trace gases.

Unit – V **12 Hour**

Basic meteorology - radar principles and technology - Radar signal processing and display - Weather radar-observation of precipitating systems - Estimation of precipitation radar observation of tropical cyclones - Use of weather radar in aviation, clear air radars - Observation of clear air phenomena - Other radar systems and applications.

Text Books:

1. Frederick K.Lutgens and Edward J.Tarbuk, The atmosphere, Holton. J.R, 1992, Dynamic Meteorology, Academic press New York.
2. Keshvamuthhy. R.N. and M.Shankar Rao, 1992, The Physics of Monsoons, Allied Publishers, New Delhi

References Books:

1. Haltiner. G.J. and R.T. Villians, 1980, Numerical Whether Prediction, John Wiley and sons, New Delhi.
2. Tom Lyons and Prillscott, Principles of Air Pollution Meteorology, CBS publishers and Distributors (P) Ltd.,

Subject Code	Analytical Instrumentation	L	T	P	C
PHY18R5033		**4**	**0**	**0**	**4**
Pre-requisite: Nil	**Course Category:** *Elective* **Course Type:** *Theory*				

Course Objective:

To strengthen the students with the fundamental terms, concepts, theory and application of analytical instrumentation.

Course Outcomes:

Upon successful completion of this course, Students will be able to

CO1: To know the fundamental terms of analytical techniques and analytical methods.

CO2: To gain the knowledge different methods based on X- rays.

CO3: Gain the knowledge of different thermal techniques.

CO4: To Learn and Understand the spectroscopic methods.

CO5: Gain the knowledge on various kind of electron microscopy techniques.

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	M	M	L	M		L
CO2	H	M	H	L	L	L	L
CO3	M	M	H	L		M	L
CO4	H	H	H	M	L	M	M
CO5	H	L	H			L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I: Introduction to Instrumental Methods **12 Hours**

Fundamental terms – Classification of instrumental techniques –Important considerations in analytical methods – Basic functions of instrumentation – Considerations in evaluating an instrumental methods – Signal to noise ratio - Sensitivity and detection limit – Accuracy and instrumental calibration.

Unit II: X – Ray Methods **12 Hours**

Production of X – ray and X – ray spectra – Instrumentation – Direct X – ray methods – X – ray Absorption, Fluorescence, Diffraction methods – Auger Emission spectroscopy (AES).

Unit III: Thermal analysis **10 Hours**

Thermogravimetry – Differential scanning calorimetry and differential analysis – Evolved gas detection and analysis – Methodology for thermogravimetry, differential scanning calorimetry, and differential thermal analysis – Thermomecahnical analysis and dynamic mechanical analysis.

Unit IV: Spectroscopic techniques **14 Hours**

Nature of electromagnetic radiation – Radiation sources, wavelength selection – fundamental laws of photometry - Instruments of absorption photometry – Correlation of infrared spectra with molecular structure – instrumentation, sample handling, quantitative analysis – Raman theory, instrumentation, quantitative analysis – comparison of Raman with Infrared spectroscopy – other spectroscopic techniques.

Unit V: Electron Microscopy analysis **12 Hours**

Scanning electron microscopy, Transmission electron microscopy, Atomic force and scanning tunneling microscopy, Surface analytical methods.

Text Book(s):

1. Hobart H. Willard, Lynne L. Merritt, Jr., John A. Dean and Frank A. Settle, Jr., Instrumental methods of analysis, Seventh Edition, CBS Publishers, 1986.

Reference Books:

1. Michael Sayer, Abhai Mansingh, Measurement, Instrumentation and Experiments in Physics and Engineering, Eastern Economy Edition, PHI Learning, 2015.
2. P.C. Angelo, Materials Characterization, Isa Publishers , 2014.
3. R.S. Khandpur, Handbook of analytical instruments, Second Edition, Tata McGraw Hill Publications, 2006.

Subject Code	Crystal Growth and Crystallography	L	T	P	C
PHY18R5034		4	0	0	4
Pre-requisite: Nil	Course Category: *Elective* Course Type: *Theory*				

Course Objective:

To strengthen the students with crystallographic and crystal growth techniques.

Course Outcomes:

Upon successful completion of this course, Students will be able to

CO1: To know the fundamentals in crystal symmetry and structures.
CO2: To gain the knowledge in X- ray Diffraction.
CO3: Gain the knowledge of different types of diffraction techniques.
CO4: To Learn and Understand the crystal growth theories.
CO5: Acquire the knowledge in crystal growth techniques.

