DEPARTMENT OF PHYSICS

POSTGRADUATE PROGRAMME
M. Sc. in PHYSICS

(Courses effective from Academic Session 2016-2017)

SYLLABI OF COURSES TO BE OFFERED
(As per Ordinance 22 (B))

SCHOOL OF MATHEMATICAL AND PHYSICAL SCIENCES

DOCTOR HARISINGH GOUR VISHWAVIDYALAYA
SAGAR (M.P.) 470003

PREAMBLE

Physics is the most basic of the natural sciences. It is concerned with understanding the world on all scales of length, time, and energy. The methods of physics are diverse, but they share a common objective to develop and refine fundamental models that quantitatively explain observations and the results of experiments. The discoveries of physics, exemplified by the laws of physics, rank among the most important achievements of human inquiry, and have an enormous impact on human culture and civilization.
The story of physics has been of people who thought outside the box. From Galileo and Newton in the 1600s to Einstein and Feynman in the 20th century, the progress of science in answering fundamental questions about the Nature is rooted in a different way of approaching things. A scientific way to test the validity of a physical theory, using a methodical approach to compare the implications of the theory in question with the associated conclusions drawn from experiments and observations conducted to test it.

The M.Sc. Physics is a rigorous study program at post graduate level covering both the depth and breadth of all relevant areas, and provides substantial research training. It is designed to impart a thorough knowledge of the fundamental principles of the several branches of physics, as mathematically and experimentally demonstrated; and also to execute with their own hands various experiments to have hands-on experience with the tools and methods of physics, not simply with the concepts. The program aims to train future generations of physicists with specialization in the frontier areas of research.

Besides training the future generations of physicists, the programme aims at imparting training in instrumentation and communication skills for all round development of students.

The programme consists of **60** credits in core area of physics, **16** credits for elective courses in physics and **four (4)** credits for interdepartmental course. Compulsory **ten (10)** credits have been assigned to communication skills and seminars. Thus, a total of **90** credits are required to complete the M. Sc. Programme in Physics. Instrumentation Skill Development and Scientific Communication Skill are unique features of the curriculum for overall skill development of the students. Eight credits have been assigned to seminars equally spread over the four semesters with an aim for better comprehension and communicative skills required for academic field. The project assignment in the fourth semester will strengthen the students' ability for independent study and develop interest into research.

The M.Sc. (Physics) is a Post Graduate four semester programme spanning over duration two years.

S.No.	Nature of Courses	Credits
1.	Core Courses	60
2.	Departmental Elective Courses	16
3.	Departmental Skill Enhancement Courses	10
4.	Open Elective Courses (from other Departments)	04
	Total	**90**

[A] Scheme of Examination :

S.No.	**Nature of Exam**	**Marks**
1.	Mid Semester Examination	20
2.	Internal Assessment	20
3.	End Semester Examination	60
	Total	**100**

[B] Assessments :

i) Internal Assessment:

a) Theory :

Each theory course must clearly mention the methodology of assessment i.e. assignment, presentation, group discussion etc depending on the number of students in the class and feasibility of adopting a particular methodology. The distribution of marks for internal assessments shall be as follows;

(i)	Evaluation of the assignment,	:	
	presentation , group discussion etc	:	15 Marks
(ii)	Attendance	:	05 Marks

The marks for attendance shall be awarded as follows :

(i)	75 % and Below	:	00 Mark
(ii)	>75 % and upto 80 %	:	01 Mark
(iii)	>80 % and upto 85 %	:	02 Marks
(iv)	>85 % and upto 90 %	:	03 Marks
(v)	>90 % and upto 95 %	:	04 Marks
(vi)	>95 % and	:	05 Marks

The introductory note must also mention that to be eligible to appear in End Semester Examination a student must appear in Mid Semester Examination and internal Assessment.

b) Practical/ Lab Courses :

(i)	Performing and getting the experiment checked regularly and incorporating the suggestion in the practical note book	:	15 Marks
(ii)	Attendance	:	05 Marks

The marks for attendance shall be as follows :

(i)	75 % and Below	:	00 Mark
(ii)	>75 % and upto 80 %	:	01 Mark
(iii)	>80 % and upto 85 %	:	02 Marks
(iv)	>85 % and upto 90 %	:	03 Marks
(v)	>90 % and upto 95 %	:	04 Marks
(vi)	>95 % and	:	05 Marks

[C] End Semester Examination for Practical/ Lab Courses :

It will consist of 60 marks as follows :

(a)	Assessment of performance in the Experiment	:	50 Marks
(b)	Viva-Voce of Experiment	:	10 Marks

[D] Evaluation of Projects :

It will be based on periodic assessment of the progress of the project and End Semester Examination as follows :

(i)	First periodic assessment of the progress after 08 weeks	:	20 Marks
(ii)	Second periodic assessment after 04 weeks	:	20 Marks
(iii)	End Semester Examination will consist of		
	(a) Evaluation of the project report	:	50 Marks
	(b) Viva-Voce of the project report	:	10 Marks

[E] Evaluation of Seminars:

1.	Documentation for the seminar	:	20 Marks
2.	First presentation of the seminar	:	20 Marks
3.	End Semester Examination	:	60 Marks
	End Semester Examination will consists :		
	(i) Presentation of the seminar	:	50 Marks
	(ii) Defense of the presentation	:	10 Marks

Attendance: 75 % attendance in a course is mandatory for a student to appear in end semester examination.

Syllabi of M.Sc. (Physics)

The detail of the course structure with code, title and the credits assigned to each course is given below.

M. Sc. (Physics): Session 2016-17

Course structure

Semester – I	Compulsory Courses (22 Credits)	L	T	P	C
PHY CC 121	Mathematical Physics	3	1	0	4
PHY CC 122	Classical Mechanics	3	1	0	4
PHY CC 123	Digital Electronics and Operational Amplifiers	3	1	0	4
PHY CC 124	Atomic, Molecular and Laser Physics	3	1	0	4
PHY CC 125	Laboratory Course – I (General-I)	0	0	2	2
PHY CC 126	Laboratory Course – II (Electronics-I)	0	0	2	2
PHY SE 121	Seminar				2

Semester – II	Compulsory Courses (22 Credits)				
PHY CC 221	Quantum Mechanics	3	1	0	4
PHY CC 222	Electrodynamics and Plasma Physics	3	1	0	4
PHY CC 223	Electronic Devices	3	1	0	4
PHY CC 224	Condensed Matter Physics	3	1	0	4
PHY CC 225	Laboratory Course –III (General -II)	3	1	2	2
PHY CC 226	Laboratory Course – IV (Electronics -II)	0	0	2	2
PHY SE 221	Seminar				2

Open Elective Courses

PHY OE 221	Energy and Environment	2	0	0	2

Semester – III	(Compulsory Courses : 14 credits; Electives: 6/8 credits)				
PHY CC 321	Statistical Mechanics	3	1	0	4
PHY CC 322	Computational Physics	3	1	0	4
PHY CC 323	Laboratory Course (Computer Programming)	0	0	2	2
PHY CC 324	Instrumentation Skill Development	0	0	2	2
PHY SE 321	Seminar				2

Elective Courses	(any two of the followings)				
PHY EC 321	Microprocessor and Microcontroller	3	0	0	3
PHY EC 322	Laboratory Course (Microprocessor and Microcontroller)	0	0	1	1
PHY EC 323	Materials Science	3	1	0	4
PHY EC 324	Laser Physics and Optical Fiber	3	1	0	4
PHY EC 325	Applied Condensed Matter Physics	3	1	0	4

Open Elective Courses

PHY OE 321	Nanomaterial's and Nanotechnology	2	0	0	2

Semester – IV	(Core : 12 credits ; Electives: 10/8 credits)				
PHY CC 421	Advanced Quantum Mechanics	3	1	0	4
PHY CC 422	Nuclear and Particle Physics	3	1	0	4
PHY SE 421	Scientific Communication Skills	2	0	0	2
PHY SE 422	Seminar				2

Elective Courses (Compulsory Project: PHY E 429 & at least one of the followings)

PHY EC 421	VLSI Design	3	0	0	3
PHY EC 422	Laboratory Course (VLSI Design)	0	0	0	1
PHY EC 423	Physics of Nanomaterials	3	1	0	4
PHY EC 424	Plasma Physics	3	1	0	4
PHY EC 425	Environmental Physics	3	1	0	4
PHY EC 426	Atmospheric Science	3	1	0	4
PHY EC 427	Nanophotonics	3	1	0	4
PHY EC 428	Nanoelectronics and Nanosystems	3	1	0	4
PHY EC 429	Project				4

PHY EC 421 & PHY EC 422 is offered as a single bunch.

*The students must earn at least **4** credits from other departments.*

The detailed syllabi of the courses are given on pages from 4 to 45.

M.Sc. (Physics): I Semester
SESSION: 2016-17

		L	T	P	C
PHY CC 121	Mathematical Physics	3	1	0	4

UNIT – I

Differential equations and special functions: Second order linear ODEs with variable coefficient, solutions by series expansion; Legendre, Bessel equations, generating functions, recursion relations.

(Lectures – 9 + Tutorials - 3)

UNIT – II

Integral Transforms: Laplace transforms, first and second shifting theorems, Inverse LT by partial fractions, LT of derivatives, and integral of functions, Fourier transform, Fourier Integral and transform of delta functions. **(Lectures – 9 + Tutorials - 3)**

UNIT – III

Green's functions: Non- homogenous boundary value problems, Green's function for one dimensional problem, Eigen function expansion of Green's function.

(Lectures – 9 + Tutorials - 3)

UNIT – IV

Green's function for electrostatic boundary value problems and quantum mechanical scattering problem.

Complex Variables: Analyticity of complex functions, Cauchy Riemann equations.

(Lectures – 9 + Tutorials - 3)

UNIT – V

Couchy theorem, Cauchy integral formula, Taylors, Maclaurin, Laurent series. Theorem of residues, simple cases of contour integration, Jordan's lemma.

(Lectures – 9 + Tutorials - 3)

Essential Readings:

1. Mathematical Methods for Physicists – G.B. Arfken & H.J. Weber, ELSEVIER Academic Press
2. Applied Mathematics for Engineers and Physicists – LA Pipes – II ed. McGraw Hill Book Company
3. Mathematical Physics – Satya Prakash –Sultan Chand and Sons,5 Ed. revised New Delhi, 2011.

Suggested Readings:

4. Mathematical Physics –B.S. Rajput, 10th Ed. Pragati Prakashan, 1994.
5. Mathematical Physics – B.D. Gupta – II Ed. ,Vikas Publishing House, 1999.
6. Advanced Engineering Mathematics – Erwin Kreyszig, Wiley International 9th Ed.
7. Mathematical Physics – P.K. Chattopadhyay 1st Edition, Wiley Eastern Limited, 1992.

