UNIVERSITY OF KERALA

Revised Syllabus for
Msc Degree Programme in Physics

(with effect from 2014 admissions)

UNIVERSITY OF KERALA

M.Sc Degree Programme (effective from 2014 - 15)

Branch II PHYSICS

A: COURSE STRUCTURE & MARK DISTRIBUTIC

Semester	Paper Code	Title of Paper	Contact hours per week			UE duration (h)	Maximum mark		
			L	T	P		IA	UE	Total
I	PH 211	Classical Mechanics	6	1	...	3	25	75	100
	PH 212	Mathematical Physics	6	1	...	3	25	75	100
	PH 213	Basic Electronics	6	1	...	3	25	75	100
	PH 251	General Physics Practicals	...	1	3	...	...	...	...
	PH 252	Electronics & Computer Science Practicals	...	1	4	...	...	...	...
		Total for Semester I (S1)	18	5	7	...	75	225	300
II	PH 221	Modern Optics & Electromagnetic theory	6	1	...	3	25	75	100
	PH 222	Thermodynamics, Statistical Physics & Basic Quantum Mechanics	6	1	...	3	25	75	100
	PH 223	Computer Science & Numerical Techniques	6	1	...	3	25	75	100
	PH 251	General Physics Practicals	...	1	3	6	25	75*	100
	PH 252	Electronics & Computer Science Practicals	...	1	4	6	25	75*	100
		Total for Semester II (S2)	18	5	7	...	125	375	500
III	PH 231	Advanced Quantum Mechanics	6	1	...	3	25	75	100
	PH 232	Advanced Spectroscopy	6	1	...	3	25	75	100
	PH 233 X	Special Paper I	6	1	...	3	25	75	100
	PH 261	Advanced Physics Practicals	...	1	4	...	...	...	...
	PH 262	Advanced Electronics Practicals	...	1	3	...	...	...	...
		Total for Semester III (S3)	18	5	7	...	75	225	300
	PH 241	Condesed Matter Physics	6	1	...	3	25	75	100
	PH 242	Nuclear & Particle Physics	6	1	...	3	25	75	100
	PH 243 X	Special Paper II	6	1	...	3	25	75	100
	PH 261	Advanced Physics Practicals	...	1	3	6	25	75*	100

IV	PH 262	Advanced Electronics Practicals	...	...	4	6	25	75*	100
	PH 201	Project	...	...	...	...	25	75	100
	PH 202	Viva Voce	...	...	...	...	...	100	100
		Total for Semester IV (S4)	18	5	7	...	150	550	700
		Grand Total	**72**	**20**	**28**	...	**425**	**1375**	**1800**

* 10 marks for records

L- Lecture IA - Internal Assesment

T - Tutorial UE - University Exam

P - Practical

X: E (Electronics),M(Materials Science)

N (Nuclear Physics) ,S (Space Physics)

T (Theoretical Physics)

B: SPECIAL PAPERS FOR THIRD AND FOURTH SEMESTERS

Special paper Category	Code Nos of Special Papers	Name of Special Papers
1 ELECTRONICS	PH 233 E PH 243 E	Advanced Electronics-I Advanced Electronics-II
2 MATERIALS SCIENCE	PH 233 M PH 243 M	Materials Science-I Materials Science-II
3 NUCLEAR PHYSICS	PH 233 N PH 243 N	Advanced Nuclear Physics Radiation Physics
4. SPACE PHYSICS	PH 233 S PH 243 S	Space Physics and Plasma Physics Advanced Astrophysics
5.THEORETICAL PHYSICS .	PH 233 T PH 243 T	Theoretical Physics-1 Theoretical Physics-2

C: GENERAL GUIDELINES

C-1 Theory papers

Books of study and corresponding chapters are given for most of the theory papers in the syllabus to define the scope of the syllabus.

For internal evaluation of theory papers at least one Viva must be conducted for each paper

For assignments and seminars current developments in the areas of the syllabus may be chosen for improving the general awareness of the student

In tutorial sessions of theory papers problem solving in different topics of the syllabus may be discussed.

C-2 Lab Courses

Rough records may be properly maintained for each practical paper and should be produced during the University Practical Examinations along with original record book.

Each student is encouraged to include critical comments on each experiments done in the original records including sources and estimates of errors,limitations in the experiments done and scope for improvements/additions in the experimental work.

In performing Electronics Practicals: Bread Board Practice is recommended in addition to soldering of electronic circuits.

C-3 Special papers

Depending on the expertise and facilities available in a College (with approval of the University and Government as per rules) one of the five Specialisations (Special paperCategory) may be chosen by a student for the third and fourth semesters of the MSc ProgrammeinPhysics.At present for all specialisationspractical courses are common.

C4-Project work and Project Evaluation

The Project may be started during the second semester of the MSc programme.

25 marks of the project is to be awarded on the basis of internal assessment carried out in the College for each studentconcerned. A Project rough record may be maintained by each student to help to evaluate the progress of the project. Each student is required to present the completed project along with experimental demonstration if any in the college before the final University examinations in the Fourth Semester of the MSc (Physics) Programme.

For University Examinations for the Project: 50 marks is allotted for Project report evaluationand 25 marks allotted for Project based Viva Voce to be conducted along with General Viva Voce examination by the University.

D Pattern of UniversityQuestion papers

D-1 Theory Papers

Each question Paper has three parts: Part A,Part B and Part C

Part A: Eight short answer questions covering the entire syllabus.*One of the question from this section may be used to test the CURRENT AWARENESS (general knowledge) of the student in the areas of syllabus covered for this paper.*Each question carries 3 marks.

Par B: contains three compulsory questions with internal choice. Questions cover all the three units in the syllabus.Each question carry 15 marks.

Part C : contains six problems covering the entire syllabus.The student need to answer any three. Each question carries five marks.
The question paper pattern for the theory papers is given separately.

D-2 PRACTICALS

Each practical paper carries a total of 75 marks. 10 marks are allotted for practical records.

PH 252: Electronics and Computer Science: Unit A-Electronics practical (4h ,45 marks)
Unit B- Computer Science (2h,20 marks)
PH261: Advanceed Physics has two parts : Physics Experiment (5h,45 marks)
Data Analysis of given scientific data (1 h,20 marks)
PH 262: Advanced Electronics has two parts : (i)Electronics Practicals (4h,45 marks)
(ii) Microprocessor Practicals (2h,20 marks)

PH 201 Project: Internal Evaluation for project is 25 marks

For University Examinations: 50 marks for Project Dissertation/report evaluation and 25 marks for Project based Viva Voce

PH 202 General Viva Voce: For General Viva Voce covering the entire MSc Syllabus, University Examinations : 100 marks

(University Question Paper pattern given separately)

Question paper pattern

MSc Degree Examination

Branch II PHYSICS

PH 2xy……………………………………………

Duration : 3 hours **Maximum marks : 75**

Instructions to question paper setter

1. Each question paper has three parts - Part A, Part B and Part C
2. Part A contains eight short answer questions spanning the entire syllabus, of which the candidate has to answer any *five* question carries *three* marks.
3. Part B contains *three* compulsory questions with internal choice. Each question shall be drawn from each unit of the syllabus. Each question carries 15 marks
4. Part C contains six problems spanning the entire syllabus . The cndidate has to answer any *three*. Each question carries *five* marks

PART A

(Answer any five question. Each question carries three marks)

I (a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)

(5 x 3 = 15 marks)

PART B

II A (a)
(b)

OR

II B (a)
(b) (15 marks)

IiI A
(a)
(b)

OR

IIi B (a)
(b) (15 marks)

IV A (a)
(b)

OR

IV B (a)

(b) (15 marks)

Part C

(Answer any three question. Each question carries five marks)

V (a)

(b)

(c)

(d)

(e)

(f)

(3 x 5= 15 marks)

PH 211: CLASSICAL MECHANICS(6L,1T)

Unit-I

Lagrangianmechanics (12 hours)

Mechanics of a particle and system of particles- constraints-D'Alemberts principle and Lagrange's equations-simple applications of Lagrangian formulation-Hamilton's principle-techniques of calculus of variations-derivation of Lagrange's equations from Hamilton's principle-conservation theorems and symmetry properties

(Chapters 1 and 2 of Goldstein)

Two body central force problem (14 hours)

Reduction to one body problem-equations of motion-equivalent one dimensional problem-diffrential equation for the orbit in the case of integrable power law potentials-Kepler's problem-inverse square law of force-scattering in central force field-Virial theorem-transformation of the scattering problem to laboratory coordinates

(Chapter 3 of Goldstein)

Theory of small oscillations (10 hours)

Equillibrium and potential energy-theory of small oscillations-normal modes with examples-longitudinal vibrations- longitudinal vibrations of carbon dioxide molecule

(Chapter 9 of Aruldas)

Unit II

Hamiltonian mechanics (12 hours)

Generalised momentum and cyclic coordinates-conservation theorems-Hamilton's equations-examples in Hamiltonian dynamics-canonical transformations-generating functions-poisson brackets-Liouoville's theorem

(Chapters 3,6 and 7 of Upadhyaya)

Hamilton-Jacobi equations(10 hours)

Hamilton-Jacobi equation-harmonic oscillator as an example-separation of variables in Hamilton-Jacobi equation-action angle variables-Kepler's problem

(Chapter 10 of Goldstein)

Rigid body dynamics(14 hours)

Generalised coordinates of rigid body-Euler's angles-infinitesmal rotations as vectors-angular momentum and intertia tensor-Euler's equations of motion of a rigid body-force free motin of symmetrical top-motion of heavy symmetrical top

(Chapter 10 of Upadhyaya)

Unit III

Special and General Relativity theory(14 hours)

Lorentz transformation in four dimensional spaces-covariant four dimensional formulations-force and energy equations in relativistic mechanics-Lagrangian formulation of relativistic mechanics-covariant Lagrangian formulation

(Chapter 7 of Goldstein)

General theory of relativity-principle of equivalence and applications-ideas of Riemannian geometry-space time curvature-geodesics-Einsteins equations of General theory of Relativity-Schwarzchild solutions-observational evidences to General relativity

(Chapters 7 to 10 of Krori and Chapter 8 of Srivastava)

Introduction to non-linear dynamics(12 hours)

Linear and nonlinear systems-integration of second order non-linear differential equations-pendulum equation-phase plane analysis of dynamical systems-linear stability analysis-limit cycles

(Chapter 10 of Aruldas,relevant Chapters of Drazin and Johnson)

Elements of classical chaos(10 hours)

Bifurcation-logisitc map-strange attractors-Lyapunov exponent and Chaos-ideas of fractals and solitons

(Chapter 11 of Aruldas)

Books for study

1 H.Goldstein,C.PooleabdS.Safko,*Classical Mechanics*,3rdEdn,Pearson Education Inc

(2008 Print)

2. J.C.Upadyaya,*ClassicalMechanics*,RevisedEditon,Himalaya Publishing Company (2005)

3. G.Aruldas,*ClassicalMechanics*,Prentice Hall of India Pvt Ltd (2008 Print)

4.K.D.Krori,*Fundementals of Special and General Relativiy*,PHI Learning Pvt Ltd (2010)

5. S.K.Srivastava,*General Relativity and Cosmology*,PHI learning Pvt Ltd (2008)

6.P.G Drazin and R.S Johnson,*Solitons –an Introduction*,Cambridge University Press(1989)