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	M	M	L	M		L
CO2	H	M	H	L	L	L	L
CO3	M	M	H	L		M	L
CO4	H	H	H	M	L	M	M
CO5	H	L	H			L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I: Crystal Symmetry and Structures **12 Hours**

Symmetry operations, elements - translational symmetries - point groups - space groups - equivalent positions – close packed structures - voids - important crystal structures – Pauling's rules - defects in crystals – polymorphism and twinning.

Unit II: X-Ray Diffraction **12 Hours**

Generation of X-rays - laboratory sources – X-ray absorption – X-ray monochromators - X-ray detectors (principles only) - diffraction by X-rays - Bragg's law - reciprocal lattice concept - Laue conditions - Ewald and limiting spheres - atomic scattering factor - anomalous scattering - neutron and electron diffraction (qualitative only)

Unit III: Single Crystal and Powder Diffraction **12 Hours**

Laue, rotation/oscillation methods - interpretation of diffraction patterns - cell parameter determination – indexing – systematic absences - space group determination (qualitative only). Powder diffraction: Debye-Scherrer method – uses.

Unit IV: Crystal Growth Theory **12 Hours**

Introduction to crystal growth - nucleation – Gibbs-Thomson equation - kinetic theory of nucleation – limitations of classical nucleation theory - homogeneous and heterogeneous nucleation – different shapes of nuclei – spherical, cap, cylindrical and orthorhombic – Temkins model – physical modeling of BCF theory.

Unit V: Crystal Growth Techniques **12 Hours**

Bridgman technique - Czochralski method - Verneuil technique - zone melting – gel growth – solution growth methods – low and high temperature solution growth methods – vapour growth - epitaxial growth techniques- LPE – MOCVD – MPE

Text Books:

1. H.E.Buckley. Crystal growth. John Wiely & sons, New York, 1981.
2. L.V.Azaroff. Elements of X-ray crystallography. Techbooks, 1992.
3. P.Ramasamy and P.Santhanaraghavan. Crystal growth processes and methods. KRU Publications, 2000.

Reference Books:

1. D.Elwell and H.J.Scheel. Crystal growth from high temperature solution. Academic Press, New York,1995.
2. R.A.Laudise. The growth of single crystals. Prentice Hall, Englewood,1970.
3. J.A.K.Tareen and T.R.N.Kutty. A basic course in crystallography. University Press, 2001.
4. C.Hammond. The Basics of Crystallography and Diffraction, IUCr-Oxford University Press, 2009.

Subject Code	Materials Science	L	T	P	C
PHY18R5035		4	0	0	4
Pre-requisite: Nil	Course Category: Elective *Course Type: Theory*				

Objective:

This course aims to give exposure to the students on basic knowledge on materials science

Course Outcomes:

Upon successful completion of this course, Students will be able to

CO1:Understand the basics of Phase diagram

CO2:Analyse the mechanical behavior of materials

CO3:Understand the basic concepts of magnetism and its applications

CO4:Apply the concepts of dielectric materials in day today life

CO5: Understand the basic knowledge on advanced materials

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H	M	H	M		L
CO2	M	L	H	H	H	L	L
CO3	H	L	L	H		M	L
CO4	H	M	M	L	L	M	M
CO5	H	M	H			L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I: Phase Diagrams **12 Hours**

Solubility limit, phase equilibrium, binary eutectic systems, ceramic phase diagram, Phase rule, microstructures, Iron-Carbon system, influence of alloying, Isothermal Transformation Diagrams, Continuous Cooling Transformation Diagrams, Austenite, Pearlite, Bainite and Martensite phases of Iron-Carbon alloys

Unit II: Mechanical Properties **12 Hours**

Factors affecting mechanical properties - mechanical tests - tensile, hardness, impact, creep and fatigue - Plastic deformation by slip - shear strength - work hardening and recovery - fracture - Griffith's theory - slip and twinning - creep resistant materials - diffusion – Fick’s law.

Unit III: Magnetic Properties **12 Hours**

Classification - dia, para, ferro, antiferro and ferrimagnetism – Langevin and Weiss theories - exchange interaction - magnetic aniostrophy - magnetic domains - molecular theory – hysterisis - hard and soft magnetic materials - ferrite structure and uses - magnetic bubbles - magnetoresistance - GMR materials - dilute magnetic semiconductor (DMS) materials..