M.Sc. (Physics): I Semester
SESSION: 2016-17

		L	T	P	C
PHY CC 122	Classical Mechanics	3	1	0	4

UNIT – I

Newtonian mechanics of one and many particles systems, Conservation laws, constraints and their classification, principle of virtual work.

D' Almbert's principle in generalized coordinates, The Lagrange's equation from D' Almbert's principle. **(Lectures – 9 + Tutorials - 3)**

UNIT – II

Hamilton's principle, Hamilton's principle from Lagrange's equation. Generalized momenta and Lagrangain formulation of the conservation theorems, Reduction to the equivalent one body problem; the equation of motion and first integrals, the differential equation for the orbit.

(Lectures – 9 + Tutorials - 3)

UNIT – III

The equations of canonical transformation and generating functions. Hamilton - Jacobi theorem, Action and angle variables.

Poisson's brackets, simple algebraic properties of Poisson's brackets. The equation of motion in Poisson's Brackets notation. Poissons theorem, Principle of least action.

(Lectures – 9 + Tutorials - 3)

UNIT – IV

Theory of small oscillations, Equations of motion, Eigen frequencies and general motion, normal modes and coordinates.

Elementary treatment of Eulerian coordinates and transformation matrices. Angular momentum inertia tensor, torque free motion for a rigid body. **(Lectures – 9 + Tutorials - 3)**

UNIT – V

Covariant four dimensional formulation, 4-vectors and 4-scalers, Relativistic generalization of Newton's laws, 4-momentum and 4-force, Variance under Lornetz transformation, relativistic mechanics, covariant Lagrangian, covariant Hamiltonian. **(Lectures – 9 + Tutorials - 3)**

Essential Readings :

1. Classical Mechanics – Godstein, Poole and Safko, 8th ed. Pearson Ed. Ltd., 2004
2. Classical Mechanics – Rana and Joag, 11th ed. Mc Graw Hill Publication, 2003
3. Classical Mechanics – Gupta Kumar & Sharma, 11th ed. Pragati Prakashan 11th ed.1995
4. Introduction to Classic al Mechanics – R.C. Takwale and P.S. Puranik, TMH Pub.1994

Suggested Readings :

5. Classical Mechanics – John R Taylor, University Sciences book.
6. Mechanics - J.P. Dentartog, Dover Publication.
7. Classical Mechanics - R. Douglas Gregory, Cambridge Univ. Press.
8. Introduction to Classical Mechanics – David Morin, Cambridge Univ. Press.
9. Classical Mechanics-Satyaprakash, Kedar Nath Ram Nath Pub. 9th Ed., 1996.
10. Classical Mechanics-T.W.B. Kibble, TMH Pub. Ist Ed. 1970.

M.Sc. (Physics): I Semester
SESSION: 2016-17

		L	T	P	C
PHY CC 123	**Digital Electronics & Operational Amplifier**	3	1	0	4

UNIT – I

Number system and digital combinational circuits:
Binary, octal and Hexa decimal number and their inter-conversion, Addition and subtraction, Logic gates: AND, OR, NOT, NAND, NOR, XOR, XNOR, AOI gates. Binary adders: Half adder, Full adder and parallel adders. Multiplexer and Demultiplexer, Encoders and Decoders.

(Lectures – 9 + Tutorials - 3)

UNIT – II
Digital Sequential Circuits:
FLIP-FLOPS : RS-FF, JK-FF, TFF, D-FF and Master Slave flip-flop, Shift Registers : SISO, SIPO, PISO, PIPO, Left / Right shift Registers, Counters: classification of counters, Ripple counter, parallel counters, BCD counters, combination of modular counters.

(Lectures – 9 + Tutorials - 3)

UNIT – III
Operational Amplifiers:
Differential Amplifier: DC and AC analysis**,** CMRR Inverting and Non-inverting**,** Block Diagram of operational amplifier, Operational amplifiers with negative feedback: Voltage Series and Voltage shunt.

(Lectures – 9 + Tutorials - 3)

UNIT – IV
Practical operational Amplifier: Input off set voltage, input offset current**,** output off voltage**,** Input Bias current and slew rate. Oscillator: Principle**,** Phase shift & Wein bridge**.**

(Lectures – 9 + Tutorials - 3)

UNIT – V
Basic comparator, fixed voltage regulator and Adjustable regulator. D/A Conversions : Binary weighted Resistors, R-2R ladder, A/D Conversions : Successive Approximation Resister method, Dual slope, and counter method.

(Lectures – 9 + Tutorials - 3)

Essential Readings :

1. Opamp & Linear Integrated Ciruits – Ramakant Gayakwad , 4th ed.. PHI, New Delhi.,2003.
2. Integrated Electronic – Milliman & Halkias, 10th Ed., TMH,1991
3. Digital Principle and Applications – Malvino and Leach, 5th Ed.,TMH interval,2007

Suggested Readings :

4. Fundamental of Digital Electronic – C. Floyd. Pearson Education Pub.,4th Ed., 2005
5. Modern Digital Electronic – R.P. Jain, 8th Ed. , TMH Pub.2000.
6. Digital Electronics – Shiv Shankar Mishra, Salya Prakashan, Delhi

M. Sc. (Physics): I Semester
SESSION: 2016-17

		L	T	P	C
PHY CC 124	**Atomic, Molecular and Laser Physics**	3	1	0	4

UNIT – I

Review of one-electron and two-electron atoms: spectrum of hydrogen, helium and alkali atoms; Many electron atoms: central field approximation, Thomas-Fermi model, Slater determinant, Hartee Fock and self-consistent field methods, Hund's rule, L-S and j-j coupling, Equivalent and nonequivalent electrons, Spectroscopic terms, Lande interval rule.

(Lectures – 9 + Tutorials - 3)

UNIT – II

Interaction with Electromagnetic fields: Zeeman, Paschen Back and Stark effects; Hyperfine structure and isotope shift, selection rules; Lamb shift; Molecular spectra: rotational, vibrational, electronic, Raman and Infra-red spectra of diatomic molecules; electronic and nuclear spin, Hund's rule, Frank–Condon principle and selection rules.

(Lectures – 9 + Tutorials - 3)

UNIT – III

Molecular structure: molecular potential; Born-Oppenheimer approximation, diatomic molecules, electronic angular momenta; Approximation methods; linear combination of atomic orbitals (LCAO) approach; states for hydrogen molecular ion; shapes and term symbols for simple molecules.

(Lectures – 9 + Tutorials - 3)

UNIT – IV

Spectroscopic techniques: Infrared, Raman spectroscopy, NMR, ESR and Mossbauer spectroscopy (Principles and instrumentation) Modern developments: optical cooling and trapping of atoms, time resolved spectroscopy in the femto second regime.

(Lectures – 9 + Tutorials - 3)

UNIT – V

Lasers: spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping; population inversion, three level and four level laser system and rate equation. Optical resonators, Stability of resonators, Characteristics of Gaussian beam, He-Ne and Ruby Lasers.

(Lectures – 9 + Tutorials - 3)

Essential Readings :

1. Physics of Atoms and Molecules, B. H. Bransden and C. J. Joachain, 2nd Ed. Pearson (2008).
2. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash, 4th Ed.,Tata McGraw 2004.
3. Elementary Atomic Structure, G. K. Woodgate, Clarendon Press 1989.
4. Quantum Chemistry, I. N. Levine, PHI 2009.
5. Elementary Quantum Chemistry, F. L. Pilar, McGraw Hill 1990.
6. Essentials of Lasers and Non-Linear Optics,G.D. Baruach, Ist Ed. Pragati Prakashan, 2000.
7. Lasers and Non-Linear Optics- B.B. Laud, 2nd Ed., New age International (P) Ltd. 1996.

Suggested Readings :

8. Introduction to Atomic Spectra, H. E. White, Tata McGraw Hill 1934.
9. Atoms, Molecules and Photons, W. Demtroder, 2nd Ed., Springer 2010.
10. Atomic Physics, C. J. Foot, Oxford, 2005.
11. Principles of Laser, O. Svelto, 4th Ed. ,Springer , 2008

M. Sc. (Physics): I Semester
SESSION: 2016-17

		L	T	P	C
PHY CC 125	**Laboratory Course –I (General -I)**	0	0	2	2

Students have to perform of at least six practicals from the following list:

1. To measure the numerical aperture of an optical fiber.
2. To measure the diameter of the laser beam.
3. To measure the bending loss in a multimode fiber.
4. To determine the resistivity of semiconductor by four probe methods and determine band gap.
5. Measurement of Curie temperature for Ferro electric material.
6. To determine Brewster's angle by the polarization of light and to verify the cosine square law (Malu's law) for plane polarized.
7. To determine the wavelength of He-Ne laser using vernier caliper.
8. To measure Hall coefficient of given semiconductor.

Note: Other practical of equivalent level can be added.

(Physics): I Semester
SESSION: 2016-17

		L	T	P	C
PHY CC 126	**Laboratory Course-II (Electronics - I)**	0	0	2	2

Students have to perform of at least ten practicals from the following list:

1. To study the input and transfer characteristics of AND, NOT and NAND gates using IC.
2. Construction of basic gates (AND, OR & NOT) using universal gates.
3. To construct circuits of Half and Full adders and draw the truth table.
4. To verify Boolean identities.
5. To study R-S, J-K and M/S flip-flops.
6. To study of an Astable multivibrator using 555 timer.
7. To study the characteristics of R-2R ladder type D/A converter.
8. Study of inverting and Non-inverting OPAMP.
9. Study of addition and subtraction using OPAMP.
10. Study of integration and differentiation using OPAMP.
11. Study of operational amplifier 741
    (A) To conduct input bias current measurement.
    (B) To conduct input offset current measurement.
12. To determine the frequency of Wein-Bridge oscillator.
13. Study of regulated power supply using IC 723.

Note: Other practical of equivalent level can be added.

PHY SE 121: Seminar

This course makes a unique component of the curriculum. It is mandatory for every student to deliver a seminar of approximately 30 minutes duration on a topic as decided by the Departmental Seminar Committee.

Each and every student would get an opportunity to express his/her level of understanding of various concepts and this, apart from strengthening the subject knowledge, would help students in developing better communication skills and higher level of confidence.

The marks will be awarded by the Seminar Committee on the basis of performance in the seminar.