References

1 N.C.Rana and B.S.Joag,ClassicalMechanics,TataMcGrawHill (1991)

2. V.B.Bhatia,Classical Mechanics with introduction to nonlinear oscillations and chaos,Narosa Publishing House (1997)

3. M.Tabor ,Chaos and integrability in nonlinear dynamics,Johnwiley& Sons (1989)

4.R.K.Pathria,The Theory of Relativity,SecondEdition,dover Publications (2003)

PH 212: Mathematical Physics(6L, 1T)

Unit I

<u>Vector analysis and matrices(8 hours)</u>

Review of vector analysis-vector calculus operators-orthogonal curvilinear coordinates –Gradient,divergence,curl,Laplacian in cylindrical\ and spherical polar coordinates-orthogonal and unitary matrices-Hermitian matrices-diagonalization of matrices-normal marices

(Chapter 1 ,2, and 3 of Arfken and Weber)

<u>Complex analysis(8 hours)</u>

Cauchy-Riemann conditions-Cauchy's integral theorm and formula-singularities and mapping-calculus of residues-dispersion relations

(Chapter 6 and 7 of Arfken and Weber)

<u>Fourier series and applications(8 hours)</u>

General principles of Fourier series-advantages and applications-Gibbs phenomeneon-Discrete Fourier Transform-Fast Fourier transform

(Chapter 14 of Arfken and Weber)

<u>Probability(12 hours)</u>

Definitions and simple properties of probability-random variables-Chebychev inequality and moment generating function-discrete and continous probability distributions-binomial distributions-posson distributions-Gauss Normal distribution-error analysisduf and least square fitting-chi-square and student ‘t’ distributions

(Chapter 19 of Arfken and Weber)

Unit II

Differential equations(16 hours)

Partial differential equations-first order equations-separation of variables-singular points-series solutions and Frobenius method-non homogeneuous partial differential equations-Green’s functions-Laplace transforms and inverse Laplace transforms-applications to solution of simple differential equations

(Chapter 9 of Arfken and Weber)

Special functions(20 hours)

Bessel functions of the first kind-orthogonality-Neumann functions-Hankelfuctions-modified Bessel functions-spherical Bessel functions-Legendre functions-generating function-recurrence relations and orthoganility-associated Legendre functions-spherical harmonics-Hermite functions-Lagurerre functions-Chebyshev polynomials-hypergeometric functions

(Chapter 11,12,13 of Arfken and Weber)

Unit III

<u>Tensor analysis (18 hours)</u>

Notations and conventions in tensor analysis-Einsteins summation convention-covariant and contravariant and mixed tensors-algebraic operations in tensors-symmetric and skew symmetric tensors-tensor calulus-Christoffel symbols-kinematics in Riemann space-Riemann—Christoffel tensor.

(Chapter 49 in Dass and Verma,Chapter 2 of Joshi)

<u>Group theory(18 hours)</u>

Definitions of a group-elementary properties-sub groups-homomorphism and isomorphism of groups-representation of groups-reducible and irreducible representations-simple applications in crystallography and molecular symmetry-Lie groups-SU(2) groups and their representations

(Chapter 1,3, and 7 of Joshi and Chapter 4 of Bagchi et al)

Books for study

1 G.B.Arfken and H.J.Weber, *Mathematical methods for Physcisits*,6th Edition,Elsavier (2005).

2. H.K.Dass and R.Verma,*MathematicalPhysics,S.Chand& Co Pvt Ltd* (1997)

3. A.W.Joshi,*Matrices and Tensors in Physics*,3rd Edition,New Age International Pub (1995)

4.A.W.Joshi, *Elements of Group Theory for Physicists*,Fourth Edition,

New Age International Pub (1997).

5.S.C.Bagchi,S.Madan,A,Sitaram,V.BTewari*A first course in representation theory and linear Liegroups*,Universities Press (India) Pvt Ltd (2000).

References

1 Harry Lass,Vector and Tensor Analysis,McGraw Hill Pub (1950)

2. M.L.Jain,Vector Spaces and Matrices in Physics,Alpha Science International (2001)

3. W.W.Bell,Special Functions for Scientists and Engineers,Dover Publications (2004)

4. W.K.Tung,Group theory in Physics,World Scientific Pub Co (1999)

5, C.Harper,Introduction to MathemaicalPhysics,Prentice Hall (1986)

6. A.K.Ghatak,I.C.GoyalamdS.T.Chua,MathematicalPHYsics,Macmillan India (1985).

PH 213:BASIC ELECTRONICS (6L,1T)

Unit I

<u>Selections from electronic circuits (24 hours)</u>

Frequency response of an amplifier circuits-power and volatage gain-imedence matching-Bode plots-Miller effects-rise time bandwidth relations-frequency analysis of BJT and FETamplifier stages

(Chapter 16 of Malvino and Bates)

Active filters-first order and second order Butterworth transfer function-first order and second order active filters-lowpass,high pass and band pass filters-comparators-OP Amp as a voltage comparator-zero crossing detectors-Schmitt trigger-voltage regulators-square,triangular and saw tooth wave form generators-Weinberg oscillatormonostable and astablemultivibrator circuits using IC 555 timer-Phase Locked Loop circuits (PLL)

(Chapters 7,8 and 9 of Gayakward)

Microwave solid state devices (12 hours)

Tunnel diode-varacter diode-IMPATT diode-Gunn diode-applications of semi conductor microwave devices

(Chapter 12 of Tyagi and Chapter 10 of Sreetman & Banerjee)

Unit II

Digital electronics

<u>Arithmetic and data processing digital circuits (16 hours)</u>

Binary adder and subractor-arithmetic logic unit-binary multiplication and division-arithmetic units using HDL-multiplexers-demultiplexers-BCD to decimal counters-encoders-parity generators and checkers-programmable logic arrays

(Chapter 4,6 and 7 of Leach etal)

<u>Seqential digital circuits(20 hours)</u>

Flip flops-clocked SR flip flops-JK flip flops-different types of registers-shift registers and applications-asynchrounous and synchronous electronic counters-decade counters-digital clock-applications of electronic counters.

(Chapters 8,9,10 and 13 of Leach et al)\

Unit III

<u>Optoelectronics(20 hours)</u>

Optical fibre as a wave guide-mode theory of circular wave guide-wave guide equations-modes in step index fibres-propagation of modes in single mode fibres-signal distortion in optical fibres-sources of attenuation and signal distortion-optical sources-LED's and Laser diodes-photodetectors-semiconductor and fibre amplifiers

(Chapers 2,3,6 and 11 of Keiser)

<u>Electronic Instrumentation(16 hours)</u>

Electronic measurements and instruments-comparison between analog and digital instruments-performance and dynamic characteristics-ideas of errors and measurement standards-voltmeters-ammeters-ohmerters-multimeters-balance bridge voltmeters-components of a CRO-dual beam and dual trace CRO-digital sorage CROclassification of transducers-active and passive transducers-force and displacement transducers-strain gauges-temaprature measurements-thermistors-thermocouples-flow measurements

(Chapters 1,4,5,7,and 8 of Lal Kishore)

Books for study

1 A.Malvino and D.J.Bates,*Electrinics Prinicples*,7th Edition,Tata McGraw Hill(2007)

2. R.A.Gayakwad, *Operational Amplifiers and Linear integrated Circuirts*,Prentice Hall of India (2000)

3.M.S.Tyagi,*Introduction to semiconductior materials and devices*,Wiley India (2005)

4. B.G.Streetman,S.K.Banerjee,*Solid state electronic devices*.Pearsoninc (2010)

5.D.P.Leach,A.P.Malvino, and G.Saha ,*Digital principles and applications*,Tata Mc Graw Hill (2011)

6. G.Keiser,*Optical Fibre Communication*,3rd edition,McGraw Pub (2000)

7. LalKishore*,Electronic measurements and Instrumentation*,Dorling Kindersley (India) Pvt Ltd(2010)

References

1 J.Millman,C,Halkias and C.D.Parikh,IntegratedElectronics,TataMcGrawHill (2010)

2T.F.Bogart Jr,J.S.Beasley and G.Reid,Electronic devices and circuits,SixthEdition,PearsonInc (2004)

3. Thomas.L.Floyd,Digital Fundementals,10th edition,Dorling Kindersley (India) Pvt Ltd (2011)

4 JoachionPiprek,Semiconductor Optoelectronic Devices,Academic Press (2003)

5. W.D.Cooper,A,O,Helfrik and H.Albert,Electronic Instrumentation and measurement Techniques,PHI (1997).

PH 221 MODERN OPTICS AND ELECTROMAGNETIC THEORY(6L,1T)

Unit I

<u>**Selections from modern optics (24 hours)**</u>

Multiple beam interference-Fabry-Perot interferometer-theory of multilayer films-antireflection films and high reflectance films -Fresnel-Kirchoff integral theorem and formula-Fraunhofer and Fresnel diffraction patterns and theory-applications of

Fourier transforms to diffraction-accoustic -optic modulation-basic ideas of Raman-Nath diffraction and Bragg diffraction-holography as wavefront reconstruction-propagation of light in crystals-optical activity and Faraday rotation

(Chapters 4 to 6 of Fowles and Chapters17 and 18 of Ghatak and Thayagarajan)

Non-linear optics(12 hours)

Physical origin of non-linear polarization-electromagnetic wave propagation in non linear media-optical second harmonic generation-ideas of parametric amplification-electro-optic modulation of laser beams-eletro-optic amplitude and phase modulation-LiNbO3 crystals as phase modulators

(Chapers 8 and 9 of Yariv)

Unit II

Electromagnetic waves(12 hours)

Electromagnetic wave equations-electromagnetic waves in non-conducting media-plane waves in vacuum-energy and momentum of electromagnetic waves-propagation through linear media-reflection and transmission at normal and oblique incidence-electromagnetic waves in conductors-modified wave equations and plane waves in conducting media-reflection and transmission at a conducting interface

(Chapter 9 of Griffiths)

Relativistic electrodynamics(12 hours)

Magnetism as a relativistic phenomena-transformation of the field-electric field of a uniformly moving point charge-electrodynamics in tensor notation-electromagnetic field tensor-potential formulation of relativistic electrodynamics

(Chapter 12 of Griffiths)

Radio wave propagation through earth's atmosphere(12 hours)

Radio wave propagation in free space-radio wave propagation through earth's troposphere-radio horizon-ideas of ground and surface waves-radio wave propagation in earth's ionosphere-maximum usable frequency and virtual height calculations-classification of different radio wave bands

(Chapter 15 of Roody and Coolen)

Unit III

<u>Transmission lines (12 hours)</u>

Transmission line parameters and equations-input impedance-standing wave ratio and power-The Smith Chart-applications of transmission lines

(Chapter 10 of Sadiku)

<u>Wave guides(12 hours)</u>

Rectangular wave guides-transverse magnetic (TM) modes-Transverse electric (TE) modes-wave propagation in the wave guide-power transmission and attenuation

(Chapter 11 of Sadiku)

<u>Antennas(12 hours)</u>

Radiation from Hertzian dipole-half wave dipole antenna-quarter wave monopole antenna-antenna chateristics-antenna arrays-effective area and Friji's equations

(Chapter 12 of Sadiku)