Unit IV: Optical Properties **12 Hours**

Optical absorption in insulators, semiconductors and metals – band to band absorption – luminescence - photoconductivity. Injection luminescence and LEDs - LED materials - superluminescent LED materials - liquid crystals - properties and structure - liquid crystal displays-comparison between LED and LC displays.

Unit V: Advanced Materials **12 Hours**

Metallic glasses - preparation, properties and applications - SMART materials - piezoelectric, magnetostrictive, electrostrictive materials - shape memory alloys - rheological fluids - CCD device materials and applications - solar cell materials (single crystalline, amorphous and thin films) - surface acoustic wave and sonar transducer materials and applications - introduction to nanophase materials and their properties.

Text Books:

1. Materials Science and Engineering, W. D. Callister, Jr. Wiley Eastern Limited, 1984.
2. V.Raghavan, Materials Science and Engineering, Prentice Hall,2003.
3. D.R.Tilley and J.Tilley, Superfludity and superconductivity, 3rd Edition, Hilger,1990

Reference Books:

1. Charles Kittel, Introduction to solid state physics, Wiley 7th edition, 1996.
2. K.V.Keer, Principles of solid state physics, Wiley - Eastern, 1993.
3. Microelectronic Materials - C.R.M.Grovenor, Adam Hilger, Bristol and Philadelphia,1989.

Subject Code	Nanoscience And Nanotechnology	L	T	P	C
PHY18R5036		**4**	**0**	**0**	**4**
Pre-requisite: Nil	**Course Category: Elective** *Course Type: Theory*				

Objective:

This course aims to give exposure to the students on basic knowledge on Nanoscience and Nanotechnology

Course Outcomes:

Upon successful completion of this course, Students will be able to

CO1: understand the fundamentals of Nanotechnology.

CO2: Acquire the basic knowledge on nucleation, materials preparation techniques.

CO3: learn the fundamentals about the different types of nanostrucures

CO4: understand the different properties of nanomaterials.

CO5: know the applications of nanomaterials in day today life.

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	H	M	H	M		L
CO2	M	L	H	H	H	L	L
CO3	H	L	L	H		M	L
CO4	H	M	M	L	L	M	M
CO5	H	M	H			L	L

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I: Background to Nanotechnology **12 Hour**

Scientific revolution- Atomic structures-Molecular and atomic size-Bohr radius – Emergence of Nanotechnology – Challenges in Nanotechnology - Carbon age–New form of carbon (from Graphene sheet to CNT).

Unit II: Nucleation **12 Hour**

Influence of nucleation rate on the size of the crystals- macroscopic to microscopic crystals and nanocrystals - large surface to volume ratio, top-down and bottom-up approaches-self assembly process-grain boundary volume in nanocrystals-defects in nanocrystals-surface effects on the properties.

Unit III: Types of Nanostructures **12 Hour**

Definition of a Nano system - Types of Nanocrystals-One Dimensional (1D)-Two Dimensional (2D) -Three Dimensional (3D) nanostructured materials - Quantum dots - Quantum wireCore/Shell structures.

Unit IV: Nanomaterials and properties **12 Hour**

Carbon Nanotubes (CNT) - Metals (Au, Ag) - Metal oxides (TiO_2, CeO_2, ZnO) - Semiconductors (Si, Ge, CdS, ZnSe) - Ceramics and Composites - Dilute magnetic semiconductor- Biological system - DNA and RNA - Lipids - Size dependent properties - Mechanical, Physical and Chemical properties.

Unit V: Applications of Nanomaterials 12 Hour

Molecular electronics and nanoelectronics – Quantum electronic devices - CNT based transistor and Field Emission Display - Biological applications - Biochemical sensor - Membrane based water purification.

Text Books:

1. M. Wilson, K. Kannangara, G Smith, M. Simmons, B. Raguse, Nanotechnology: Basic science and Emerging technologies, Overseas Press India Pvt Ltd, New Delhi, First Edition, 2005.
2. C.N.R.Rao, A.Muller, A.K.Cheetham (Eds), The chemistry of nanomaterials: Synthesis, properties and applications, Wiley VCH Verlag Gmbh&Co, Weinheim, 2004.