M.Sc. (Physics): II Semester
SESSION: 2016-17

		L	T	P	C
PHY CC 221	**Quantum Mechanics**	3	1	0	4

UNIT – I

General Formalism of Quantum Mechanics:

Linear vector space, basis and expansion theorem, Hilbert space, linear operators, eigen values and eigen functions, Hermitian operators and their properties, postulates of quantum mechanics, simultaneous eigen functions, general uncertainty relation, Dirac's notation for state vectors, Application of operator method: simple harmonic oscillator, creation and annihilation operators.
Matrix representation of state vectors and operators, change of basis: unitary transformation, Application of matrix method: simple harmonic oscillator. **(Lectures – 9 + Tutorials - 3)**

UNIT – II

Angular Momentum and Spin:

Angular momentum operators, angular momentum commutation relations, eigenvalues of L^2 and L_z. General angular momentum, eigenvalues of J^2 and J_z , angular momentum matrices, spin angular momentum, spin – (½) systems, spin vectors for spin – (½) system, Addition of angular momenta , Clebsch - Gordan coefficients. **(Lectures – 9 + Tutorials - 3)**

UNIT – III

Identical Particles:

Identical Particles, symmetric and anti symmetric wave functions, Pauli's exclusion principle, Slater determinant, inclusion of spin, spin functions for many electron systems. (Two and three electron systems), spin statistics connection. **(Lectures – 9 + Tutorials - 3)**

UNIT – IV

Time-Independent Approximation Method – I:

Basic concepts, non-degenerate and degenerate energy levels, Applications: ground state of He-atom, An-harmonic oscillator, Stark effect in hydrogen. **(Lectures – 9 + Tutorials - 3)**

UNIT – V

Time-Independent Approximation Method – II:

The Variation method: The variational principle, Rayleigh – Ritz method, Applications: ground state of He-atom, hydrogen-molecular ion and deuteron.

The WKB approximation method: WKB method, validity of WKB method, connection formula penetration of a barrier, Application: α–decay. **(Lectures – 9 + Tutorials - 3)**

Essential Readings :

1. Quantum Mechanics, G. Aruldhas, PHI, 2Ed. ,2011.
2. Quantum Mechanics, E. Merzbacher, Wiley.
3. Quantum mechanics:Theory and Applications, A.K. Ghatak and S. lokanathan, Kluwer Academic Publishers.
4. Quantum Mechanics, D.J. Griffith,Prentice Hall.
5. Quantum Mechanics, L.I. Schiff, McGraw-Hill. 3rd Edition.

Suggested Readings :

1. Principles of Quantum Mechanics, R. Shankar, Springer.
2. Quantum Mechanics, A. Messiah, Dover.
3. Modern Quantum mechanics, J.J. Sakurai, Pearson Addison-Wesley.
4. Principles of Quantum mechanics- P.A.M. Dirac, Oxford University Press.
5. Quantum Mechanics – PM Mathew and K Venkatesan, Mc Graw Hill 2nd Ed.
6. Advance Quntum Mechanics- Satya Prakash, Kedar Nath Ram nath 5th Ed.,2003.
7. Quantum Mechanics- SL Gupta & V. Kumar 3rd Ed. Jai Prakash Nath KG, 1976.

M. Sc. (Physics): II Semester
SESSION: 2016-17

		L	T	P	C
PHY CC 222	**Electrodynamics and Plasma Physics**	3	1	0	4

UNIT – I

Maxwell's equations, Scalar and vector potentials, gauge transformation, Lorentz gauge, Coulomb Gauge, radiations by moving charges, retarded potentials, Lienard Wiechrt potentials, fields of charged particles in uniform motion, fields of arbitrarily moving charged particle. **(Lectures – 9 + Tutorials - 3)**

UNIT – II

Fields of an accelerated charged particles at low velocity and high velocity, angular distribution of power radiated, Review of four vector and Lorentz transformation in 4-dimensional spaces, Invariance of electric charge, relativistic transformation properties of E and H fields. **(Lectures – 9 + Tutorials - 3)**

UNIT – III

Electromagnetic fields tensor in 4- dimensional Maxwell equation, Four Vector current and potential and their invariance under Lorentz transformation, convariance of electrodynamics. Langragian and Hamiltonian for a relativistic charged particle in external EM field. **(Lectures – 9 + Tutorials - 3)**

UNIT – IV

Elementary concept of occurrence of plasma, Gaseous and solid state plasma, Production of gaseous and solid state plasma, Plasma parameters, Plasma confinement pinch effect, instability in a pinched-plasma column, Electrical neutrality in a plasma, Debye screening distance. Plasma oscillations: Transverse oscillations and longitudinal oscillations. **(Lectures – 9 + Tutorials - 3)**

UNIT – V

Domain of Magnetohydordynamics and plasma Physics : Magnetohydrodynamic equations, magneto hydrodynamic waves: Magneto-sonic and Alfven waves, particle orbits motion of charged particles in electromagnetic fields, (uniform E and B Fields) and drift motion in a plasmas.

(Lectures – 9 + Tutorials - 3)

Essential Readings :

1. Introduction to Electrodynamics - David J. Griffiths: Benjamin Cummings 2nd Ed. Prentice Hall of India, 1993.
2. Introduction to Plasma Physics – Chen Francis F, Springer Pub.2nd Ed.
3. Electrodynamics - Gupta, Kumar & Singh,

Suggested Readings :

1. Fundamentals of Plasma Physics - J.A. Bittencourt, Springer Pub. 3rd Ed.
2. Plasma Physics (Plasma State of Matter) – S.N. Sen, Pragati Prakashan, 2006
3. Classical Electrodynamics – Jackson: Wiley
4. Classical Electricity and Magnetism - Pnofsky & Philips: Dover Publications.
5. Principle of Plasma Mechanics- B.Chakraborty, Wiley Eastern Ltd. 1978.
6. Electromagnetic theory & Electrodynamics- Satya Prakash New Edition, Kedar Nath Ram Nath, 2004-05.

M. Sc. (Physics): II Semester
SESSION: 2016-17

		L	T	P	C
PHY CC 223	**Electronic Devices**	3	1	0	4

UNIT – I

BJT: Construction, transistor biasing in active region, transistor operation in active.

JFET: Construction, Biased JFET, JFET characteristics.

MOSFET: Depletion and Enhancement type MOSFET, MESFET.

Basics of microprocessor and Microcontroller. **(Lectures – 9 + Tutorials - 3)**

UNIT – II

Photonic Devices: Light dependent resistor (LDR), diode photo detectors, Solar cell (I-V characteristics, Spectral response, fill factor), LED, diode lasers.

(Lectures – 9 + Tutorials - 3)

UNIT – III

Semiconductor Memories: Memory organization, Expanding memory size, classification of memories. ROM and RAM chip. Charged compiled device (CCD) memory, content addressable memory. **(Lectures – 9 + Tutorials - 3)**

UNIT - IV

Transducers – Temperature, pressure and vibration. Measurement and control, signal conditioning system AC and DC, instrumentation amplifier. Lock in amplifier.

(Lectures – 9 + Tutorials - 3)

UNIT – V

Filters: passive and active, first order, second order. Types of filters: Butterworth, elliptic, Bessel and all-pass filters, Network analysis.

(Lectures – 9 + Tutorials - 3)

Essential Readings :

1. Instrumentation (Devices and systems) : Ranjan, Mani and Sharma – Tata McGraw Hill, 2nd Ed. , 2000 New Delhi.
2. Electronic Instrumentation: H.S. Kalsi- Tata McGraw Hill, New Delhi.1995 16th reprint 2003.
3. Electronic Devices and Circuits – Millmant Halkia McGraw Hill, New Delhi 2002.
4. Electronic Devices and Circuits – Raju – I.K. International.

Suggested Readings :

1. Digital Electronics – Gothman – PHI, 2nd Edition, 1998.
2. Digital Electronics – Jain (TMH-Eduction)
3. Electronics Devices & circuits – J.S. Katre-Tech-Max Pub., Pune.

M. Sc. (Physics): II Semester
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		L	T	P	C
PHY CC 224	**Condensed Matter Physics**	3	1	0	4

UNIT – I

Crystal Structure: Symmetry, crystal system, Bravais lattice, concept of point group, space group, Miller indices, Unit cell, Wigner-Seitz unit, reciprocal lattice, closed packed structure, (BCC,FCC, HCP, DC) coordination number & coordination geometry. Principle of powder diffraction method; Elementary idea about interpretation of power XRD Types of Crystal binding: Ionic, Covalent, Matellic , Vander walls bonding, **(Lectures – 9 + Tutorials - 3)**

UNIT – II

Free electron theory: Free electron theory of metals. Hall Effect, Elementary ideas of quantum Hall effect, Thermal and transport properties. Thermal conductivity in metals. Vibration in solid, normal modes, phonons, normal and unklopb processes, Mobility of charge carriers and Seeback coefficient, Wiedmann Franz law. Electronics specific heat. Bloch functions. Nearly free electron approximation. Formation of energy bands. gaps at Brillouin zone boundaries. Effective mass and concept of holes. Fermi surface.

(Lectures – 9 + Tutorials - 3)

UNIT – III

Super Conductivity: Survey of important experimental result; critical temperature, persistent current, Meissner effect; Basic idea of BCS theory, Type I and Type II superconductor super conducting Material and their application. High Tc super conductivity. **(Lectures – 9 + Tutorials - 3)**

UNIT – IV

Dielectric properties of solids: Complex dielectric and dielectric losses, relaxation time and Debye equation for orientational polarizabiltiy; theory of electronic and ionic polarization, Ferroelectricity-diplole theory, classifications of ferroelectric material. **(Lectures – 9 + Tutorials - 3)**

UNIT – V

Diamagnetic susceptibility. Quantum theory of paramagnetism. Transition metal ions and rare earth ions in solids. Crystal field effect and orbital quenching. Ferromagnetic and antiferromagnetic ordering. Curie-Weiss theory, Heisenberg theory, Curie and Neel temperatures.

Optical properties of solids: band to band absorption, excitions. Polarons, Colour centres. Luminescence. Photoconductivity. **(Lectures – 9 + Tutorials - 3)**

Essential Readings :

1. Introduction to Condensed Matter Physics – K.C. Barua (Alpha Science International Ltd.)
2. A Basic Course in Crystallography – JAK. Tareen & TRN Kutly. (Universities Press, India Pvt.)
3. An Introduction to Crystallography, F.C. Phillips, Longman Higher Education.
4. Crystallography Applied to Solid State Physics – A.R. Verma and O. N. Srivastava, New Age International limt., 2nd Ed. Reprint 2005.
5. Elements of Solid state Physics, M. Ali omor Peasson Education 3rd Indian reprient, 2002

Suggested Readings :

1. Solid state Physics, C. Kittel, Wiley. 5th Edition.
2. Solid state Physics, A.J. Dekkar, Macmillan.
3. Elementary Solid state Physics: Principles and Applications, M. Ali Omar, Addison-Wesley.
4. Introduction to Solids, L.V. Azaroff, Tata Mc-Graw Hill.
5. Solid state Physics: An introduction to Principles of Materials Science, H. Ibach and H. Luth, Springer.
6. Solid state Physics, S.O. Pillai, New Age International.
7. Condensed matter Physics, M.P. Mardar,Wiley.
8. Physics of solids, C.A. Wert and R. M. Thomson, McGraw-Hill.
9. Fundamentals of Solid state Physics, J. R. Christmaan, Wiley.
10. Solid State Physics- Structure and Properties of materials, M.A. Wahab, Narosa Publishing House
11. Solid State Physics – N.W. Ashcroft and N.D. Mermin, New York : Holt, Rinehart and Winston.
12. Solid State Physics, J.S. Blakemore, Cambridge University Press.
13. Solid State Theory, Mendel Sachs, McGraw-Hill.