Books for study

1 G.R.Fowles,, Introduction to Modern Optics,SecondEdition,Dover Publications (1989)

2 A.Yariv,Introduction to Optical electronics,Holt,Reinhart and Winston (1976)

3. A.Ghatak and K.Thyagarajan, Optical Electronics,Cambridge University Press (1998)

4. D.Roody and J.Coolen,,ElecronicCommunications,FourthEdition,DorlingKindersley (India) Pvt Ltd (2008)

5. D.J.Griffiths ,Indroduction to Electrodynamics,PHI Learning India Pvt Ltd (2007)

6.M.N.O.Sadiku,Elements of electromagnetics,Oxford University Press (2007)

References

1 J.R.Meyer-Arendt,Introduction to Classical and Modern Optics,Prentice Hall Intl (1995)

2. J.C.Palais,Fibre optic communications,FiftghEdition,Pearson Education Inc (2005)

3. E.C.Jordan and K.G.Balmain,Electromagnetic waves and radiating systems,SecondEdition,Pearson Education (2002)

4. D.K.Cheng,Field and Wave electromagnetics , Second Edition ,Addison Wesley (1999)

5. L.Ganesan and S.S.Sreejamole,Transmission lines and wave guides,SecondEdition,TataMcGrawHill (2010).

PH 222: THERMODYNAMICS,STATISTICAL PHYSICS AND BASIC QUANTUM MECHANICS (6L,1T)

UNIT I

Thermodynamic relations and consequences (20 hours)

Thermodyanamic functions and Maxwells's equations-Clausius -Claepyrans equations-Properties of thermodyanamic potentials-Gibbs-Helmoltz relation-thermodynamic equilibrium-Nerst –heat theorem and its consequences-Gibb's phase rule-chemical potential-vapour pressure relation and chemical constants

(Chapter 2 of Satyaprakash)

Foundations of classical statistical physics (16 hours)

Phase space-ensembles-Lioville's theorem-statistical equilibrium-microcanonical ensemble-partition functions and thermodynamic quantities-Gibb's paradox-Maxwell-Boltzmann distribution laws-grand canonical ensemble

(Chapter 6 and 7 of Satyparakash)

Unit II

Quantum statistics(24 hours)

Quantum statistics of classical particles-density matrix in microcaonical,canonical and grand canonical ensembles-Bose Einstein statistics and Bose Einstein distribution law-Maxwell Boltzmann statistics and Maxwell Boltzmann distribution law—Fermi Dirac statistics and Fermi Dirac distribution law-comparison of three types of statistics-applications of quantum statistics-Planck radiation laws-Bose Einstein gas and Bose Einstein condensation—Fermi Dirac gas-electron gas in metals-thermionic emission-statistical theory of white dwarfs

(Chapter 8 of Satyaprakash)

Phase transitions (12 hours)

Triple point-Vander wal's equation and phase transitions-first and second order phase transitions-Ehrenfest's equations-Ising model-Yang and Lee theory of phase transitions-London theory of phase transitions

(Chapter 12 of Satyparakash)

Unit III

<u>Foundations of quantum mechanics(12 hours)</u>

Basic postulates if quantum mechanics-Hilberts space-observabales-Hermitian operators-general statistical interpretation-Uncertainty principle-minimum uncertainty wave packet-energy time uncertainty principle-Dirac notation-Matrix representation of state vectors and operators-change of represenatations-eigenvalue problem in matrix mechanics-energy and momentum representations-unitary transformations involving time-Schrodinger,Heisenberg and interaction pictures.

(Chapter 3 of Griffiths,Chapters 2 and 10 of Agarwal and Hariprakash)

<u>Paradoxes in quantum mechanics(8 hours)</u>

Examples of paradoxes in physics-paradoxes in quantum mechanics-The Stern Gerlach experiment and the measurement process-EPR paradox-Bell's theorem and inequality-Schrodinger cat-quantum zero paradox

(Chapter 10 of Devanarayanan and Chapter 12 of Griffiths)

<u>Exactly solvable problems in quantum mechanics (16 hours)</u>

one dimensional eignenvalue problems-square well potential-potential barrier-alpha particle emission-Bloch waves in periodic potential-linear harmonic oscillator problem using wave mechanics and operator methods-free particle wave functions and solutions-three dimensional eigen value problems-particle moving in spherical symmetric potential-rigid rotator-hydrogen atom problem-three dimensional potential well-Deutron

(Chapters 4 and 5 of Aruldas)

Books for study

1 SatyaPrakash,*StatisticalMechanics*,Kedarnath Ram Nath Publishers, Meerut and Delhi (2009)

2. B.K.Agarwal and HariPrakash,*QuantumMechanics*,Prentice Hall of India (2002)

3. S.Devanarayanan,*QuanrtumMechanics*,Sci Tech Publications (India) Pvt Ltd (2005)

4. D.J.Griffiths,*Indroducion to Quanum Mechanics*, Second Edition,Pearson Education Inc

(2005)

5.G.Aruldas,*Quantum Mechanics*,2ond Edition,PHI learning Pvt Ltd (2009).

References

1 R.K.Srivastava and J.Asok , *Statistical Mechanics*,Wiley Easter Ltd (2005)

2. S.K.Sinha,StatsticalMechancis-*Theory and Applications*,Tata Mc Graw Hill (   )

3. P.M.Mathews and K.Venkitesan,*A Text Book of Quantum Mechanics*,Tata Mc Graw Hill (2010)

4. A.Ghatak and S.Lokanathan ,*QuantumMechancis Theory and Applications*,Kluewer Academic apublishers (2004).

5.V.K.Thankappan,*QuantumMechancics*,SecondEdition,New Age International Pvt Ltd

(2003)

PH 223:COMPUTER SCIENCE AND NUMERICAL TECHNIQUES (6L,1T)

Unit I

Foundations of computer science(12 hours)

Introduction to computers-computer architecture-memory and storage-I/O devices-computer languages-operating systems-data communications and computer networks-data bases-Internet basics-multimedia

(Chapter 1 and 3-15 of ITL Education solutions)

<u>Introduction to Python Programming (10 hours)</u>

Python programming basics –strings-numbers and operators-variables-functions-Classes amd objects-organizing programs-files and directories-other features of Python language

(Chapter 1 to 9 of Peter Norton et al)

<u>Introduction to microprocessors (12 hours)</u>

Evolution of microprocessors-microcontrollers and digital signal processors-Intel 8085 8 bit microprocessor-pin description-functional description-8085 instruction

format-addressing modes of 8085-interrupts of 8085-memory interfacing-8085 machine cycles and Bus timings-Assembly language programming of 8085
(Chapter 1 of Udayakumar and Umasankar and Chapter 3 and 4 of Abhishek Yadav)

Unit II

Programming with C++(36 hours)

Features of C++-basic structure of C++ programs-header files-in and out functions-compilation and execution-data types-constants and variablesglobal variables-operators and
Expressions of C++-flow control-conditional statements-iterative statements-switch statements-conditional operators as an alternative to IF-nested loops-break statements-ext( )
functions-structured data types-arrays-storage classes-multidimensional arrays-sorting of strings-functions-built in and user defined-accesing function and passing arguments to functions-calling functions with arrays-scope rule for functions and variables-structures in C++-classes abd objects –definition-class declaration-class function definitions-creating objects-use of pointers in the place of arrays-file handling in C++-basic file operations-serial and sequential files-reading and writing on to disks.
(Relevant Chapters from both Ravichandran and Somasekhara)

Unit III

<u>Numerical Techiques(36 hours)</u>

Solution of simultaneious linear algebraic equations-Gauss elimination method-Gauss Jrdan method-inverse of amatric using Gauss elimnaion method-Finite differences-forward and backward differences-central differences-difference of a polynomial-error propagation in difference table-Interpolation with equal intervals-Gregory Newton forward and backward formula-errorin polynomial interpolation-central difference intgerpolation formula-Gauss's fprward and backward formula-Striling's formula-Lagrange interpolation formula-numerical differentiation-numerical integration using general quadratature formula-Trapezoidal rile-Simsons 1/3 and 1/8 rules-numerical solutions to ordinary differential equations-Euler and modified Euler methods-RangaKutta methods-numerical solution to partial differential equations-soluitions to Poisson and Laplace equations

(Chapters 4,5,6,7,8,9,11 and 12 of Vedamurty and Iyengar)

Books for study

1 ITL Education Solutions Ltd,*Introducion to Computer Science*,SecondEdition,Dorling Kindersley(India) Pvt Ltd (2011)

2 V.N.Vedamurty and N.Iyengar,*NumericalMethods*,Vikas Publishing Pvt Ltd (1998)

3 K.Udayakumar, and B.S.Umasankar,*The 8085 microprocessor*,Dorling Kindersley(India) Pvt Ltd (2008)

4 Peter Norton etal., *Beginning Python*,Wiley Publishing (2005)

5 AbishekYadav,*Microprocessor 8085 8086*,University Science Press,New Delhi (2008)

6 D.Ravichandran,*Programming in C++,*Tata Mc Graw Hill (2011)

7 M.T.Somasekhara,*Programming in C++,* PHI Pvt Publishing (2005)

References

1. V.Rajaraman,Fundementals of Computers,5thEdition,PHI (2010)

2. R.S.Gaonkar,Microprocessor-Architecture,Programming and Applications with 8085,

3. S.S.Sastry,Introductory method of Nuimerical analysis,5thedition,PHI (   )

4. P.Ghosh,NumericalMethodswith computer programs in C++,PHI learning Pvt Ltd

5. BjorneStroustrup,The C++ Programming Lanuguage ,4thEdition,Addison Wesley

PH231:QUANTUM MECHANICS(6 L , 1 T)

Unit I

Approximation methods in quantum mechanics (24 hours)

The variational principle-Rayleigh Ritz method-variation method and excited states-ground state of Helium and Deutron-time independent peturbatin theory-non degerate energy levels-anharmonic oscillator-ground state of He atom using perturbation theory-Stark effect in hydrogen atom-time dependent perturbation theory-first order and harmonicpeturbation-absorption and emission of radiation-Einstein's A and B coefficients-Rayleigh and Raman scattering-WKB method-connection formulas-barrier potential-penetration-alpha particle emission-bound states in a potential well

(Chapters 9-12 of Aruldas)

Angular momentum(12 hours)

Angular momentum in operators and commutation relations-eigen values and eigen functions of L^2 and L_z –general angular momentum-eigen values of J^2andJ_z-angular momentum matrices-spin angular momentum –spin vectors for a spin ½ system-addition of angular momentum-Clebiz-Jordon coefficients

(Chapter 8 of Aruldas)

Unit II

<u>Symmetry and conservation laws (10 hours)</u>

Symmetry transformations-space translation and conservation of angular momentum-time translation and conservation of energy-roation in space and conservation of angular momentum-space inversion-time reversal

(Chapter 7 of Aruldas)

<u>Quantum theory of scattering(12 hours)</u>

Scattering cross section and scattering amplitude-partial wave anaylsis and scattering by a central potrential-scattering by attractive square well potential-scatteri8ng length-expression for phase shifts-Born approximation-scattering by Coloumb potential-Laboratary and centre of mass coordinate transformations

(chapter 14 of Aruldas)

<u>System of identical particles(14 hours)</u>

Identical particles-Paul;is exclusion principle-inclusion of spin-spin function for a two electron system-Helium atom-central field approximation-Thomas Fermi model of an atom-Hartree and Hartree-Fock equations.