Reference Books:

1. Kenneth J. Klabunde (Eds), Nanoscale Materials Science, John Wiley & Sons, InC, 2001.
2. C.S.S.R.Kumar, J.Hormes, C.Leuschner, Nanofabrication towards biomedical applications, Wiley –VCH Verlag GmbH & Co, Weinheim, 2004.
3. W. Rainer, Nano Electronics and information Technology, Wiley, 2003.
4. K.E.Drexler, Nano systems, Wiley, 1992.
5. G.Cao, Naostructures and Nanomaterials: Synthesis, properties and applications, Imperical College Press, 2004.

Subject Code	Research Methodology	L	T	P	C
PHY18R5041		2	0	0	2

Pre-requisite: Nil **Course Category: Special course**
Course Type: Theory

Objective:
This course aims to give exposure to the students on research methodology

Course Outcomes:
Upon successful completion of this course, Students will be able to
CO1: understand the basics of research methodology
CO2: understand the different types of research design and know the concepts on experimental design
CO3: learn the fundamentals of optical and thermal property related instrumentation techniques.
CO4: Understand the working principles of magnetic property and compositional analysis related instrumentation techniques.
CO5: solve the numerical problems through numerical problems.

Mapping of Course Outcome(s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	M	M	L	M		L
CO2	H	L	M		M		
CO3	H	M	L			L	
CO4	H	M	L	L		L	
CO5	H	M	L		L		

H – High correlation; M – Medium Correlation; L – Low Correlation

Unit I: Basics of Research methodology **12 Hours**
Selection of a research problem - literature survey - choosing a problem - current status of the problem - analysis of the problem - inferences - art of publishing research articles, reports.

Unit II: Research Design **12 Hours**
Meaning of Research Design – Need for Research Design – Features of Good Design – Concepts – Different Research Design – Basic Principles of Experimental Designs

Unit III: Characterization techniques – I **12 Hour**
Infrared, Raman, Ultraviolet, Atomic Absorption Spectroscopy, Thermal Gravimetric Analysis, Differential Thermal Analysis, (all the methods instrumentation and application only).

Unit IV: Characterization techniques – II **12 Hour**
Microhardness, Vibration Sample Magnetometer, Scanning electron microscope , Energy Dispersive X-ray Analysis, Ellipsometry, Photoluminesence (all the methods instrumentation and application only)

Unit V: Numerical methods **12 Hour**
Newton Raphson method- successive approximation method- Gauss elimination method-trapezoidal method-Simpson's rule-comparison of trapezoidal and Simpson rule(error analysis).

Reference books

1. Reseach methodlogy, C.R.Kothari, New age international publishers, 2005.
2. Research methodology, A step by step guide for beginners, Ranjit Kumar, Sage, 2005.
3. Instumental methods of chemical analysis, Gurseep R.Chatwal, Sham K. Anand, Himalaya Publishing house, 2007 reprint.
4. Computer oriented numerical methods, V.Rajaram, Prentice hall, 2004.
5. Relevant research articles

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Course Work for Ph.D. in Physics

(2018 Onwards)

PHY17RD024	RADIATION PHYSICS	L	T	P	C
		3	0	0	3

Unit I: Radiation Detection

Principles of Radiation Detection and measurement – Basic Principles of radiation detection – Gas filled detectors – Ionization chambers – Theory and design – Construction of condenser type chambers and thimble chambers – Gas multiplication – Proportional and GM counters – Characteristics of organic and inorganic counters – Dead time and recovery time – Scintillation detectors – Semiconductor detectors – Chemical systems – Radiographic and Radiochromic films – Thermoluminescent Dosimeters (TLD) – Optically stimulated Luminescence dosimeters (OSLD).

Unit II: Absolute dose measurements in high energy photon and electron beams

Primary standard dosimetry, Secondary standard dosimetry, Reference standard dosimetry, International code of practice for dosimetry – IAEA TRS 398 protocol -Absorbed dose determination in photon and electron beams - Use of thimble chamber - Use of parallel plate chamber. **Radiation dose distribution and scatter analysis:** Phantoms, Tissue Air Ratio, Effect of distance, Variation with depth, energy and field size, Back scatter factor, Percentage depth dose, Dependence on beam quality and depth, Initial depth dose build up, Effect of field size and shape, Dependence on source surface distance relationship between TAR and percentage depth dose, Conversion of percentage depth dose from one SSD to another, Equivalent squares and circles for rectangular and irregular fields, Scatter air ratio.

Unit III: Radiation therapy planning

Isodose curves, Measurement of is dose curves, Parameters of isodose curves-Beam quality, SSD, SDD, and source size, Beam collimation, Beam flattening filter, Wedge filter-Wedge angle, Wedge transmission factor, Effect on beam quality, Design aspects of wedge filters, Isocentric techniques- Stationary beams, Rotation therapy.