M. Sc. (Physics): II Semester
SESSION: 2016-17

		L	T	P	C
PHY CC 225	**Laboratory Course - III (General -II)**	0	0	2	2

Students have to perform of at least six practicals from the following list:

1. To study the g-factor by the ESR spectrometer.
2. To study the B-H curve of a given sample.
3. To study the effect of temperature on the resistivity of semiconductor.
4. To study the Fourier analysis of signals (Sine & Square).
5. To determine the dielectric constant of a given sample.
6. To determine the Curie temperature of Ferro-magnetic material.
7. Measurement of Hall coefficient in Metals.
8. To measure the bending loss in a multimode fiber.

Note: Other practical of equivalent level can be added

M. Sc. (Physics): II Semester

SESSION: 2016-17

		L	T	P	C
PHY CC 226	**Laboratory Course – IV (Electronics Devices)**	0	0	2	2

Students have to perform of at least eight practicals from the following list:

1. Study the frequency response of two-stage R-C coupled amplifier with and without negative feedback.
2. Study the characteristics of field effect transistor (FET).
3. Study the frequency response, input and output impedance of FET amplifier.
4. Study of characteristics of MOSFET.
5. Study the frequency response of MOSFET amplifier.
6. Study of low pass, high pass and band pass passive filters.
7. Study of low pass, high pass, band pass and notch active filters.
8. Study of Harley's & Colpitt's oscillators.
9. Study of multivibrators using timer (IC 555).
10. Study of phase shift oscillator using transistor.

Note: Other practical of equivalent level can be added

PHY SE 221 : Seminar

This course makes a unique component of the curriculum. It is mandatory for every student to deliver a seminar of approximately 30 minutes duration on a topic as decided by the Departmental Seminar Committee.

Each and every student would get an opportunity to express his/her level of understanding of various concepts and this, apart from strengthening the subject knowledge, would help students in developing better communication skills and higher level of confidence.

The marks will be awarded by the Seminar Committee on the basis of performance in the seminar.

M.Sc. II Semester
Session 2016-2017

		L	T	P	C
PHY OE 221	**Energy and Environment**	**2**	**0**	**0**	**2**

Credits: 02

Theory: 30 Lectures

The aim of this course is not just to impart theoretical knowledge to the students but to provide them with exposure and hands-on learning wherever possible

UNIT I

Energy and Development: The principles underlying energy processes: basic ideas; energy efficiency, measurement of energy and its unit. Energy consumption, planning and Management: Global and Indian scenario. Energy resources: harnessing, utilization, advantage and limitations of conventional energy sources (Coal, Oil, natural gas and nuclear fission), Future energy options for sustainable development.

(Lectures – 6)

UNIT II

New and Renewable Sources of Energy : Solar energy and its conversion into various forms of energy, Wind Energy, hydro energy, Geothermal and Tidal Energy, Hydrogen energy and fuel cell: principle of working and applications. Nuclear fusion energy: basic principles and application. **(Lectures – 6)**

UNIT III

Energy Conservation: Introduction to energy conservation, need for energy conservation, energy conservation measures in industry, transport, households, buildings, agriculture, lighting. Energy conservation in Thermal Utilities, Energy conservation in Electrical Systems and Utilities, Waste Heat Recovery.

(Lectures – 6

UNIT IV

Energy Storage: Need and importance of energy storage in conventional and nonconventional energy systems, various forms of energy storage: Thermal, chemical, mechanical, electrical and nuclear energy storage; Energy storage devices and systems.

(Lectures – 6)

UNIT V

Environmental Impact of Energy Systems: Environmental degradation due to energy production and utilization, primary and secondary pollution; air, water, soil, thermal, nuclear radiation, radioactive waste and noise pollution; depletion of ozone layer, biological damage due to environmental degradation,; Pollution control: Mechanism, process and devices for pollution control. Global and Indian Concerns for global warming and Climate change.

(Lectures – 6)

Essential Readings :

1. Energy and Environment: Robert A. Ristinen, Jack P. Kraushaar: WILEY publications II edition 2005-06.
2. Renewable Energy: Physics, Engineering, Environmental Impacts, Economics & Planning: Sore,BEHT SORENSEH Academic Press, 4th Edition, 2010.
3. Non-conventional Energy Sources: G.D. Rai, Khanna Publishers:4th Edition, New Delhi, 2009.
4. Energy Conservation and Management: Suresh K Soni, Tech India Publications, Satya Prakasan, II Ed. ,New Delhi 2010
5. Environmental Science: Earth as a living planet: D.B. Botkin and E. A. Keller, WILEY Pub. 6th Ed.,2009.

Suggested Readings :

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi,2011
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.,1983
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.,1996
4. Godfrey Boyle, “Renewable Energy, Power for a sustainable future”, 2004, Oxford University Press, in association with The Open University.
5. Dr. P Jayakumar, Solar Energy: Resource Assessment Handbook, 2009

M. Sc. (Physics): III Semester

SESSION: 2016-17

		L	T	P	C
PHY CC 321	**Statistical Mechanics**	3	1	0	4

UNIT I

Fundaments of statistical physics: Phase space, Liouville theorem and its consequence, specification of states of a system, statistical distribution function; Statistics of various Ensembles - Micro canonical, Canonical, grand canonical ensembles; Example of various ensemble – an electron in a magnetic field, a free particle in a Box, a linear harmonic oscillator; Basic postulates; Behaviour of the density of states; partition functions and their properties; calculation of thermodynamic quantities; the classical ideal gas; the entropy of mixing and Gibbs paradox; the correct enumeration of microstates; The Equipartition theorem; Maxwell velocity distribution.

(Lectures – 9 + Tutorials - 3)

UNIT II

Isolated system; System in contact with reservoir; Stability conditions for homogeneous substance; Phase transformation; First order and second order phase transition; Equilibrium conditions between phases; The Clausius-Clapeyron equation. **(Lectures – 9 + Tutorials - 3)**

UNIT III

Classical and Quantum statistics; Identical particles and symmetry requirements; the classical and quantum distribution functions; Maxwell-Boltzmann statistics, Bose-Einstein statistics, Fermi-Dirac statistics; Degeneracy criterion. **(Lectures – 9 + Tutorials - 3)**

UNIT IV

Bose systems: Thermodynamic behaviour of ideal Bose-gas; Thermodynamics of Black Body radiation; Bose-Einstein condensation; Super fluidity.

Fermi systems: Thermodynamics of ideal Fermi systems; Magnetic behaviour of an ideal Fermi gas; Pauli Paramagnetism; Landau diamagnetism; Degenerate Fermi systems - electron gas, Electron gas in metal- Thermionic emission and Photo-electric emission; Statistical equilibrium of White dwarf stars. **(Lectures – 9 + Tutorials - 3)**

UNIT V

Systems of interacting particles; Harmonic lattice vibrations: Phonons; Einstein model and Debye model regarding the explanation of temperature dependent of specific-heat; Interaction between spins; Weiss molecular-field approximation regarding the explanation of ferromagnetism; Mean field theory of Ising model and its exact solution in one-dimension; Thermodynamic fluctuation; The Brownian motion; The Langevin theory; The Fokker-Planck equation; The fluctuation-dissipation theorem; The Onsager relation. **(Lectures – 9 + Tutorials - 3)**

Essential Readings :

1. Statistical Mechanics- K. Huang: John Wiley & Sons,2nd Ed., New York, 1987.
2. Statistical Physics (Vol. 5), L. Landau & I. LifshitzPergamon Press, 3rd Ed., 1980.
3. Fundamentals of statistical and thermal physics, F. Reif: McGraw-Hill Book Company New York, 1965 .
4. Statistical Mechanics, R. K. Pathria: Butterworth-Heinemann 1996.

Suggested Readings :

5. Thermodynamics and Statistical Mechanics, A. Sommerfeld: Academic press, New York, 1956.
6. Lectures on Phase transitions and the Renormalization Group, Frontiers in PhysicN. Goldenfeld: s, Addison Wesley, Reading Massachusetts, 1994
7. Principles of Condensed Matter Physics, P. Chaikin and T. Lubensky, Cambridge University Press, 1995

M.Sc. (Physics): III Semester
SESSION: 2016-17

PHY CC 322	Computational Physics	3	1	0	4

UNIT – I

Solution of Algebraic and Transcendental Equations: The Bisection method, Iteration methods, Newton-Raphson method.

Solution of Systems of Nonlinear Equations: The method of iteration, Newton-Raphson method.

(Lectures – 9 + Tutorials - 3)

UNIT – II

Interpolations: Introduction, Newton interpolation formula, Lagrange interpolation formula. Interpolation with cubic splines **(Lectures – 9 + Tutorials - 3)**

UNIT – III

Curve Fitting and Approximation: Least squares curve fitting, fitting a straight line and nonlinear curve fitting. Weighted least squire approximation: Linear weighted least squire approximation, Nonlinear weighted least squire approximation. Method of least squires for continuous functions

(Lectures – 9 + Tutorials - 3)

UNIT – IV

Numerical Differentiation: Introduction**,** errors in numerical differentiation, the cubic spline method.

Numerical Integration: Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, Gaussian integration.

(Lectures – 9 + Tutorials - 3)

UNIT – V

Matrices and Linear Systems of Equations: Basic definitions, matrix operations, transpose and inverse of a matrix. Solution of linear systems, direct methods: matrix inversion method, Gaussian elimination method. Solution of linear systems: Iterative method.

(Lectures – 9 + Tutorials - 3)

Essential Readings :

1. Introduction to numerical analysis : S.S. Sastry, III Ed. PHI, 2003.
2. Numerical Analysis- Goel Mittal, Pragati Prakashan 16th Ed., 2001.

Suggested Readings :

3. Numerical Analysis: E. Balaguruswamy, TMH Pub., 21st Reprint 2007.
4. Computer Oriented Numerical Methods – V. Rajaramn, IIIEd. PHI.2004
5. Numerical Methods for Engineers, Stevan C. Chapra, Mc. Graw Hill Pub., 5th Ed., 2006.

M. Sc. (Physics): III Semester
SESSION: 2016-17

		L	T	P	C
PHY CC 323	**Laboratory Course (Computer Programming)**	0	0	2	2

Students have to perform of at least six practicals from the following list:

1. Numerical Integration using Simpson 1/3.
2. Numerical Integration using Gauss quadrature methods for one and two-dimensional integrals.
3. Least Square fitting (Linear).
4. Solution of second-order differential equation using Runge-Kutta method.
5. To find roots of an equation of degree 1, 2 and 3 by using Bisection method.
6. Solution of Simultaneous Linear Algebraic equations by Gauss-Jordan elimination method.
7. Interpretation and Extrapolation by using Lagrangian method.
8. Finding eigenvalues and eigenvectors of square matrices.