Unit III

<u>Relativistic quantum mechanics(24 hours)</u>

Klein-Gordon equations and its relevance-particle in aColoumb'sfild-Dirac's relativistic theory-Dirac's equation for a free particle-Dirac matrices-covariant form of Diracs equations-probability density-plane wave solutions-negative energy starts-spin in Dirac's theory-magnetic moment of anelectrom-relativistic corrections of Hydrogen atom spectrum-spin orbit correction-Lamb shift

(Chapter 15 of Aruldas)

<u>Elements of Quantum Field theory (12 hours)</u>

Lagrangian and Hamiltonian formulation of classical fields-quantisation of fields-quantisation of the Schrodinger equation-Klein-Gordon and Dirac fields-quantisation of the electgromagnetic field

(Chapter 16 of Aruldas)

Book for study

1 G.Aruldas,QuantumMechanics,SecondEdition,PHI learning Pvt Ltd (2009)

References

1 S.Devanarayanan,*QuanrtumMechanics*,Sci Tech Publications (India) Pvt Ltd (2005)

2 D.J.Griffiths,*Indroducion to Quanum Mechanics*, Second Edition,Pearson Education Inc (2005)

3. P.M.Mathews and K.Venkitesan,A Text Book of Quantum Mechanics,Tata Mc Graw Hill (2010)

4. A.Ghatak and S.Lokanathan ,QuantumMechancis Theory and Applications,Kluwer Academic Publishers (2004).

5.V.K.Thankappan,QuantumMechancics,SecondEdition,New Age International Pvt Ltd

(2003)

6. J.J.Sakurai,Advamced Quantum Mechanics,Pearson Education Inc (2009)

7. L.H.Ryder,Quantum Field TheorySecondEdition,Cambridge University Presss (1996)

8. Steven Weinberg,Quantum Theory of Fields(in Three Volumes), Cambridge University Presss (2002)

PH 232:ADVANCED SPECTROSCOPY (6l,1T)

Unit I

General tools of experimental spectroscopy(14 hours)

General components of absorption measurements-dispersing elements-prisms-grating and interferometers-tools in different regions of the electromagnetic spectrum-atomic absorption spectroscopy-inductively coupled plasma emission spectroscopy-recording spectrophoto meters for IR,visible and UV regions(Chapter 3 of Hollas)

Molecular symmetry(10 hours)

Symmetry operators-symmetry elements-algebra of symmetry operations-multiplication tools-matrix representation of symmetry operators-molecular point groups-reducible and irreducible representations-great orthogonality theorem-character tables for point groups-symmetry species of point groups-IR and Raman activity

(Chapter 5 of Aruldas)

Molecular rotational spectroscopy(12 hours)

Classification of molecules-rotational spectra of diatomic molecules-isotope effect and intensity of rotational lines-non rigid rotator-linear polyatomic molecules-symmetric and asymmetric top molecules-microwave spectrometer-analysis of rotational spectra.
(Chapter 6 of Aruldas)

Unit II

IR spectroscopy(12 hours)

Vibrational spectra of diatomic molecules-charestrisitic IR spectra-vibrations of polyatomic miolecules-anharmonicity-Fermi resonance-hydrogen bonding-normal modes of vibration
in a crystal-interpreation of vibrational spectra-Fourier transform IR spectroscopy
(Chapter 7 of Aruldas)

Electronic spectra of molecules(12 hours)

Vibrational coarse structure and analysis of bound systems-Deslanders table-Frank condon principle-vibrational electronic sopectra-rotational fine structure-Fortrat parabola-electronic angular momentum in diatomic molecules
(Chapter 9 of Aruldas)

Raman spectroscopy(12 hours)

Theory of Raman scattering-rotational and vibrational Raman spectra-Raman spectrometer-structure determination using Raman and IR spectroscopy-nonlinear Raman effects-Hyper Raman effect-stimuated Raman scattering –coherent antistokes Raman scattering

(Chapter 8 and 15 of Aruldas)

Unit III

ESR and NMR spectroscopy(12 hours)

Principle of NMR-ESR spectrometer-Hyperfine structure-ESR spectra of Free radicals-Magnetic properties of nuclei-resonance condition-NMR instrumentation-chemical shift-NMR spectra of solids-NMR imaging-interpreation of NMR spectra
(Chapters10 and 11 of Aruldas)

Mossabauerspectroscopy(8 hours)

Recoilless emission and absorption-Mossbauer spectrometer-experimental techniques-isomer shift-quadrupole interaction-magnetic hyperfine interaction
(Chapter 13 of Aruldas)

<u>Photoelectron and Photo-accousticspectroscopy(16 hours)</u>

Photroelectron spectroscopy-experinertal methods-photoelectron spectra and their interpretation-Auger electron and X ray Flourescence spectroscopy-Photo-accoustic effect-basic theory-experimental arrangement-applications
(Chapter 8 of Hollas and Chapter 13 of Suresh Chandra)

Books for study

1 J.M.Hollas,*ModernSpectroscopy*,FourthEdition,John Wiley &Sons (2004)

2. G.Aruldas,*Molecular Structure and Spectrocopy*,PHI learning Pvt Ltd (2007)

3. Suresh Chandra, *Molecular Spectroscopy*,Narosa Publishing Co (2009)

References

1. C.N.Banwell and E.M.McCash,Fundementals of Molecular Spectroscopy,Fourthedn,TataMcGrawHill (1995).

2. D.N.Satyanarayana,Vibrational spectroscopy-Theory and applications,New Age International Pvt Ltd (2004)

3. J.L.McHale,MolecularSpectroscopy,Pearson education Inc (2008).

SYLLABUS FOR SPECIAL PAPERS (SPECIAL PAPER I)

PH 233 E : ADVANCED ELECTRONICS -I (6L,1T)

Unit I

Analog radio frequency communications (16 hours)

Different types of analogcontinous wave modulation-analog baseband signal transmission-signal distortions and equilization-linear continous wave modulation schemes-amplitude modulation-DSB and SSB schemes-frequency conversion-angle modulation-spectra of angle modulated signals-power and bandwidth of FM signals-generation and demodulation of FM signals-commercial radio broadcasting techniques-AM and FM radio broadcasting and reception

(Chapter 5 of Sam Shanmugam)

Microwave radio communications (10 hours)

Advantages and disadvantages of microwave radio communications-digital and analog systems-frequency and amplitude modulation techniques-FM microwave radio system-FM microwave repeaters-FM microwave radio stations-line of sight path characteristics

(Chapter 24 of Tomasi)

Pulse modulation (10 hours)

Different types of pulse modulation-pulse amplitude modulation (PAM)-PAM spectrum-pulse code modulation(PCM)-sampling and quantization of analog signals-quantization error-signal to noise ratio-differential PCM_delta modulation-other pulse modulation schemes-applications of pulse modulation

(Chapter 13 of Kennedy and Davis and Chapter 11 Roody and Coolen)

Unit II

<u>Digital communications (16 hours)</u>

Basics of information theory-ideas of digital codes –noise in information carrying channel-Digital carrier modulation -binary ASK,PSK and FSK schemes-bandwidth and power requirements-synchronization methods-ideas of error control coding and error corrections-digital transmission of analog signals-transmission using PCM –frequency and time division multiplexing (TDM) –TDM in PCM telephone system.

(Chapter 13 &14 of Kennedy and Davis, and 10 of Sam Shanmugam and Chapter 12 of Roody and Coolen))

<u>Optical fibre communications (20 hours)</u>

Overview of the optical communication system and its components-optical communication receiver and its equivalent circuit-direct and coherent detection systems- digital modulation and demodulation schemes for coherent optical communication receivers-heterodyne and homodyne detection – principles of wavelength division and code division multiplexing in potical communication- -optical solitons-soliton based optical communication systems

(Chapters 1,7-10 of Keiser and Chapters 1,3,6-10 of Agrawal)

Unit III

<u>Mobile cellular communications (12 hours)</u>

Mobile telephone services-cellular telephone-frequency reuse-cell splitting-sectoring,segmentation and dualisation-cellular system topology-roaming and handoffs-cellular telephone nework components and call processing-first and second generation cellular telephone services-digital cellular telephone system-global system for mobile communicartion-personnal satellite communication system

(Chapters 19 and 20 of Tomasi)

<u>Digital Signal processing (24 hours)</u>

Basics of signals and systems (6 hours)

Classification of signals-amplitude and phase spectra-classification of system-simple manipulations of discrete time signals-representation of systems-analog to digital conversion of signals

(Chapter 1 of Salivahananetal)

Fourier analysis of signals and systems (12 hours)

Triganometric Fourier series-exponential form-Parseval's idendity-power spectrum of a period function-Fourier transform-properties of Fourier transform-Fourier transform of important signals-Fourier transform of power and energy signals-Discrete time fourier transform - Fast Fourier transform (FFT)

(Chapter 2 of Salivahanan et al)

z-transofrms (8 hours)

Definition of z transform-properties of z-transform-evaluation of the inverse z-transform

(Chapter 4 of Salivahanan et al)

Digital Filters (10 hours)

Magnitude and phase response of Digital filters- Finite Impulse Response (FIR) digital filters-frequency response of linear phase FIR filters-design techniques of FIR filters-ideas of Infinite Impulse Response filters.

(Chapter 7 of Salivahanan et al)

Books for study

1 K.SamShanmugam,Digital and Analog communication systems,JohnWileya& Sons (2006)

2. W.Tomasi,Electroniccommunicationsystems:Findementals through advanced,DorlingKinderley (India) Pvt Ltd (2009)

3. G.Kenndy and B.Davis,Elecrinuic communication systems,FourthEdiion,Tata Mc Graw Hill (2003)

4.G.Keiser,*Optical Fibre Communication*,3rdedition,McGraw Pub (2000)

5.G.P.Agrawal,Fibre optic communication systems,John Wiley& Sons (1993)

6.S.Salivahanan and G.Ganapriya,Digital Signal Processing,Tata Mc Graw Hill (2011)

References

1 H.Taub,D,Schilling and G.Saha,Principle of Communiation systems,3rdEdition,Tata Mc Graw Hill (2008)

2. W.C.Y.Lee,Mobile Communications-design,Fundementals,SecondEdition,John Wiley & Sons (1993)

3. J.S.Chitode,DigitalCommunications,Technical Publications Pune (2008)

4. J.M.Senior,Optical Fibre Communications-Principles and Practice,SecondEdition,Pearson Education (2006).

5.J.J.Carr ,Microwave and Wireless communications Technology,Butterworth-Heinemann

(1996)

PH 233 M: MATERIALS SCIENCE- I (6L,1T)

Unit I

Introduction to Crystals (36 Hrs)

Crystals

Lattice –Unit cells-Basis- and crystal structures-Periodicity in crystals-Combination of symmetry elements – Symmetry groups-point groups. Structure of crystals**-** l-Determination of crystal structures-Diffraction theory-Scherrer formula-Calculation of particle size-line broadening Determination of unit cell content-. Atomic packing in crystals**:** Rules governing the packing of atoms-Pauling's rules-applications in crystal structures-complex ions-polymorphism-solid solutions. Electronic Structure of atoms-Atomic and ionic arrangements in materials-Short range and long range order-Liquid crystals-Amorphous materials-Softmaterials

Classification of materials,-**Functional classification of materials**

Materials for Aerospace, Biomedical, Electronic, Energy technology, Environmental technology, Magnetic, Photonic and Structural Applications- Smart materials. Structuralclassification of Materials- Crystalline-Single crystals-polycrystalline materials- Grains and grain boundaries. **Crystal structures of ionic** materials-Cesium chloride, Fluorite, Perovskite and Corundum type structures-Covalent structures.