Tumor dose specification for external photon beams-Target volume, Treatment volume, irradiated volume, maximum, minimum and mean target dose, Hot spots.

Unit IV: Small Field Dosimetry

Definition of small field – Dosimetric challenges and issues related to small field dosimetry – Electron range and loss of charge particle equilibrium – Effect of radiation source size – Measurement issues – Corrections and perturbations.

Dosimeter choice in small field dosimetry: Properties and dependence – Measurement task in relative dosimetry – Profile – Penumbra – PDD – Total scatter factor (Scp) – Head Scatter factor (Sc) – Phantom Scatter factor (Sp) – Dosimetric effects of collimating jaws for tertiary collimated beams.

Unit V: Small field measurements in advanced radiotherapy techniques

Stereotactic Radiosurgery (SRS): Linac based SRS, micro Multileaf collimator – stereotactic circular cones – Beam data acquisition and parameters required for SRS - Dose calculation - Quality assurance requirements.

Intensity Modulated Radiation Therapy (IMRT): Multi-leaf collimators - Design features, transmission requirements - Intensity modulation: Static IMRT, Dynamic IMRT, Arc therapy with dynamic delivery, Treatment planning, Plan optimization, Dose display and evaluation of plan – Small field dosimetric concerns in IMRT.

Reference Books:

1) The Physics of Radiology, H.E. Johns and J.R.Cunningham, Charles C Thomas Pub Ltd; Subsequent edition, 1983.
2) The Physics of Radiation Therapy, Faiz M.Khan, Lippincott Williams and Wilkins; 4th Revised edition, 2009.
3) Radiation Oncology Physics: A hand book for teachers and students, E. B. Podgorsak, IAEA, 2005.
4) Introduction to Radiological Physics and Radiation Dosimetry, Frank H Attix, Wiley VCH, 1986.
5) Clinical Dosimetry Measurements in Radiotherapy (Medical Physics Monograph No 34), DWO. Rogers, J.E. Cygler., American Association of Physicists in Medicine (AAPM), 2009.
6) Radiation Detection and Measurement, Glenn F. Knoll, John Wiley & Sons; 4th Edition, 2010.
7) Advanced Medical Radiation Dosimetry, K. N. Govinda Rajan., Medical Physics Pub Corp., 1992.
8) The Physics of Three-Dimensional Radiation Therapy (Medical Science Series), Conformal Radiotherapy, Radiosurgery and Treatment planning, Steve Webb, 1993.
9) An International Code of practice for Dosimetry based dose to water IAEA Tech. Series No.398, Absorbed dose determination in external beam radiotherapy, IAEA, Vienna, 2000.
10) Small Field MV photon dosimetry. Institute of Physics and Engineering in Medicine, 2010.

PHY17RD025	BIOSENSORS	L	T	P	C
		3	0	0	3

Unit I: Biosensor Transducers

Electrochemical transducers (amperometric- potentiometric, conductimetric) - Semiconductor transducers (ISFET, ENFET)-Optical transducers (absorption, fluorescence-bio/chemiluminescence, SPR)-Thermal transducers; Piezoelectric and acoustic-wave transducers-Limitations & problems to be addressed-An Overview of Performance and Applications.

Unit II: Biosensor Fabrication

Methods for biosensors fabrication – self-assembled monolayers – screen printingphotolithography – soft lithography– micro contact printing – Deposition and selective etching – thin film growth and deposition - MEMS – Engineering concept

Unit III: Types Of Biosensors

Catalytic biosensors- mono-enzyme electrodes-bi-enzyme electrodes-enzyme sequence electrodes and enzyme competition electrodes-Affinity-based biosensorsInhibition- based biosensors-Cell-based biosensors-Biochips and biosensor arraysProblems and limitations.

Unit IV: Detection In Biosensors/ Biorecognition System

Enzymes- Oligonucleotides and Nucleic Acids - Lipids (Langmuir-Blodgett bilayers, Phospholipids, Liposomes) - Membrane receptors and transporters; Microbial metabolism-Tissue and organelles (animal and plant tissue)-Cell culture; Immunoreceptors-Chemoreceptors-Limitations.