Note: Other practical of equivalent level can be added.

M.Sc. (Physics): III Semester
SESSION: 2016-17

PHY CC 324	Instrumentation Skill Development	0	0	2	2

(A) Workshop Practice: (any two)

1. Cutting and filling of iron rod.
2. Operation of Shaping machine
3. Operation of Lathe machine.
4. Welding practice.

(B) Glassblowing Practice : (any two)

1. Making of Capillary tube.
2. Making of Glass joint – Band & T
3. Making of test tube.
4. Cutting and Grinding.

(C) Electronics Instrumentation : (any three)

1. Measurement of resistance in series and parallel combination by colour code and multimeter.
2. Testing of components and pin identification of capacitor diode and transistors by multimeter.
3. Familiar with CRO to measure frequency and amplitude of AF signal.
4. Making of PCB.
5. Design and fabrication of simple circuitry.
6. Software based electronic circuit design and simulation.

Note: More skills may be added during the progression of the course

Note: Other practical of equivalent level can be added.

PHY SE 321	**Seminar**	**0**	**0**	**2**	**2**

This course makes a unique component of the curriculum. It is mandatory for every student to deliver a seminar of approximately 30 minutes duration in the field of chosen electives and on a topic as decided by the Departmental Seminar Committee. Each and every student would get an opportunity to express his/her level of understanding of various concepts and this, apart from strengthening the subject knowledge, would help students in developing better communication skills and higher level of confidence.

The marks will be awarded by the Seminar Committee on the basis of performance in the seminar and the seminar report submitted by the student.

M.Sc. (Physics): III Semester
SESSION: 2016-17

PHY EC 321	**Microprocessors and Microcontrollers**	**4**	**0**	**0**	**4**

UNIT – I

The 8085 pin configuration and functional Block Diagram, Interrupt, Register, Addressing mode, instruction set, instruction set and their classification, Addressing of I/o devices, DMA, Input/output port. **(Lectures – 9 + Tutorials - 3)**

UNIT – II

The 8086 Introduction, 8086 architecture and pin configuration 8086 addressing modes, 8086 instruction sets, 8089 input/ output, processor. **(Lectures – 9 + Tutorials - 3)**

UNIT – III

The microprocessor and its Architecture internal microprocessor architecture, Real mode memory addressing, Introduction to protected mode memory addressing, memory paging.

(Lectures – 9 + Tutorials - 3)

UNIT – IV

Memory Interface:

Memory devices, Address Decoding, 8088 and 80188 memory interface, 8086, 80186, 80286, 80386 (SX) memory interface, 80386 (DX) and 80486 memory interface.

(Lectures – 9 + Tutorials - 3)

UNIT – V

Microcontroller, Types of microcontroller, Embedded and External memory microcontrollers CSIC and RISC Architecture microcontrollers, Harvard and Princeton memory Architecture microcontroller 8051 microcontroller (only Hardware).

(Lectures – 9 + Tutorials - 3)

Essential Readings :

1. The Intel Microprocessor - Barry B. Brey - Pearson Education.6th Edition, 2003.
2. Microprocessor Theory and Application - M. Rafiquzzman –PHI, Revised Edition 1999.

Suggested Readings :

3. Introduction to Microprocessor – Gaonkar (Prentice Hall)
4. Microcontroller – Raj Kamal – Pearson Education, 1st Ed. 2005
5. Introduction to Microprocessor- Aditya P. Mathur, TMH, 3rd Edition.

M.Sc. (Physics): III Semester
SESSION: 2016-17

PHY EC 322	**Laboratory course (Microprocessors and Microcontrollers)**	**0**	**0**	**2**	**2**

Students have to perform of at least eight practicals from the following list:

1. Write programs for data transfer in 8085.
2. Write programs for Addition and subtraction in 8085
3. Write programs for Logical operation in 8085.
4. Write programs for multiplication and division in 8085.
5. Write programs for Addition and subtraction in 8086.
6. Write program are multi byte addition in 8086.
7. LED and seven segment display with AVR microcontroller.
8. Interfacing of LCD with AVR microcontroller.
9. LED matrix interfacing with AVR microcontroller.
10. LDR interfacing with AVR microcontroller.
11. Interfacing of relay with AVR microcontroller.

Note: Other practical of equivalent level can be added.

M. Sc. (Physics): III Semester
SESSION: 2016-17

		L	T	P	C
PHY EC 323	**Materials Science**	3	1	0	4

UNIT – I

Classification of Materials: Crystalline and amorphous material, semiconductor, metals and alloys; glassy, composites and ceramic materials, polymers, gels & quasi crystals, Structure of Materials: Important crystal structure. NaCl (Rock salt) Wurtzite (ZnS), Fluorite, (CaF_2) Rutile (TiO_2). **(Lectures – 9 + Tutorials - 3)**

UNIT – II

Preparation of Materials by different techniques: Mechanisum of crystal growth form melt, growth from crucibles, epitaxial growth, melt spinning and quenching method,

((Lectures – 9 + Tutorials - 3)

Physical Method for characterization Solids: Bragg's equation, Spectrum of x-ray, powder XRD, crystallite size. Scanning electron microscopy (SEM) Transmission electron microscopy (TEM) Differential scanning calorimetry (DSC), Thermogravimetric analysis (TGA). **(Lectures – 9 + Tutorials - 3)**

UNIT – III

Disorder in Solids: Solid solution –Hume-Rothery rules; substitutional & interstitial solid solution, Point defect, vacancy, interstitial Frenkel & Schottky defects. Line defect edge and screw dislocation, Burger's vector, planer defects (grain boundaries, high and low angle tilt boundaries twin boundaries). short range order, medium range order, long range order, and network modifier/former.

(Lectures – 9 + Tutorials - 3)

UNIT – IV

Phase diagram - Complete Solid solution, Gibb's phase rule, Binary phase diagram, eutectic, eutectiod, diagram, Example of binary phase diagram.

Phase transformation: Solidifications and crystallization, glass transition, Volume-Temperature diagram**.**

(Lectures – 9 + Tutorials - 3)

UNIT – V

Devices : Application to material Devices; Solid state electrochemical devices, Solid State Battery, Fuel cells, Solar cells.

(Lectures – 9 + Tutorials - 3)

Essential Readings :

1. Introduction to Condensed Matter Physics – K.C. Barua (Alpha Science International Ltd.)2006
2. A Basic Course in Crystallography – J.A.K. Tareen & Kutly.Hydrabad (Universities Press, India Pvt.)
3. Material Science and Engineering – A first course V. Raghavan (Prentice Hall, India Pvt.)
4. Introduction of Material Science for Engineers – James F. Shackelford – Macmillan Pub.2006
5. Crystallography Applied to Solid State Physics – A.R. Verma and O. N. Srivastava (New Age International Pub.)2005
6. Physical Properties of Materials – MC Lovell, A.J. Avery. M.W. Vernon (ELBS) Van Nostrad Reinhold UK. Co. Ltd.
7. Principles of Electronics Ceramics –L.L. Hench, and J.K. West. (John-Wiley & Sons) Ist. Editions.
8. Introduction to Ceramics – WD Kingery, HK Bowen, DR Uhlmann (University Press, Cambridge) IInd Edtions.

Suggested Readings :

9. Solid State Physics – N.W. Ashcroft and N.D. Mermin, New York : Holt, Rinehart and Winston.
10. Solid State Physics Solid State Devices and Electronics – CM Kachhava. (New Age International Pub.)
11. Solid state chemistry : An introduction Leslay E smart & Elaine A Moore (Taylor & Francis)
12. Thin film by : K.L. Chopra.(Mc Graw Hill)
13. Material Science and Engineering An Introduction – W.D. Callister, David G. Rethwisch, John Wiley and Sons. 8th Ed.
14. Elements of Material Science and Enginerring – Lawrence H. Van Vlack ,Peasson Education 6th Ed.
15. Physical Metallurgy Principle , Robirt E Reed Hill, D Van Nostrand Company, 2nd Ed.

M.Sc. (Physics): III Semester
SESSION: 2016-17

PHY EC 324	**Laser Physics and Optical Fiber**	**3**	**1**	**0**	**4**

UNIT-I:

Basic Principles of Laser; Two, three and four level laser system, Rate equations for three and four level system, threshold pump power, Relative merits and de-merits of three and four level system.
(Lectures – 9 + Tutorials - 3)

UNIT-II:
Optical resonators, Stability of resonators, Characteristics of Gaussian beam, Transverse and Longitudinal modes, mode selection, losses in a resonator, mirror mounts, Q-switching and Mode locking **(Lectures – 9 + Tutorials - 3)**

UNIT-III: Various Laser Systems
Gas Lasers:
(i) Molecular gas lasers- CO_2 laser and N_2 laser
(ii) Ionic gas laser – Ar^+ laser
(iii) Solid State Laser: (i) Nd:YAG laser, (ii) Nd:Glass laser,
(iv) Tunable solid state laser: Ti:sapphire laser; Chemical Laser: HF laser, HCl laser; Free electron laser; semiconductor diode laser. **(Lectures – 9 + Tutorials - 3)**

UNIT-IV:
Nonlinear optics second harmonic generation (SHG), three waves mixing: Up conversion and down conversion, self beam focusing, Kerr effect. Holography, Medical and Industrial applications.
(Lectures – 9 + Tutorials - 3)

Unit V:
Optical fiber: Principle, classification and features, Numerical aperture, attenuation and dispersion. Optoelectronic devices (qualitative), **(Lectures – 9 + Tutorials - 3)**

Essential Readings :
1. Laser Theory and Applications: K. Thyagarajan and A.K. Ghatak, Macmillan India Limited
2. Principles of Lasers : O. Svelto, Springer 4 Edition.
3. Laser Spectroscopy and Instrumentation : W. Demtroder, Springer.2013
4. Laser Material Processing : William M. Steen,Mazumdar, Jyotirmay, Springer.2010
5. Modern Spectroscopy, J. M. Hollas, Willey,
6. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E.M. Mc Cash, Tata Mc Graw Hill.1994
7. Advances in Laser spectroscopy: Edited by F.T.Arecchi, Springer.1983

Suggested Readings :
8. Laser Applications: Monte Ross , Academic Tron
9. Lasers By Milloni & Eberly, Willey Publication.
10. Laser Fundamentals – William T Silfvast, Cambridge Univ. Press.
11. Laser and Non liner Optics – B.B. Loud , New Age International (Pvt. Ltd.)
12. Optical Fiber and Laser – Dr. Anuradha De, New Age International (Pvt. Ltd.)
13. Optical Fiber Communications – John M. Senior, Prentice- Hall of India Pvt. Ltd.