Imperfections in crystals

Types of imperfections in crystals -Point defects-Interstitial defects-Substitutional defects-Frenkel and Schottky defects-Line Kronger-Vink notation for defect chemical reaction- Dislocations and Diffusion in crystals - Dislocations- Burgers vectors – edge and screw dislocations –slip-significance of dislocations-Schmid's law-Surface defects-Domain boundaries- Importance of defects –Diffusion**-** Applications of Diffusion-Stability of atoms and ions-Mechanism for diffusion-Activation energy for diffusion- Permeability of polymers-Composition profile-Diffusion and materials processing.

Unit II

Formation of crystalline materials (36 hrs)

Growth from the melt - the Bridgmann technique – crystal pulling -Czochralski method- liquid solid interface shape -crystal growth by zone melting - Verneuil flame fusion technique. Low temperature solution growth - methods of crystallization - slow cooling, solvent evaporation, temperature gradient methods - crystal growth system - growth of KDP, ADP and KTP crystals - high temperature solution growth, gel growth.

Unit III

Properties of materials -Mechanical and Thermal properties - (36 hrs)

Mechanical properties

Stress-strain relation and tensile test-True stress and true strain-Bend test for brittle materials-Hardness of materials-Knoop test-Strain rate effects-Ductile -brittle transition temperature.-Fracture mechanics-Micro-structural features of fractures in ceramics and compounds-Fatigue

Thermal properties

Heat capacity and specific heat-thermal expansion-thermal conductivity-Thermal diffusivity-thermal shock in materials. **Transformation in crystals-**Elements of thermodynamics-Free energy-First order and second order transformations-order-disorder transitions-Equilibrium diagrams-phase rules-solid solutions

Reference Books

1. Introduction to solids –L.V.Azaroff Tata Mc Graw Hill
2. The Science and Engineering of Materials: Donald R Askeland and Pradeep P Phule 6 Edition-Thomson Brooks/Cole.
3. Principles of Electronic Materials and Devices , S.O.Kasap .Tata Mc Graw Hill
4. Crystallography and crystal defects, A. Kelley, G.W. Groves & P. Kidd, Wiley
5. Crystallography applied to Solid State Physics, A.R. Verma, O.N. Srivastava, NAI
6. Solid State Physics, A.J.Dekker, Macmillan, (1967).
7. Solid State Physics, S.L. Gupta and V.Kumar, Pragati Prakashan.
8. Introduction to Theory of Solids, H.M. Rosenberg, Prentice Hall.
9. Solid State Physics,J.S. Blakemore, W.B.Saunders & Co. Philadelphia.

10. Solid State Physics, N.W. Ashcroft & N.D. Mermin, Brooks/ Cole (1976).
11. Crystal Defects and Crystal Interfaces, W. Bollmann, Springer Verlag.
12. Elementary solid State physics M.Ali Omar-Pearson
13. Solid State Physics R.J.singh-Pearson
14. Thermal Analysis, Wesley W.M. Wendlandt , Wiley.

PH 233N :ADVANCED NUCLEAR PHYSICS(6L,1T)

Unit I

Nuclear properties and structrure (36 hours)

Nuclear structure – charge, mass, shape, and size of nucleus, spin, parity, electric and magnetic moments, isospin, binding energy, packing fraction, Experimental determination of nuclear mass, Aston's mass spectrograph, Measurement of nuclear spin (using Zeeman effect) and magnetic moment (using NMR), nature of nuclear forces, ground and excited states of deuteron, spin dependence, effective range theory, non central force, n-p scattering and p-p scattering at low energies, nature of two nucleon potential, charge independence and saturation of nuclear force, exchange forces, meson theory of nuclear force.

Nuclear models - liquid drop model: Bethe-Weizsacker formula and its applications, shell model, evidence and limitations of shell model, single particle shell model, nuclear vibrations and rotations, optical model, collective model.

Unit II

Nuclear instrumentation(36 hours)

Gas filled detectors, Ionization Chamber, Proportional counter, GM Counter, Scintillation counter, Cerenkov counter, semiconductor detectors [Si(Li), Ge(Li), HPGe], Solid state nuclear track detectors, Nuclear emulsion, neutron detectors, scaling circuits.

Classification of accelerators, cyclotron, synchro-cyclotron, Betatron, Tandem accelerators, linear accelerator (LINAC). Nuclear Reactor – self sustained reaction, four factor formula, reactor theory, critical size, reactor materials, reactor control, breeder reactor, thermonuclear fusion, fusion in plasma, fission reactor, conditions for sustained fusion, magnetic confinement, toroidal confinement: Tokomak.

Unit III

<u>Nuclear reactions and Particle Physics (36 hours)</u>

Types of nuclear reactions, conservation laws, energetics of nuclear reactions, nuclear transmutations, cross section of nuclear reaction, compound nucleus hypothesis, Breit-wigner one level formula, direct reactions, stripping and pick up reactions, heavy ion induced reactions, Nuclear fission, energetic of nuclear fission, Bohr-wheeler theory, nuclear fusion, stellar energy and nucleo-synthesis.

Neutrons, Kinematics in high energy collisions, particles in high energy reactions, classification of elementary particles, interactions among particles, states of particles in terms of quantum numbers, Yukawa hypothesis, properties of pi mesons, muons, K-mesons and hyperons, particle interactions and Feynman diagrams, symmetries and conservation laws, CP T invariance, Gellmann Nishijima Formula, Quark Model, Quantum Chromo Dynamics (QCD), symmetry classifications of elementary particles, weak interactions, Grand Unification Theory (GUT).

Books for Study

1. S.N. Goshal. Atomic and Nuclear Physics, S Chand & Company Ltd. 1998
2. Kenneth S Krane. Introductory Nuclear Physics, John Wiley & Sons, 1987
3. Sathya Prakash Nuclear Physics & particle Physics, S Chand 2005
4. John S Liley. Nuclear physics, Wiley India, 2007

References

1. Irving Kaplan, "Nuclear Physics", Narosa Book Distributors, 2002.
2. R.D. Evans, "The atomic Nucleus", McGraw-Hill, 1955.
3. D.C.Tayal, Nuclear Physics, Himalayan Publication house, Bombay, 1980
4. R.R. Roy & B P Nigam, Nuclear Physics Theory and Experiments, Wiley Eastern, 2000.
5. D.J. Griffiths, Harper & Row, Introduction to elementary particles, Wiley Eastern, 1987

PH 233 S: SPACE PHYSICS AND PLASMA PHYSICS (6L,1T)

Unit I

Basic Plasma Phenomena (6h)

Plasma Concepts – Debye shielding – plasma parameters – Plasma as a fluid - Fluid equations – Fluid drift perpendicular to B – Fluid drift parallel to B.

[Ref. 1,Ch 1, 2&3].

Waves in plasma (20h)

Plasma oscillations –Electron plasma waves – sound waves – ion waves – Electrostatic electron oscillations perpendicular to B - Electrostatic ion waves perpendicular to B – Lower hybrid frequency – Electromagnetic waves perpendicular to B_0 – cut offs and resonances - Electromagnetic waves parallel to B_0 – Hydromagnetic waves – Magnetosonic waves.

Diffusion and Resistivity- Decay of plasma by diffusion – steady state solutions – Recombinations – Diffusion across a magnetic field – Collisions in fully ionized plasma – Single fluid MHD equations.

[Ref. 1, Ch. 4 and 5].

Magnetohydrodynamics (10h)

Maxwell's equations in MHD – MHD Induction equation – Magnetic Reynold's number – Momentum equation, Pressure force – Magnetic tension force – Magnetic Buoyancy – Acoustic waves – Alfven waves – Internal gravity waves – MHD waves – Whistlers. **[Ref. 3, Ch. 9].**

UNIT II

Solar Physics (16h)

Solar interior and energy production – Neutrino problem – Helioseismology – solar activity – sunspot cycle - Sun's magnetic field – solar rotation - Photosphere – Chromosphere – Corona – Coronal heating – Solar flares – Solar wind – importance of solar terrestrial studies.

[Ref. 3; Ch. 6].

Solar wind Physics (16h)

Coronal expansion – Parker's hydrodynamic theory – solar wind parameters – interplanetary magnetic field – sector structure – solar wind variations and its relationship with solar phenomena**. [Ref.5].**

Cosmic rays and energetic particles (4h) Galactic cosmic rays – solar cycle modulation of galactic cosmic rays – solar energetic particles – Interstellar pick up ions – Anomalous cosmic rays – Cosmic ray detectors**. [Ref.5].**

UNIT III

Neutral atmosphere (8h) Neutral atmosphere – scale height – Variation of temperature with altitude – Troposphere – Stratosphere – Mesosphere – Thermosphere – Heat balance equation – Exosphere. [Ref.7].

Ionosphere and Magnetosphere (16h) Ion composition and chemistry – D, E, F_1 and F_2 regions – Ionospheric conductivities and currents – Equatorial anomaly. Magnetosphere, intrinsic magnetic field – Interaction of solar wind with magnetosphere – Bow shock and magnetopause – Magnetospheric current systems – Magnetic diffusion – Magnetic reconnection – magnetic activity and substorms – magnetic storms – geomagnetic activity indices**. [Ref.6].**

Observational technique (12h) Upper atmosphere sensing – direct, indirect and remote – Direct methods for neutral atmosphere – Direct methods for ionized component – Langmuir probe – Impedance and resonance probes – Mass spectrometers – Detectors for energetic particles and radiation environment – Satellite drag and related methods – Remote sensing of the neutral atmosphere – Remote sensing by radio propagation – Experimental technique for ionospheric studies – Ionosonde technique – Incoherent scatter technique. **[Ref 4 ,6 & 10.]**

References

1. Chen F. F.: Introduction to Plasma Physics and Controlled Fusion, Plenum Press.
2. Dendy R. O. : Plasma Dynamics (Clarendon Press, 1990).
3. Tamas I. Gombosi: Physics of the Space Environment (Cambridge University Press, 1998)
4. Harra L. K. and Mason K. O.: Space Science (Imperial College Press)
5. Peter Foukal: Solar Astrophysics (Wiley, 1990)
6. Ratcliffe: Introducion to ionosphere and magnetosphere (CUP,1972)
7. Robert G. Fleagle and Joost A. Businger: An Introduction to Atmospheric Physics, Academic Press, London, 1971.
8. Banks P. M. and G. Kocharts: Aeronomy, Academic Press, London, 1973.
9. Savindra Singh: Climatology, Prayag Pustak Bhavan, 2005.
10. Michael D. Pappagiannis: Space Physics and Space Astronomy, Gordon and Breach Science Publishers Ltd., 1972.