Unit V: Biosensors For Medical Applications

Biorecognition elements and transduction technology - Biorecognition elements - Transduction technology - Biosensors for diabetes applications - Glucose as diabetes biomarker - Biosensors for glucose measuring - Biosensors for cardiovascular diseases applications - Cardiovascular disease biomarkers - Biosensors in cardiovascular disease Biosensors for cancer applications - Cancer biomarkers - Biosensors in cancer diseases

Reference Books

1. Tatsuo Togawa, Toshiyo Tamura, P. Ake Oberg, Biomedical Transducers and Instruments, CRC Press, New York, 1997.
2. Jacob Kline, Handbook of Bio Medical Engineering, Academic press Inc., Sandiego, Oxford University Press, 2004.
3. Smart Biosensor Technology, G. K. Knoff, A. S. Bassi, CRC Press, 2006
4. Jiri Janata, Principles of Chemical Sensors, Plenum Press, 1989
5. Frontiers in Biosensors, Edited by: F. Schellr, F. Schubert, J. Fedrowitz, Birkhauser Verlag, 1995.
6. Optical Biosensors. Present & Future. Editors: F. Ligler, C. Rowe Taitt, Elsevier, 2002.
7. Biosensors for Health, Environment and Biosecurity, Edited by Prof. Pier Andrea Serra, Intech 2011.

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Elective paper for M.Tech. Bio Technology

Syllabi

(2018 Onwards)

PHY18R5071	MOLECULAR BIOPHYSICS	L	T	P	C
		3	0	0	3

Course Outcomes:

At the end of the course, students would be able to

CO1: Explain the principles of molecular biophysics.
CO2: Summarize the role of membrane proteins.
CO3: Describe the principles and working of structural genomics, proteomics, sequence analysis.
CO4: Apply the principles of molecular and statistical thermodynamics
CO5: Explore the advanced topics in biophysical methods and their applications.

CO and PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H		H	H							
CO2	H	H		H	H							
CO3	H	H		H	H							
CO4	H	H		H	H							
CO5	H	H		H	H							

Unit I: Introduction To Molecular Biophysics 9 hours

Biological macromolecules: conformation, patterns and equilibrium; structure of DNA and protein; Basics of I-P-EF-E-R-C: charge (I), potential (P), electric field(EF), energy(E), resistance (R), and capacitance(C). Biological organization and point of association; Chemical constituents of living biosystems; Basics of SP-K-RC-E symmetrical processes (SP); Kinetics(K), Rate constants(RC), Equilibrium(E); Transition state theory.

Unit II: Introduction to Membrane Proteins 9 hours

Organization, biological relevance and role of cell membranes: Protein Isolation, Purification, Biophysical assays and its Functions; The general architecture of the cell membrane; Bilayer Lipid Membranes and Liposomes: Physical characteristics, reflexive electrical characteristics, transport and biological significance; . Transport: diffusion, assisted transport, ion channel, potential, action potential, ionic current. Case studies: neuron’s arrangement and physiological significance, axon., unmyelinated axon membrane.

Unit III: Structural Genomics, Proteomics, Sequence Analysis 9 hours

Introduction to structural genomics – *de novo* methods, *ab initio* modeling, sequence based modeling, threading, protein structural databases and classification; Spectroscopic methods of structure determination. Basics of proteins and proteomics- Introduction to amino acids and proteins, protein folding/mis-folding, introduction to proteomics. Case study of a G-coupled protein receptor. Basic methods of sequencing.

Unit IV: Thermodynamics 9 hours

Molecular Thermodynamics: molecular forces, energy, entropy and strength of natural structures; Statistical Thermodynamics: structural changes in biopolymers, folding/unfolding of proteins and nucleic acids.

Unit V: Biophysical Methods 9 hours

Introduction of the tools for inclusive, micro and individual molecule measurement; optical and force spectroscopy: UV/VIS, IR, and FTIR, Optical and Magnetic Tweezers; Microscopy: SEM, TEM, STEM, STM, SNOM and SECM; Nano-electrochemistry and molecular electronics.

Text Books

1. Tuszynski, J.A. and Kurzynski, M., Introduction to molecular biophysics, CRC press, 1st edition, 2003.
2. Volkenstein, M. V; Molecular biophysics, Elsevier, 1st edition, 2012.

References

1. Jackson, M.B; Molecular and cellular biophysics, Cambridge University Press, 1st edition, 2006.
2. Nemecek, D. and Thomas, G. J. Handbook of Molecular Biophysics. Methods and Applications, 1st edition, 2009.