M.Sc. (Physics): III Semester
SESSION: 2016-17

PHY EC 325	**Applied Condensed Matter Physics**	**3**	**1**	**0**	**4**

UNIT – I

Dielectrics, Ferroelectrics and Optical Properties: Internal electric field in a dielectric. Clausius-Mossotti and Lorentz-Lorenz equations. Properties of dielectrics in alternating fields, Dielectric dispersion and loss. Dipolar Relaxation, Ferroelectrics: types and models of ferroelectric transition, Piezoelectrics, Applications.

Optical properties of solids: band to band absorption, excitons, polarons, Colour centres, Luminescence, Maser and Laser, Applications, Photoconductivity, Diffusion and ionic conductivity. Superionic materials. Extended defects: dislocations, models of screw and edge dislocations. **(Lectures – 9 + Tutorials - 3)**

UNIT – II

Magnetism and Super Conductivity: Diamagnetic susceptibility. Quantum theory of paramagnetism: unfilled electron shells; Hund's rule. Crystal field effect and orbital quenching. Ferromagnetic and antiferromagnetic ordering. Curie-Weiss theory, Curie and Neel temperatures. Domain walls, Spin waves and magnon dispersion. Soft and Hard Magnetic materials, Magnetic force microscopy, Applications.

BCS Theory: Cooper pair formation, Coherence length, BCS ground state and energy gap, Determination of energy gap, tunneling across Josephson's junctions, SQUID. High Tc Superconductors. Applications of superconductivity. **(Lectures – 9 + Tutorials - 3)**

UNIT – III

Current Phenomena of Condensed Matter: Magneto-resistance, Colossal Magneto Resistance, Giant Magneto Resistance, Tunnelling Magneto Resistance, Magneto Impedance, Giant Magneto Impedance, Dilute Magnetic Semiconductors, Multiferroics and Magneto-electrics, Electromagnetic Interference shielding. Applications of all these phenomena and materials. **(Lectures – 9 + Tutorials - 3)**

UNIT – IV

Semiconductors, Glasses, Polymers and Composites: Statistics of electrons and holes in intrinsic and extrinsic Semiconductors, Quantum Hall effect: Integer quantum Hall effect in two dimensional systems, Semiconductor devices.

Glass formation and types of glasses, Glass transition temperature, Glass and Polymer as electrolyte in Ionic conductors, Ionic conductors for super-capacitor applications, Electronic structure of amorphous solids.

(Lectures – 9 + Tutorials - 3)

UNIT - V

Energy Storage and Photovoltaics: Polymer Dielectrics as Energy storage materials, Ferroelectric polymers and their applications, Polymer nanocomposites, Insulator to metal transition, Percolation, Scaling and Critical exponents, Impedance and Dielectric Spectroscopy, Photovoltaics.

(Lectures – 9 + Tutorials - 3)

Essential Readings : Suggested Readings :

1. Elements of Solid state Physics, J.P. Srivastava, PHI, 2011
2. Quantum theory of Solids, C. Kittel, Wiley, 2nd Edition 1987.
3. Elementary Solid state Physics: Principles and Applications, M. Ali Omar, Addison-Wesley.1994
4. Introduction to Solids, L.V. Azaroff, Pub.Tata Mc-Graw Hill,1960.
5. Solid state Physics, S.O. Pillai, New Age International, 2015

Suggested Readings :

6. Solid State Physics – N.W. Ashcroft and N.D. Mermin, Holt, Rinehart and Winston, New York: Holt, Rinehart and Winston. 1976.
7. Principles of Condensed matter Physics, P.M. Chaikin and T.C. Lubersky, II Ed. Cambridge University Press.2004.
8. Principles of the theory of solids, J.M. Ziman, II Edition. Cambridge University Press., June, 2013
9. Introduction to Superconductivity, M. Tinkham, Pub, Dover. II Edition, 1973.
10. Introduction to Magnetic materials, B.D. Cullity, Willey, II Edition, Feb., 2008

M.Sc. III Semester : Physics
SESSION**: 2016-17**

PHY OE 321	**Nanomaterials and Nanotechnology**	**2**	**0**	**0**	**2**

UNIT – I:

Introduction : History of nano- materials, Michael faraday and divided metals, story of Damascus sword. How nanoworld different from world around us. What is nano? Beginning of nano Science; feynmani's there is plenty of room at bottom. **(Lectures – 6)**

UNIT – II

Nanomaterials: Top- down or bottom up approch, different type of nano materials,
Special Carbons : Carbon nanotube, fullernece, Type of CNT: SWNT(single wall nano tube), Multi wall nano tubles. 2D nano material , Graphite and Graphene, metal nano particle silver and gold, Si
(Lectures – 6)

UNIT – III

Synthesis of nano materials : Physical Methods, PLD. Sputtering, Thermal evaporation
Chemical Methods – CVD, Sol-gel, Hydrothermal.
Biological Methods – Green Synthesis, self assembly. **(Lectures –6)**

UNIT – IV

Properties of Nano materials: magnetic, optical, thermal, mechanical, electrical for nano materials.

(Lectures – 6)

UNIT – V

Applications of Nano-technology: Solar-cell, thermoelectric, cosmetics, Light emitting diode (LED), Medicine, Bio-marker, Sensors.

(Lectures – 6)

Essential Readings :

1. Introduction to Nano Science and Nano Technology – K.K. Chattopadhyay & AN Banerjee PHI Pvt. Ltd.,2009.
2. Nano technology: Principles and practices - Sulabha K. Kulkarni, Capital Publisher Co. ,2015.
3. Introduction to nano technology: Charles P. Poole, Jr. Frank J. Owen, Wiley, Interscience Pub., May, 2003.
4. Nanostructures & Nanomaterials Synthesis Properties & Applications. Guozhong Cao, Imperials College Press London. 2004

Suggested Readings :

1. Nano: The Essentials. T. Pradeep, McGraw Hill Education.20/01/2007
2. Handbook of Nanostructures: Materials and nanotechnology, H.S. Nalwa Vol 1-5, Academic Press, Bostan., I Ed.,Oct., 1999.
3. Nano world An introduction to nanoscience & Technology – CNR Raw,

M.Sc. (Physics): IV Semester
SESSION: 2016-17

		L	T	P	C
PHY CC 421	**Advanced Quantum Mechanics**	3	1	0	4

UNIT – I

Time Dependent Perturbation Theory: Introduction, method of variation of constants, Constant perturbation, Harmonic perturbation, Transition probability, Transition to continuum of states, Fermi's Golden Rule, Adiabatic and sudden approximation. **(Lectures – 9 + Tutorials - 3)**

UNIT – II

Semi Classical Theory of Radiation: Introduction, electric dipole approximation, transition probability, Einstein's transition probability, selection rules for electric dipole transitions and forbidden transitions. **(Lectures – 9 + Tutorials - 3)**

UNIT – III

Theory of Scattering: Introduction, Stationary collision theory, scattering cross-section, scattering amplitude, Method of partial wave analysis of scattering theory, Applications: scattering from spherically symmetric potential, scattering from a perfectly rigid/hard sphere.
Integral equation, the method of Born approximation, Validity of Born approximation, Application: scattering from screened Coulomb potential. **(Lectures – 9 + Tutorials - 3)**

UNIT – IV

Relativistic Quantum Mechanics: Introduction, Klein-Gordon equation, Interpretation of Klein-Gordon equation. K-G equation in electromagnetic field, particle in a Coulomb field.
Dirac's equation for free particle, Dirac's matrices, probability density, plane wave solution, negative energy states, spin of the Dirac particle, magnetic moment and spin-orbit interaction energy of the electron. **(Lectures – 9 + Tutorials - 3)**

UNIT – V

Quantisation of the fields : Introduction, Classical Field theory, The Lagrangian and Hamiltonian formulations, quantum equation for the field, Method of second quantization for system of Bosons and system of Fermions, Creation, annihilation and number operators, occupation number representation. **(Lectures – 9 + Tutorials - 3)**

Essential Readings :

1. Quantum Mechanics: Concepts and Applications, N. Zettily, Wiley.,II edition,
2. Quantum Mechanics, G. Aruldhas, PHI.
3. Quantum Physics, S. Gasiorowicz, Wiley.
4. Quantum mechanics: Theory and Applications, A.K. Ghatak and S. Lokanathan, Kluwer Academic Publishers.
5. Advanced Quantum Mechanics, J.J.Sakurai, Pearson Addison-Wesley.
6. Quantum Mechanics, Vol-2, Claude Cohen-Tannoudji, Wiley.
7. Scattering Theory: The Quantum Theory of Non-relativistic Collisions, J.R. Taylor, Dover.
8. Scattering Theory of Waves and Particles, R.G. Newton, Dover.

Suggested Readings :

9. Relativistic Quantum Mechanics, J.D. Bjorken and S.D. Drell, Mcgraw-Hill College.
10. Student friendly Quntum field theory, R.D. Klauber, Sandtrove Press.
11. Quntum field theory, C. Itzykson and J.B. Zuber, Dover.
12. Quntum field theory, F. Mandl and G. Shaw, Wiley.
13. Quntum field theory, David Tong, Create Space Independent Publishing Platform.
14. An Introduction to Quntum field theory, M. Peskin and D. Schroeder, West view Press Inc.
15. An introduction to Quntum theory of fields, S. Weinberg, Cambridge University Press.

M.Sc. (Physics): IV Semester
SESSION: 2016-17

PHY CC 422	**Nuclear and Particle Physics**	**3**	**1**	**0**	**4**

UNIT I

Structure of nuclei: Basic Properties of Nuclei: Mass, Radii, Charge, Angular Momentum, Spin, Magnetic Moment (μ), Stability and Binding Energy. Nuclear size determination from electron scattering; nuclear form factor, Rutherford scattering. **(Lectures – 9 + Tutorials - 3)**

UNIT II

Radioactivity : Law of Radioactive Decay. Half-life, Theory of Successive Radioactive Transformations. Radioactive Series, Binding Energy, Mass Formula, α-decay :- Range of α-particles, Geiger-Nuttal law and α-particle Spectra. Gamow Theory of Alpha Decay. β-decay :- Energy Spectra and Neutrino Hypothesis. Fermi theory of beta decay, neutrino detection method, parity violation in beta decay, properties of neutrino, γ-decay :- Origin of γ-rays, Nuclear Isomerism and Internal Conversion, measurements of gamma rays energies, selection rules for gamma emission, total decay rate, Angular momentum and parity selection rules.

(Lectures – 9 + Tutorials - 3)

UNIT III

Nuclear Models : Liquid Drop Model. Fermi Gas model, shell model, Experimental evidence of shell model. Spin orbit coupling in shell model. Magic numbers. Applications of liquid drop model. Mass parabola. Beta stability. Angular momentum and parity determination using shell model for nuclear ground state. Collective nuclear model.