PH 233 T: THEORETICAL PHYSICS-I (6L,1T)

Unit I - Quantum Mechanics(36 hours)

• Formalism
Linear vector space, linear operators, normed spaces, Hilbert spaces, self-adjoint operators, representation of operators and states in suitable basis, spectral properties of self-adjoint operators - spectral theorem.
[Ref 1, 2, 3, 4]

• Groups and Symmetry
Review of groups: Irreducible representations of groups, discrete and continuous groups, Lie groups, Lie algebra.
how symmetries form a group, unitary and anti-unitary symmetry operators, Rotation and O(3) group, SU(2) group, angular momentum algebra, vector operators, Tensor operators, Wigner-Eckart theorem
Discrete symmetries - space and time inversion symmetries. Ref [5, 6, 7,

8, 9, 10]
• Relativistic quantum mechanics Lorentz group - generators, representation of Lorentz group extended by parity and Dirac equation, hydrogen atom [Ref 5, 7, 10, 11]

• **Field theory**

Lagrangian formalism, Noether's theorem, Hamiltonian density, quantisation of fields, second-quantization, quantisation of EM field. [Ref 10]

Unit II

<u>Statistical Physics(36 hours)</u>

• **Stochastic processes**

Review of probability and measure, equilibrium vs non-equilibrium, Brownian motion, Langevin equation, Ito vs Stratanovic, Markov processes, Fokker-Planck equation, Fluctuation-Dissipation theorem. [Ref 13, 14, 16, 15]

• **Special topics in non-equilibrium systems**

Einstein diffusion equation - derivation and boundary conditions, free diffusion in one-dimensional half-space, flourescencemicrophotolysis [Ref 13]

<u>Unit III - General relativity (36 hrs)</u>

• **Differential geometry**

Tensors, diffentiable manifolds, geodesics, curvature, Riemannian tensor [Ref 3, 4, 17, 18]

• **Relativity**

Principle of equivalence, Einstein equations, centrally symmetric gravitational fields, Schwaarzchild solution, singularities [Ref 17, 18]

References

[1] F. Scheck, *Quantum Physics*, Springer (2007).
[2] G. Teschl, *Mathematical Methods in Quantum Mechanics*, American Mathematical Society (2009).
[3] P. Szekeres, *Modern Mathematical Physics*, Cambridge University Press (2004).
[4] M. T. Vaughn, *Introduction to Mathematical Physics*, Wiley - VCH Verlag (2007).
[5] Arfken, *Mathematical Physics for Physicists*, Academic Press (2013).
[6] J. J. Sakurai, *Modern Quantum Mechanics*, Addison-Wesley Publishing Company (1994).

[7] L. I. Schiff, *Quantum Mechanics*, McGraw-Hill Book Co. (1968).
[8] R. Shankar, *Principles of Quantum Mechanics*, Springer (1994).
[9] L. E. Ballentine, *Quantum Mechanics*, World Scientific Publishing Co. (2000).
[10] L. H. Ryder, *Quantum Field Theory*, Cambridge University Press (2008).
[11] J. J. Sakurai, *Advanced Quantum Mechanics*, Addison-Wesley (1967).
[12] M. Le Bellac, *Quantum and Statistical Field Theory*, Oxford University Press (2001).
[13] K. Schulten and I. Kosztin, *Lectures in Theoretical Biophysics*, University of Illinois at Urbana-Champaign (2000).
[14] R. Kubo, M. Toda and N. Hashitsume, *Statistical Physics II: None quilibrium Statistical Mechanics*, Springer-Verlag (1985).
[15] G. F. Mazenko, *Nonequilibrium Statistical Mechanics*, Wiley-VCH Verlag (2006).

[16] V. Balakrishnan, *Elements of Nonequilibrium Statistical Mechanics*, CRC Press (2008).
[17] B. F. Schutz, *A First Fourse in General Relativity*, Cambridge University Press (2009).
[18] S. Caroll, *Spacetime and Geometry: An Introduction to General Relativity*, Addison-Wesley (2004).
[19] A. Altland and B. Simons, *Condensed Matter Field Theory*, Cambridge University Press (2008).

[20] J. W. Negele and H. Orland, *Quantum Many-particle Systems*, Levant Books (2006).
[21] E. Fradkin, *Field Theories of Condensed Matter Systems*, Levant Books (2006).
[22] P. M. Chaikin and T. C. Lubensky, *Principles of Condensed Matter Physics*, Cambridge University Press (2004).
[23] A. M. Tsvelik, *Quantum Field Theory in Condensed Matter Physics*, Cambridge University Press (2003).

PH 241:CONDENSED MATTER PHYSICS

Unit I

Crystal physics(10 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

(Chapter 4 of SO Pillai)

Lattice vibrations and thermal properties (10 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.

(Chapters 7 and 9 of Wahab)

Free electron and band theory(16 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-conductors,semiconductors and insulators-elementary ideas of Fermi surfaces

(Chapters 10,11 and 12 of Wahab)

Unit II

Semiconductors(12 hours)

Free carrier concentration in semiconductors-mobility of charge carriers-temparature effects-
electrical conductivity of semiconductors-Hall effect in semiconductors-semiconductor
junction properties
(Chapter 13 of Wahab)

Dielectric and magnetic properties of materials(24 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-Ferreoelectric domains-classification of magnetic materials-atomic theory of magnetism-Langevins theory-paramagnetism and quantum theory-Weiss molecular exchange
field-ferromagnetic domains-anti ferromagnetism-Ferrites
(Chapter 14 and 16 of Wahab)

Unit III

Superconductivity(20 hours)

Experimental attributes to superconductivity-critical temparature,critical current and critical
magnetic field of superconductors-effects of magnetic field on superconductors-Type I and II
superconductors-intermediate and vortex states-thermal conductivity,specific heat and energy
gap in superconductors-microwave and IR properties-coherence length-Theories of superconductivity-London equations-Ginzberg-Landau theory-BCS theory-AC and DC
Josephson effects in superconductors- Examples and properties of High Temperature

superconductors
(Chapter 13 of Singh)

<u>Introduction to nano science and technology(16 hours)</u>

Scope of nano science and technology-nano material preparation techniques-Lithgraphic and nonlithographic techniques-sputtering-chemical vapur deposition-pulsed laser deposition-molecular beam epitaxy-sol-gel technique-characterisation of nono materials-scanning probe microscopy-atomic force microscopy-SEM and TEM techniques-carbon nano structures-elements of nano electronics.
(Chapters 1,7, and 8 of Chattopadhya)

1 S.O.Pillai,*Solid State Physics*,Third Edition New Age International Pvt Ltd (1999)

2. M.A.Wahab,*Solid State Physics*,Narosa Publishing House (1999)

3. R.J.Singh,Solid State Physics ,Dorling Kindersley (India) Pvt Ltd (2012)

4. K.K.Chattopahyay,A.N.Banerjee,Introduction to Nano Science and NanoTechnology,Prentice Hall of India (2009)

References
1. N.W.Ashcroft and N.D.Merwin,Solid State Physics,Cenage Learning India (2001)
2. Charles.C.Kittel,Introduction to Solid State Physics,wiley Student Edition (2007)
3. M.AliOmar,elementary Solid State Physics,Pearson Education Inc (1999)
4.P.Phillips,Advanced Solid State Physics,SecondEdn,Cambridege University Press (2012)

PH242:**NUCLEAR AND PARTICLE PHYSICS** (6L,1T)

Unit I

<u>Nuclear forces(10 hours)</u>

Deuteron-neutron –proton scattering and proton-proton scattering at low energies-non central forces-nuclear exchange force-meson theory of nuclear forces

(Chapter 8 of Tayal)

<u>Nuclear models (12 hours)</u>

Detailed studies on liquid drop,shell and collective models of the nuclei.

(Chapter 9 of Tayal)

Nuclear reactions (14 hours)

Conservation laws-energetic nuclear reactions-Q value equation-partial wave analysis of nuclear reaction cross section- compound nuclear hypothesis-resonance reations-Brot-Wigner one level formula-optical model-theory of stripping reactions.

(Chapter 10 of Tayal)

Unit II

Nuclear fission(20 hours)

Mechanism of nuclear fission-calculation of critical energy based on liquid drop model-fission products and energy release-fission chain reactions-neutron cycle and and four factor formula-general features and classification of nuclear fission reactors

(Chapter 7 of Verma et al)

Nuclear fusion (16 hours)

Nuclear fusion in stellar interiors-proton-proton reactions-carbon-nitrogen cycle-thermo nuclear reactions in the laboratary-conditions for the construction of nuclear fusion reactor-critical ignition temperature-Lawson criterian-plasma confinement in fusion- principles of pinch ,magnetic and inertial confinements

(Chapter 7 of Verma et al)

Unit III

Nuclear detectors and particle accelerators (20 hours)

Gas filled detectors-ionization chamber and proportional counters-GM counter-scintillation detectors-semiconductor detectors-cerenkov detector-bubble chamber

(Chapter 6 of Verma eta al)

Particle accelerators-electrostatic accelerators-cyclotron accelerators-synchrotrons-linear accelerators-colliding beam accelarators

(Chapter 15 of Krane)

<u>Elementary particle physics (16 hours)</u>

Elementary particle interactions-symmetries and conservation laws-quark model of elementary particles-colored quarks and gluons-ideas of charm,beuty and truth-quark dynamics-ideas of grand unified theories of fundamental forces

(Chapter 18 of Krane)

Books for study

1 D.C.Tayal,*Nuclear Physics*,5th Edition,Himalaya Publishing Co (2008)

2 J.Verma,R.C.Bhandari,D.R.S.Somayajulu,*Fundementals of Nuclear Physics*,CBS Publishers and Distributors (2005)

3 K.S.Krane,Introductory*NuclearPhysics*,Wiley India Pvt Ltd (1988)

References

1 S.B.Patel,Nuclear Physics-An Introduction,New Age International Pvt Ltd (1996).
2. B.R.Marhu,Nuclae and Particle Physics- an Introducion,SecondEdition,Wiley (2012)
3. S.N.Ghoshal,NuclearPhysics,S,Chand Ltd (1997)
4.M.P.Khanna,Introduction to Particle Physics,PHI (2011)
5. J.Freidberg,Plasma Physics and Fusion Energy,Cambridge University Press (2007)
6. FF.Chen,Introduction to Plasma Physics,Springer,London (2002).

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SPECIAL PAPER SYLLABUS : SPECIAL PAPER -II

PH 243 E: ADVANCED ELECTRONICS-II (6L,1T)

Unit I

Microprocessor 8086 : Introduction and Programming (18 hours)

Internal architecture of 8086-pin configuration of 8086-memory organization of 8086-addressing modes of 8086-minimum and maximum mode configurations-instructions set of 8086-data movment instructions-arithematic and logic instructions-programming of 8086-flow charts and programming steps

(Chapter 2,3,4 of Sunil Mathur)

Microprocessor interfacing devices and advanced microprocessors(12 hours)

Programmed I/O –direct memory access-micro controllers-8251A USART-8257 DMA controller-8259A programmable interrupt controller-8279 programmable keyboard/display interface-analog to digital and digital to analog converters-advanced microprocessors-80186/80188 high integration 16-bit microprocessors-80386 and 80386 processors-RISC processors.

(Chapter 6 and 7 of Abishek Yadav)

Elements of embedded systems (6hours)

Example of an embedded system-processor chips for embedded applications-a simple micro controller using embedded systems-embedded processor families

(Chapter 10 of Hamacher et al)

Unit II

Introduction to artificial intelligence and expert systems (20 hours)

Overview of artificial intelligence (AI)-knowledge representation in AI-problem solving in AI-search methods-predicate and propositional logic-Formal symbolic logic-LISP and PROLOG basics-network representations of knowledge-natural language study in AI-Fuzzy sets and Fuzzy logic- Expert systems-rule based expert systems-nonproduction system architectures-examples of expert systems.