Nuclear Reactions : Types of Reactions and Conservation Laws. Concept of Compound and Direct Reaction. Compound Nucleus. Scattering Cross-section. Reaction Rate. Q-value of Reaction. Fission and Fusion. **(Lectures – 9 + Tutorials - 3)**

UNIT IV

Accelerators : Van de Graaff Generator, Linear Accelerator, Cyclotron, Betatron, and Light and Heavy Ion Synchro-Cyclotron. Idea of Large Hadron Collider

Detectors of Nuclear Radiations :- Interaction of Energetic particles with matter. Ionization chamber. GM Counter. Cloud Chambers. Wilson Cloud Chamber. Bubble Chamber. Scintillatipn Detectors. Semiconductor Detectors (Qualitative Discussion Only). An Idea about Detectors used in Large Hadron Collider. **(Lectures – 9 + Tutorials - 3)**

UNIT V

Introduction to particle physics. Classification and fundamental interactions of elementary particles, conservations laws, Elementary idea about CP invariance. Properties of elementary particles. Quark model. Gell-mann Okubo mass formula for octal and decuplet hadrons, symmetry schemes of elementary particles, SU(2) and SU(3) symmetry. **(Lectures – 9 + Tutorials - 3)**

Essential Readings :

1. Concepts of Modern Physics by Arthur Beiser, McGraw-Hill Book Company, 1987
2. Concepts of nuclear physics by Bernard L.Cohen.New Delhi: Tata Mcgraw Hill, 1998.

Suggested Readings :

3. Introduction to the physics of nuclei and particles by R.A. Dunlap.Singapore: Thomson Asia, 2004.
4. Nuclear physics by Irving Kaplan. Oxford & IBH, 1962.
5. Introductory nuclear physics by Kenneth S. Krane. John Wiley & Sons, 1988.

M.Sc. (Physics: IV Semester
SESSION: 2016-17

PHY SE 423	**Scientific Communication Skills**	**2**	**0**	**0**	**2**

Preamble: *This course is designed to expose students to the fundamentals of academic and professional communication in order to effectively apply communication theories and best practices to meet their academic needs.*

Aims: *The course aims to equip students with communication skills suitable for their academic purposes. It is further meant to develop in students skills necessary for effective communication in life in general.*

Methodology: *The course will be taught mainly through lectures, tutorials, group discussions, simulations and student presentations.*

UNIT I

Introduction to communication: Communication defined**,** the process of communication**,** models of communication**,** communication barriers

Communication for academic purposes: Introduction to academic writing, summarizing, paraphrasing and argumentation skills, textual cohesion, avoiding plagiarism.

(Lectures – 9 + Tutorials - 3)

UNIT II

Non-verbal communication and impression management: Introduction to non-verbal communication, verbal and non-verbal communication relationships, categories of non-verbal communication, non-verbal communication barriers.

Communication in organizations: Formal communication networks in organizations, informal communication networks, computer- mediated communication

Public Speaking and Presentation skills: Effective public presentation skills, Audience analysis, Effective argumentation skills, Interview skills. **(Lectures – 9 + Tutorials - 3)**

UNIT III

Technical Communication: Presenting technical information**,** tables, graphs, charts, visuals and pictorials**,** Technical reports and proposals**,** overcoming technical communication challenges **(Lectures – 9 + Tutorials - 3)**

Coursework will include in-class tests, individual assignments and group presentations.

Essential Readings :

1. Communication Information and Development, Abidi S.A.H Kenya Masaki Publishers. 1991
2. Business Communication Today Bovee C. and Thill J. V. 5th ed., Prentice Hall.1997

Suggested Readings :

3. The Art of Public Speaking Lucas, S.E. 8th ed. McGraw Hill, 2004
4. Guide to Technical and Scientific Communication. Zimmerman D. E and Clark D.G Random House Inc. 1987

PHY SE 424 : Seminar

This course makes a unique component of the curriculum. It is mandatory for every student to deliver a seminar of approximately 30 minutes duration in the field of chosen specialization and on a topic as decided by the Departmental Seminar Committee. Each and every student would get an opportunity to express his/her level of understanding of various concepts and this, apart from strengthening the subject knowledge, would help students in developing better communication skills and higher level of confidence.

The marks will be awarded by the Seminar Committee on the basis of performance in the seminar and the seminar report submitted by the student.

M.Sc. (Physics): IV Semester

SESSION: 2016-17

PHY EC 421	VLSI Design	4	0	0	4

UNIT – I

MOS Transistor, CMOS Logic: The inverter, The NAND gate, Combinational logic, The NOR gate, compound gates, Pass Transistor and Transmission gates, Tristates, Multiplexers, Latches and Flip-Flops. **(Lectures – 9 + Tutorials - 3)**

UNIT – II

COMS Fabrication layout: Inverter Cross section, Fabrication process, layout design rules, gate layout, stick diagram. VLSI design flow: Design specification, design entry, functional simulation, planning placement and Routing, Timing simulation.

(Lectures – 9 + Tutorials - 3)

UNIT – III

MOS Transistor Theory: Ideal I-V characteristics, C-V characteristics, non-Ideal I-V effects, DC transfer characteristics.

(Lectures – 9 + Tutorials - 3)

UNIT – IV

COMS Processing Technology: CMOS Technologies: Back ground, water formation, photolithography, wall and channel formation, Silicon dioxide, Isolation, Gate and source/drain formation, contact and metallization. **(Lectures – 9 + Tutorials - 3)**

UNIT – V

Layout Design Rule: Design rule back ground, scribe line and other structure, MOSIS and CMOS design rule, Micron Design rule.

(Lectures – 9 + Tutorials - 3)

Essential Readings :

1. CMOS VLSI Design – Weste, Harris and Banerjee – Pearson Education, 4th Edition,2006

Suggested Readings :

2. Modern VLSI Design – Wolf – PHI, 4th Edition, 2009.
3. Basic VLSI Design – Pucknell and Eshraghian, PHI , 3rd Ed., 2007.

M.Sc. (Physics: IV Semester
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PHY EC 422	**Laboratory Course(VLSI Design)**	**0**	**0**	**2**	**2**

Students have to perform of at least eight practicals from the following list:

1. Gate based design for half adder and full adder using software.
2. Gate based design for Half Subtractor and full subtractor using software.
3. Gate based design for BCD to Excess-3 code convertor using software.
4. Gate based multiplexer for two selection line using software.
5. MOS transistor based design for NAND Gate using software.
6. MOS transistor based design for Inverter using software.
7. MOS transistor based design for NOR gate using software.
8. MOS transistor based design for Flip-Flop using software.
9. MOS transistor based design for Multiplexer using software.
10. MOS transistor based design for Tristates using software.

Note: Other practical of equivalent level can be added.

M.Sc. (Physics: IV Semester
SESSION: 2016-17

PHY EC 423	**Physics of Nanomaterials**	**3**	**1**	**0**	**4**

UNIT – I:
Introduction to nanomaterials: Introduction to the world of nanostructures, different types of nanomaterials. Size and dimensionality effects. Fermi gas and density of states. Properties dependent on density of states. Quantum confinement-zero, one, two, three dimensional systems, potential wells, tunneling of a particle through a potential barrier. Structure and bonding, electronic structures of solids, Excitons. **(Lectures – 9 + Tutorials - 3)**

UNIT – II
Synthesis of nanomaterials: Top-down and bottom-up approach.
Physical methods: mechanical methods, methods based on evaporation, sputter deposition, chemical vapour deposition, Electric arc deposition, Ion beam techniques, and molecular beam epitaxy. **(Lectures – 9 + Tutorials - 3)**

UNIT – III
Chemical methods: Synthesis of nanoparticles by colloidal route, Langmuir – Blodgett (L-B) methods. Microemulsions and sol-gel methods.
Characterization Techniques: Determination of particle size: microscopy, Diffraction Techniques, Spectroscopy. **(Lectures – 9 + Tutorials - 3)**

UNIT – IV
Properties of Nanomaterials: Size dependent properties of nanomaterials, mechanical and structural properties, melting of nanoparticles, electrical conductivity, optical and magnetic properties. **(Lectures – 9 + Tutorials - 3)**

UNIT – V
Applications of Nanotechnology : Introduction, applications in electronics, energy, automobiles, nano cosmetics, textiles, space and defense, nanosensors, domestic appliances, drug delivery and cancer therapy, tissue engineering, nanotechnology and environment.
(Lectures – 9 + Tutorials - 3)

Essential Readings :

1. Introduction to Nano Science and Nano Technology – K.K. Chattopadhyay & AN Banerjee PHI Pvt. Ltd.,2009.
2. Nano technology: Principles and practices - Sulabha K. Kulkarni, Capital Publisher Co. ,2015.
3. Introduction to nano technology: Charles P. Poole, Jr. Frank J. Owen, Wiley, Interscience Pub., May, 2003.
4. Nanostructures & Nanomaterials Synthesis Properties & Applications. Guozhong Cao, Imperials College Press London. 2004

Suggested Readings :

5. Nano: The Essentials. T. Pradeep, McGraw Hill Education.20/01/2007
6. Handbook of Nanostructures: Materials and nanotechnology, H.S. Nalwa Vol 1-5, Academic Press, Bostan., I Ed.,Oct., 1999.
7. Fundamental of Physics- Rashnik Halliday, Walker, Willy 6th Edition. ,2015.

M.Sc. (Physics): IV Semester
SESSION: 2016-17

PHY EC 424	Plasma Physics	3	1	0	4

UNIT – I

Introduction to the plasma state, Elementary concepts and definition of temperature, mean velocity and flux and other plasma parameters, occurrence and importance of plasma for various applications, Status, problems and technological requirements of thermo-nuclear fusion.

(Lectures – 9 + Tutorials - 3)

UNIT – II

Production of plasma in the laboratory, physics of glow discharge, electron emission, ionization and breakdown of gases, Townsend discharge and the evolution of discharge, I-V characteristic of discharge, Paschem's law and different regimes of E/P in a discharge.

(Lectures – 9 + Tutorials - 3)

UNIT – III

Plasma diagnostics, single probe and double probe measurements of density and temperature, energy analyzers, magnetic probes and optical diagnostic (preliminary concepts.).

(Lectures – 9 + Tutorials - 3)

UNIT – IV

Distribution function and Liouville's equation, Boltzmann and Vlasov equations, derivation of moment equations from Boltzmann equation. **(Lectures – 9 + Tutorials - 3)**

UNIT – V

Macroscopic parameters of plasma, two and one fluid equations for plasma, MHD approximations commonly used in one fluid equations and simplified one fluid and MHD equations.

(Lectures – 9 + Tutorials - 3)

Essential Readings :

1. Introduction to Plasma Physics : F.F. Chen, Plenum Press, New-York I Edition, 1994..
2. Principles of Plasma Physics : N.A. Krall and A.W. Trivelpiece, Mc-Graw Hill Kogakusha, Ist Edition, New Delhi, 1973.
3. Introduction to Plasma Theory, : D.R. Nicholson, John-Wiley & Sons, New-York, Ist Edition 1983
4. Plasma Dynamics : T.J.M. Boyd & J.J. Sanderson, Thomas Nelson (Australia)
5. The Theory of Plasma waves, : T.H. Stix, Mc Graw Hill Book company, INC, , Ist Edition New-York 1992

Suggested Readings :

6. The Plasma State : J.L. Shohet Academic press. , Ist Edition 1971
7. Introduction to Plasma Physics : M. Uman, Mc Graw Hill , Ist Edition 1964.
8. Principles of plasma diagnostic, : I.H. Hutchison, Cambridge University Press.

M.Sc. (Physics): IV Semester
SESSION: 2016-17

PHY EC 425	Environmental Physics	3	1	0	4

UNIT – I

Essentials of Environmental Physics: Structure and thermodynamics of the atmosphere. Composition of air, Greenhouse effect; transport of matter, energy and momentum in nature; Stratification and stability of atmosphere. Laws motion, hydrostatic equilibrium; General circulation of the tropics. Elements of weather and climate of India. **(Lectures – 9 + Tutorials - 3)**

UNIT – II

Solar and Terrestrial Radiation: Solar and Terrestrial Radiation : Physics of radiation. Interaction of light with matter. Rayleigh and Mie scattering. Laws of radiation (Kirchoffs law, Planck's law, Beer's law, Wien's displacement law, etc.) Solar and terrestrial spectra. UV radiation. Ozone depletion problem. IR absorption energy balance of the earth atmosphere system.

(Lectures – 9 + Tutorials - 3)

UNIT – III

Environmental Degradation: Elementary fluid dynamics. Diffusion, Turbulence and turbulent diffusion. Factors governing air, water and noise pollution. Air and water quality standards. Waste disposal. Heat island effect. Land and sea breeze. Puffs and plumes. Gaseous and particulate matters. Wet and dry deposition. **(Lectures – 9 + Tutorials - 3)**

UNIT – IV

Global and Regional Climate: Elements of weather and climate. Stability and vertical motion of air. Horizontal motion of air and water. Pressure gradient forces. Viscous forces. Inertia forces. Reynolds number. Enhanced Greenhouse Effect. Energy balance- a zero-dimensional Greenhouse model. Global climate models **(Lectures – 9 + Tutorials - 3)**

UNIT -V

Atmospheric Pollution: 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.

(Lectures – 9 + Tutorials - 3)

Essential Readings :

1. The Physics of Atmosphere- J.T. Hougtion, Cambridge University Press 1977.
2. Reneable Energy Resources- J. Twidell and J. Weir, Elbs, 1988.

Suggested Readings :

3. An introduction to Solar Energy for Scientists and Engineers- Sol Wieder, John Willey 1982.
4. The Physics of Monsoons, R.N. Keshavamurthy and M. Shanker Rao, Applied Pub. 1992.
5. Numerical Weather Prediction, G.J. Haltiner and R.T. Williams, John Willey, 1980.

M.Sc. (Physics): IV Semester
SESSION: 2016-17

PHY EC 426	Atmospheric Science	3	1	0	4

UNIT – I

Origin, Composition and structure of atmosphere: Atmosphere as a part of biospheric ecosystem, Origin and evolution of atmosphere, Composition of atmosphere and structure of atmosphere.

Insolation and energy (Heat) balance: The energy system, Flux of solar energy in the biosphere, insolation, Mechanism of solar radiation, distribution of insolation, factor effecting the distribution of insolation, Heat budget (energy balance), net radiation and latitudinal heat balance, Human influence on radiation (heat) balance. **(Lectures – 9 + Tutorials - 3)**

UNIT – II

Temperature: Transfer of heat energy, Heating and cooling of the atmosphere, Mean temperature, Range of temperature, Distribution of temperature, Vertical distribution of temperature. Inversion of temperature, Horizontal distribution of temperature

Atmospheric pressure and motion: Meaning of atmospheric pressure, Pressure gradient, Variation in air pressure and pressure belts, Meridional distribution of pressure, Shifting of pressure belts, Atmospheric motion (pressure gradient and air circulation, coriolis force, wind direction and related laws, frictional force), Resultant air circulation (geostrophic wind, gradient wind), Wind direction and speed, Classification of winds. **(Lectures – 9 + Tutorials - 3)**

UNIT – III

Monsoon dynamics: Local winds, meaning and concepts, Periodical local winds (Land and sea breezes, mountain and valley breezes), non-periodic local winds (urban heat island circulation and countryside-city breeze, dust devils), Monsoon (meaning and concept, types and distribution of monsoon, Asian monsoon, North American modification monsoon, pseudo monsoon, Australian monsoon) Concept of the origin of monsoon (thermal concept, dynamical concept), Origin of Indian monsoon, Seasonal characteristics of Indian monsoon. **(Lectures – 9 + Tutorials - 3)**

UNIT – IV

Atmospheric Pollution:

Residence time and reaction rates of pollutants: sulphur compounds, nitrogen compounds, carbon compounds, organic compounds, aerosols, toxic gases and radioactive particles, trace gases.

(Lectures – 9 + Tutorials - 3)

UNIT – V

Atmospheric Instruments and Systems:

Ground based instruments: Ground based instruments for the measurement of Temperature, pressure, Humidity, Wind and Rainfall Rate.

Air borne instruments: Radiosonde, Basic structure of Radiosonde and its application in atmospheric study.

Global Positioning System (GPS): Basic structure of GPS, Kind of GPS, and various applications of GPS.

(Lectures – 9 + Tutorials - 3)

Essential Readings :

1. Environmental Studies- Dr. S. K. Dhameja, 2012

Suggested Readings :

2. Climatology -Dr. Savindra Singh, 2005

M.Sc. (Physics): IV Semester
SESSION: 2016-17

PHY EC 427	**Nanophotonics**	**3**	**1**	**0**	**4**

UNIT-I

Foundations for Nanophotonics: Photons and electrons: similarities and differences, free space propagation. Confinement of photons and electrons; Propagation through a classically forbidden zone: tunneling. Localization under a periodic potential: Band gap. Cooperative effects for photons and electrons; Nanoscale optical interactions.

(Lectures – 9 + Tutorials - 3)

UNIT-II

Light generation by nanostructures: Light generation by semiconductor quantum wells, wires, dots, nano-crystals, and nanowires, Optical micro-resonators (micro cavities): microspheres, microdisks, microposts, photonic crystal cavities. **(Lectures – 9 + Tutorials - 3)**

UNIT-III

Confinement of light and quantum waves: Light confinement: Metallic Mirrors, total internal reflection (TIR), distributed Bragg reflection; Photonic crystals (1D), (2D) and (3D); optical waveguides: fibers, photonic crystal wave guides. **(Lectures – 9 + Tutorials - 3)**

UNIT-IV

Confinement of quantum mechanical wave: Infinite quantum well, Tunneling, semiconductor quantum wells, quantum wires, quantum dots, carbon nanotubes, fullerenes.

(Lectures – 9 + Tutorials - 3)

UNIT-V

Plasmonics: surface plasmons (propagation at metal-dielectric interfaces, transmission through sub wavelength hole), metallic nanoparticles, particle chain and arrays.
Near-field optics, system applications: optical communication and bio chemical sensing

(Lectures – 9 + Tutorials - 3)

Essential Readings :

1. Principles of Nano-Optics, by Lukas Novotny and Bert Hecht Cambridge Univ. Press, New York, 2006.
2. Nanophotonics, by Herve Rigneault, Jean-Michel Lourtioz, Claude Delalande, Juan Ariel Levenson 1996

Suggested Readings :

3. Surface Plasmon Nanophotonics, by Mark L. Brongersma, Pieter G. Kik
4. Nanophotonics, by P.N. Prasad, Wiley, March, 2004.
5. Photonic Crystals, by John D. Joannopoulos, Robert D. Meade, Joshua N. Winn

M.Sc. (Physics): IV Semester
SESSION: 2016-17

PHY EC 428	Nanoelectronics and Nanosystems	3	1	0	4

UNIT-I

Introduction: The Development of Microelectronics, the region of nanostructure, recent past, the present and its challenges.

Potential of silicon Technology: Semiconductor as base structure, technologies, Methods and limits of micro minimization, Microelectronics and mechanical systems (MEMS).

(Lectures – 9 + Tutorials - 3)

UNIT – II

Physical fundamentals : Electromagnetic field and photons, quantization of action, charge and flux, electrons behaving as waves, electron in potential well, photons interacting with electrons in solids, diffusion process, basic information theory.

(Lectures – 9 + Tutorials - 3)

UNIT – III

Biology – Inspired Concept: Biological neurons, the function of neuronal cell, Biological neuronal cells on silicon, modeling of neuronal cells by VLSI circuit Neuronal networks with local adaptation and distributed data processing.

Biochemical and Quantum Mechanical Computers: DNA computer, Quantum computer.

(Lectures – 9 + Tutorials - 3)

UNIT – IV

Parallel Architecture of Nanosystems: Architectural principles, Architectures for parallel processing in nanosystem, method of soft computing, characteristic of Neural networks in nanoelectronics, complex integrated systems and their properties.

(Lectures – 9 + Tutorials - 3)

UNIT – V

Quantum Electronics : Quantum electronics Devices, short channel MOS transistor, Split-Gate transistor, electron spin transistor, Quantum cellular Automata, Quantum dot array, Bio electronics, Molecular electronics, nano electronics with tunneling devices.

(Lectures – 9 + Tutorials - 3)

Essential Readings :

1. Nanoelectronics and Nanosystems: From Transistor to Molecular & Quantum Devices: Kari Goser, JanDienstuhl and others, Springer, 2004.
2. Nano Electronics and Information Technology: Rainer Waser, Wiley –VCH, 3rd Edition.

Suggested Readings :

3. Concepts in Spintronics – Sadamichi Maekawa, Tohoku University, Japan
4. Spin Electronics – David Awschalom, 2004.

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PHY EC 429	**Project**	**Self study**	**4**

Each student will be allocated a (departmental) faculty member as project supervisor on the topic of his/her interest. For realization of meaningful projects, longer duration will be provided by way of assignments of projects by the end of third semester.

The students are required to submit a dissertation on the project of the topic assigned to him/her under the supervision of a faculty member allocated to him/her by the department. The grading for the project will be based on the progression of the project during the semester and final submission of the dissertation. The internal assessment of **40** marks will be based on the progression of the assigned project to be jointly evaluated by a Board of Examiners appointed for the purpose. The Board of Examiners will be appointed by the Board of Studies and it will consist of the Supervisor of the project concerned and another faculty member of the Department.

The end semester examination of **60** marks will be split in two parts (Project submission: **40** marks & viva voce: **20** marks) for the evaluation of the dissertation and viva on it and shall be conducted on the lines as mentioned in the ordinances for the purpose.