(Chapters 1,2,4,5,7,9,12 & 15 of Patterson; Chapter 1-5 and 8 of Rich and Knight)

<u>Adsvanced artificial intelligence systems (16 hours)</u>

Introduction to robotics-artifical intelligence machines-language based and knowledge based machines-Fuzzy expert systems-fuzzy quantifiers-fuzzy inference-fuzzy rule based systems-engineering applications of fuzzy logic-applications in power plants,datamining,image processing and control instrumentation-basic concepts of artificial neural networks-neural network architectures-learning methods-neural network systems-ADALINE and MADALINE networks –neural network application domains.

(Chapter 21 of Rich and Knight,Chapter 16 of Janakiramanetal,Chapters 1 and 7 of Rajasekaran and Pai,,Chapter 8 of Sivanandan et al)

Unit III

<u>Television (14 hours)</u>

Television broadcasting fundementals-scanning,blanking and synchronizing pulses-video bandwidth-video signal charecterisitcs-TV broadcasting channels-TV camera tubes-monochrome TV transmission and reception-color camera tube-color TV system-advanced TV systems-satellite TV techniques-cable TV system-Digital colorTV system

(Chapter 1 to 5 of Veera Lakshmi and Srivel)

<u>Radar(12 hours)</u>

Basic principles of radar-Radar equation-MTI,Pulse and Doppler Radars-Radar signal analysis-ideas of Radar transomiters and receivers-hyperbolic systems for navigation-LORAN and DECCA systems.

(Relevant chapters of Skolni,Chapter 4 of Nagaraja)

<u>Satellite communications(10 hours)</u>

Satellite orbits-Geosynchronous satellites-antenna look angles-satellite classifications-spacing and frequency allocations-satellite antenna radiation patterns-satellite system link models –satellite system parameters and link equations (Chapter 25 of Tomasi)

Books for study

1 Sunil Mathur,*Microprocessor 8086-Architecture,Programming and Interfacing*,PHI learning Pvt Ltd (2011)

2. AbishekYadav,*Microprocessor 8085 8086*,University Science Press,New Delhi (2008)

3. Carl Hamacher,Z.G.Vranesic,S.G.Zaky,*Compter organization*,5thEdition,McGraw Hill Education (2002)

4. V.S.Janakiraman,K.Sarukesi and P.Gopalakrishnan,*Foundations of Artificial Intelligenceand Expert systems*,Macmillan Publishers India Ltd (2011).

5. E.Rich and K.Knight,*ArtificialIntelligence*,SecondEdition,Tata McGraw Hill Pub Co

(2006),

6. D.W.Patterson,Introduction to *Artificial Intelligence and Expert Systems*,Prentice Hall of India Pvt Ltd (2001)

7. S.Rajasekharan and G.A.VijalekshmiPai,*Neural NetworksFuzzy logic and Geneticalgorithms*,PHI learning PVt Ltd (2010).

8.S.N.Sivanandan,S.Sumathi and S.N.Deepa,*Introduction to Fuzzy logic usingMATLAB*,Springer (2007).\

9. A.Veera Lakshmi and R.Srivel,*Television and Radio engineering*,AnnBookd Pvt Ltd

(2010)

10. Skolini.M.I,*Introducion to Radar systems*,Thirdediton,Tata Mc GrawHill (2001)

11. Nagaraja,*Elements of Electronic navigation*,Second Edition, Tata Mc GrawHill (2006).

PH 243 M:MATERIALS SCIENCE –II (6L,1T)

Unit I

Functional materials and properties (36 hrs)

Electronic, Magnetic and photonic materials and properties

Electronic materials and properties- Electrical conductivity-Conductivity of metals and alloys-superconductivity-conduction in ionic materials-semiconductors-Insulators-dielectrics-polarisation in dielectrics-Electrostriction-piezoelectricity-piezoelectricity and ferroelectricity-Magnetic materials and properties-Classification of magnetic materials- -magnetisation-permeability and the magnetic field-Diamagnetic-paramagnetic-ferromagnetic-ferrimagnetic and super-paramagnetic materials-Domain structure and the hysteris loop-Curie temperature-Applications of magnetic materials-Metallic and ceramic magnetic materials-**Photonic materials and properties**- Electromagnetic spectrum-Reflection, refraction, absorption and transmission-Selective absorption and transmission-Emission phenomenon-luminescent and phosphorescent materials-Fibre optic communication system.

Unit-II-

Nanostructured materials and properties (36 Hrs)

Size and dimensionality effects - size effects - potential wells - partial confinement - conduction electrons and dimensionality – quantum well-quantum wires-quantum dots-Fermi gas and density of states - Carbon based nano-materials-Fullerenes-carbon nanotubes- nanoshells- graphene- biological and smart nanomaterials. Properties of nanomaterials- elctrical-optical-mechanical-and thermo dynamical properties. Synthesis of nanomaterials- CVD-Sol-gel-Combustion-hydrothermal- Colloidal growth-nanotube synthesis-Lithographic process**-**: Lithography, Nanolithography, split gate technology, self assembly, limitation of lithographic process**.**Non-lithographic techniques**:** Plasma arc discharge, sputtering, evaporation.Tools of nanomaterials**:** X-ray diffraction-FTIR spectroscopy-Raman spectroscopy-Band assignments-UV-Vis spectroscopy-Determination of band gap-Tauc's plot –

For qualitative study only(Non evaluative) *:* Scanning probe microscopy-STM-AFM- NSOM- Electron Microscopies-TEM-HRTEM and SEM.

Unit III-Nano-electronics (36 Hrs)

Introduction to Nanoelectronics

Properties dependent on density of states - excitons - single-electron tunnelling - applications infrared detectors - quantum dot lasers-Tunnel junction and application of tunnelling-Tunneling through a potential barrier, potential energy profiles of material interfaces, applications of tunnelling. Micro-electromechanical systems (MEMSs) and Nano-electro-mechanical systems (NEMSs), Intrduction to Spintronics-History and overview of spin electronics; Classes of magnetic materials; Quantum Mechanics of spin; Spin relaxation mechanisms; spin relaxation in a quantum dots.

Qualitative studyonly(Non evaluative)

Resonant Tunnelling Diode, Quantum Cascade lasersSingle electron transistor-: Coulomb Blockade, single electron transistor, other SET and FET structures. Molecular Machines, Nano-biometrics- Molecular and Nano-electronics-Microbial Fuel Cells-Hydrogen storage-Nano medicine-Biological applications-Photonic nano crystals and integrated circuits-Quantum computers Intrduction to Spintronics- :Spin Galvanic effect; Spin LEDs: Fundamental and applications, Spin photoelectronic devices, Electron spin filtering, Materials for spin electronics,. Spin-Valve and spin-tunneling devices: Read Heads, MRAMS, Field Sensors, Spintronic Biosensors, Spin transistors, Quantum Computing with spins.

Reference Books

1. The Science and Engineering of Materials: Donald R Askeland and Pradeep P Phule 6 Edition-Thomson Brooks/Cole.
2. Principles of Electronic Materials and Devices , S.O.Kasap .Tata Mc Graw Hill
3. Crystallography and crystal defects, A. Kelley, G.W. Groves & P. Kidd, Wiley
4. Crystallography applied to Solid State Physics, A.R. Verma, O.N. Srivastava, NAI
5. Solid State Physics, A.J.Dekker, Macmillan, (1967).
6. Solid State Physics, S.L. Gupta and V.Kumar, Pragati Prakashan.
7. Introduction to Theory of Solids, H.M. Rosenberg, Prentice Hall.
8. Solid State Physics,J.S. Blakemore, W.B.Saunders & Co. Philadelphia.
9. Solid State Physics, N.W. Ashcroft & N.D. Mermin, Brooks/ Cole (1976).
10. Crystal Defects and Crystal Interfaces, W. Bollmann, Springer Verlag.
11. Elementary solid State physics M.Ali Omar-Pearson
12. Solid State Physics R.J.singh-Pearson
13. Introduction to Nanotechnology, Charles P. Poole, Jr. and Frank J.Owens, Wiley, (2003) 92
14. Nano The Essential-T Pradeep; Mc Graw Hill Education
15. Nanotechnology An Introduction to Synthesis properties and Applications of Nanomaterials: Thomas Varghese and K.M.Balakrishna-Atlantic Publishers.
16. MEMS/NEMS: micro electro mechanical systems/nano electro mechanical systems Volume1, Design Methods, Cornelius T.Leondes, Springer, (2006).
17. Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons and Burkhard Raguse "Nanotechnology", Overseas Press New Delhi 2005
18. W. R. Fahrner (Ed.) "Nanotechnology and Nanoelectronics", Springer 2006. S. Bandyopadhyay, M. Cahay

PH 243 N : RADIATION PHYSICS (6L,1T)

Unit –I

<u>Interaction of radiation with matter (36 hours)</u>

Ionizing radiations, terrestrial sources, extraterrestrial sources, non-ionizing radiations, natural and man-made sources, interaction of radiation with matter, energy loss rate, bremstrahlung, range energy relation, stopping power, photoelectric absorption, Compton scattering, pair production, properties of gamma gays and neutrons.

Particle flux and fluenc, Energy flux and fluence , Cross section, Linear and mass attenuation coefficients , Mass energy transfer and mass energy absorption coefficients, Stopping power – Linear Energy Transfer (LET) - Weighing Factors(W-values), Radiation and tissue weighting factors, absorbed dose- equivalent dose, effective dose, committed equivalent dose, committed effected dose – Concept of KERMA (Kinetic Energy Released per unit Mass)

Unit II

<u>Radioactivity, detection and dosimetry (36 hours)</u>

Law of radioactive decay, half life, mean life, specific activity, successive disintegration, radioactive equilibriums, age of minerals and rocks, α-decay: barrier penetration, range energy relationship, β decay: Fermi theory, parity violation, Kurie-plot, γ-decay, radiative transitions in nuclei, selection rules.

Thermo luminescent Dosimeters (TLD) – Optically stimulated Luminescence dosimeters (OSLD) –Neutron Detectors – Nuclear track emulsions for fast neutrons – Solid State Nuclear track (SSNTD) detectors, Radon dosimetry, Instruments for personnel monitoring – TLD badge readers – Digital pocket dosimeters using solid state devices and GM counters - Contamination monitors for alpha, beta and gamma radiation – Scintillation monitors for X and gamma radiations - Neutron Monitors, Tissue equivalent survey meters – Flux meter and dose equivalent monitors – Pocket neutron monitors

Unit III

<u>Biological effects of radiation (36 hours)</u>

Somatic effects of radiation – Physical factors influencing somatic effects – Dependence on dose, dose rate, type and energy of radiation - Acute radiation sickness – Effects of chronic exposure to radiation – Induction of leukemia – Radiation Carcinogenesis – Risk of carcinogenesis – Genetic effects of radiation – Factors affecting frequency of radiation induced mutations – Dose-effects relationship – first generation effects – Effects due to mutation of recessive characteristics – Genetic burden – Prevalence of hereditary diseases and defects – Spontaneous mutation rate – Concept of doubling dose and genetic risk estimate.

Books for study

1. G.F. Knoll, Radiation detection and Measurement, John Wiley & Sons, 2000

2. K. Thayalan, Basic Radiological Physics, Jaypee brothers medical publishers, New Delhi,2003

3. Alan Martin and Samuel A. Harbison, An Introduction to radiation Protection Third edition,

Chapman and Hall, New York 1986

References

1. R.R. Roy & B P Nigam, Nuclear Physics Theory and Experiments, Wiley Eastern, 2000

2. UNSCEAR Report, United Nations Scientific Committee on the Effects of Atomic Radiation, 2008.

PH 243 S: ADVANCED ASTROPHYSICS (6L,1T)

UNIT I

General features of observational astronomy (36 hours)

Emergence of modern astronomy - Astronomy in different bands of electromagnetic radiation.Celestial co-ordinates – Spherical coordinates – Altazimuth system – Local equatorial system – universal equatorial system – Ecliptic system – Galactic coordinates – conversion of coordinates.Apparent luminosity of stars – measurement of apparent luminosity –various magnitude systems – correction for apparent magnitude.Stellar distances and absolute luminosities – measurement of distances within the solar system – trigonometric parallaxes of stars – method of measurement of luminosity -.surface temperature of stars – spectral classification of stars-stellar magnetic fields.**[Ref. 1]**

UNIT II

Stellar physics and Stellat evolution (36 hours)

Theory of radiative transfer – Radiative transfer equation – Thermodynamic equilibrium – radiative transfer through stellar atmosphere – formation of spectral lines-Basic equation of stellar structure – Hydrostatic equilibrium in stars – Virial theorem – energy transport inside stars – convection inside stars – stellar models – some relations among stellar quantities – determination of stellar parameters – main sequence – red giants and white dwarfs

Nucleosynthesis and Nuclear reactions in stars – calculation of nuclear reaction rates – Important nuclear reactions in stellar interiors – Helioseismology – solar neutrino experiments – Stellar evolution – Evolution of binary systems – mass loss from stars –

stellar winds-Stellar collapse – Degeneracy pressure of Fermi gas – structure of white dwarfs – Chandrasekhar limit – neutron stars – pulsars – binary X – ray sources. accretion disks.[**Ref. 2]**

UNIT III

Galactic Physics and elements of Cosmology (36 hours)

Normal galaxies – morphological classification - physical characteristics and kinematics – expansion of the universe – active galaxies – super luminal motion in quasars – black hole as central engine – unification scheme – cluster of galaxies – large scale distribution of galaxies – gamma ray bursts.

Space time dynamics of the universe – general relativity – the metric of the universe – Friedman equation for the scale factor – cosmic background radiation – evolution of matter dominated universe – evolution of radiation dominated universe.Primordial nucleosynthesis – cosmic neutrino background – nature of dark matter. **[Ref. 2,3 &4]**

References

1. Abhyankar K. D. - *Astrophysics Stars and Galaxies,*Universities Press.
2. Arnab Rai Choudhuri - *Astrophysics for Physicists*, Cambridge University Press.
3. Padmanabhan T. – *Theoretical Astrophysics*, Cambridge University Press.
4. Narlikar J. B.- *Introduction to Cosmology*, Cambridge University Press.

PH 243 T;THEORETICAL PHYSICS – II (6L,1T)

Unit I

Functional Integrals in Physics(36 hours)

• Functionals
Function vs functional, functional derivatives, functional integration, Guassian integrals [Ref 19, 20, 21, 22]

• Path integrals in quantum mechanics
– Single particle systems- Feynman path integral, propagator as a functional integral, Born approximation, Coulomb scattering,
– Many particle systems - Second quantization, coherent states and many-body path integrals, field integral for the quantum partition function.
– Quantum Fields - Path integrals for fields, functionals for bosonic andfermionic fields, generating functions for free and interacting fields, Wick's theorem, Perturbation theory. [Ref 8,13,14,17,10, 20, 21, 23]

Unit II

Many particle physics(36 hours)

• **Broken symmetry and collective phenomena**

Mean field theory, Bose-Einstein condensation and superfluidity, superconductivity, interacting electron gas and disorder

• **Response functions**

Linear response theory, analytic structure of correlation functions, electromagnetic linear response

Unit III

Critical phenomena (36 hrs)

Continuous phase transitions, critical behaviour, scaling, renormalization group, Ising model, RG analysis of ferromagnetic transition.
[Ref 19, 22]

References

[1] F. Scheck, *Quantum Physics*, Springer (2007).
[2] G. Teschl, *Mathematical Methods in Quantum Mechanics*, American Mathematical Society (2009).
[3] P. Szekeres, *Modern Mathematical Physics*, Cambridge University Press (2004).
[4] M. T. Vaughn, *Introduction to Mathematical Physics*, Wiley - VCH Verlag (2007).
[5] Arfken, *Mathematical Physics for Physicists*, Academic Press (2013).
[6] J. J. Sakurai, *Modern Quantum Mechanics*, Addison-Wesley Publishing Company (1994).
[7] L. I. Schiff, *Quantum Mechanics*, McGraw-Hill Book Co. (1968).
[8] R. Shankar, *Principles of Quantum Mechanics*, Springer (1994).
[9] L. E. Ballentine, *Quantum Mechanics*, World Scientific Publishing Co. (2000).
[10] L. H. Ryder, *Quantum Field Theory*, Cambridge University Press (2008).
[11] J. J. Sakurai, *Advanced Quantum Mechanics*, Addison-Wesley (1967).
[12] M. Le Bellac, *Quantum and Statistical Field Theory*, Oxford University Press (2001).
[13] K. Schulten and I. Kosztin, *Lectures in Theoretical Biophysics*, University of Illinois at Urbana-Champaign (2000).
[14] R. Kubo, M. Toda and N. Hashitsume, *Statistical Physics II: None quilibrium Statistical Mechanics*, Springer-Verlag (1985).
[15] G. F. Mazenko, *Nonequilibrium Statistical Mechanics*, Wiley-VCH Verlag (2006).

[16] V. Balakrishnan, *Elements of Nonequilibrium Statistical Mechanics*, CRC Press (2008).
[17] B. F. Schutz, *A First Fourse in General Relativity*, Cambridge University Press (2009).
[18] S. Caroll, *Spacetime and Geometry: An Introduction to General Relativity*, Addison-Wesley (2004).
[19] A. Altland and B. Simons, *Condensed Matter Field Theory*, Cambridge University Press (2008).
[20] J. W. Negele and H. Orland, *Quantum Many-particle Systems*, Levant Books (2006).
[21] E. Fradkin, *Field Theories of Condensed Matter Systems*, Levant Books (2006).
[22] P. M. Chaikin and T. C. Lubensky, *Principles of Condensed Matter Physics*, Cambridge University Press (2004).
[23] A. M. Tsvelik, *Quantum Field Theory in Condensed Matter Physics*, Cambridge University Press (2003).

PH 251: GENERAL PHYSICS PRACTICALS

(Total of 10 experiments to be done from Section A and B)

Section A(*at least 5 experiments to be done in this section*)

1. Determinationof elastic constantsby Cornu's method (elliptical and hyperbolic fringes)

2.Analysis of absorption spectra of liquids using spectrometer

3. Study of ultrasonic waves in liquids

4. Determination of e/k using Ge and Si transistors

5 Anderson Bridge –determination of self and mutual inductance

6. Michelson Interferometer experiments

7. Identification of Fraunhofer lines in solar spectra

8. Verification of Richardson's equation using diode valve

9.LED experiments (a) wavelength determination (b) I-V characteristics (c) output power variations with applied voltage etc.

10. Thermal diffusivity of brass

Section B(*at least 2 experiments to be done from this section*)

1. BH curve-anchor ring

2. Study of photoelectric effect and determination of of Planck's constant

3. Determination of Stefan's constant

4. Experiments using Laser:

(a) Laser beam characteristics (b) Diffraction grating (c) Diffraction at different types of slits and apertures (d) refractive index of liquids (e) particle size determination

5. Youngs modulus of different materials using strain gauge

6. Determination of magnetic force in a current carrying conductor

7. Optical fibre characteristics

8. Cauchy's constants of liquids and liquid mixtures using hollow prism and spectrometer

9.Surface tension of a liquid using Jaeger's method

10 Expriments using Phoenix Kit

(a) Capacitor charging/discharging experiments (b) Dielctric constant of glass

PH 252 Electronics and Computer Science Practicals

Unit I – Electronics Experiments (A total of 10 experiments to be done)

Secion A(*atleast 5 experiments to be done*)

1. Single stage CE amplifier –Design and study of frequency response

2. Study of RC Phase shift oscillator circuits using Transistors

3. Construction and study of Astablemultivibrator and VCO circuits using Transistors

4. Study of OP Amp circuits (a) summing amplifier (b)difference amplifier (c) zero cross detector etc

5. OP Amp as an integrator and differentiator

6. Characteristics of JFET and MOSFET

7. Characteristics of SCR

8. Design and study of negative feedback amplifier circuits

9. Study of Clipping and Clamping circuits

10. UJT Characteristics and UJT relaxation Oscillator

Section B(*at least 3 experiments to be done*)

1. Emitter follower and source follower circuits

2. Weinberg oscillator using OP Amp

3. SR and JK Flip Flops -construction using Logic Gates and study of truth tables

4. Study of the frequency response of a tuned amplifier

5. Study of power amplifier circuits

6. Frequency multiplier using PLL

7 Study of Schmitt trigger circuits

8. Construction and study of acascode amplifier circuit using transistors.

9. Simple electronics experiments using Phoenix and Python based Kits.

Unit II Comptuter Programming

(*A minimum of 8 experiments to be done,programs should be written in C++ language*)

1. Least square fitting

2. First derivative of tabulated function by difference table

3. Numerical integration (Trapezoidal rule and Simson method)

4. Solution of algebraic and transcendental equations using Newton-Ralphson method

5. Solution of algebraic equations using bisection method

6. Numerical interpolation using Newton and Lagrangian methods

7. Monte Carlo simulation

8. Evaluation of Bessel and Legendre functions

9. Matrix addition,multiplication ,trace,transpose and inverse

10. Fourier series analysis

11.Study of motion of projectile in a central force field

12. Study of Planetary motion and Kepler's laws

PH 261 Advanced Physics Practicals

(*A total of 10 experiments to be done*)

<u>Unit I: Physics experiments</u>

Section A(*atleast 5 experiments to be done*)

1. e/m of an electron-Thompson's method

2. Charge of an electron-Millikan's method

3. Determination of Fermi energy of Copper

4. Study of variation of resistance of a semiconductor with temperature and determination of band gap

5. Magnetic Suceptibility of a liquid using Quincke's method

6. Ferromagnetic studies using Guoy's method

7. Hall effect in a semiconductor

8. Rydberg constant deterimination using grating,spectrometer and discharge tubes.

9. Thermo-emf of bulk samples like Al,Cu.Brass etc.

Section B (*at least two experiments to be done*)

1. Electrical characteristics of a solar cell

2. Studies usingUV visible spectrophotometer

3. Refractive index of liquids and liquid mixtures using Abbe's refractometer

4. Optical activity studies using Polarimeters

5.Determination of temperature characteristics of a Flame

(a) Candle flame using digital photography and image analysis

(b) sodium flame in comparison with incandescent lamp using a spectrometer

6. LDR and photodiode characteristics

7. Simple experiments using GM counter

8. Determination of dielectric constant of materials

9. Experimental determination of Avogadro's number using an electrochemical cell

10 Study of arc spectra and hydrogen spectra using an imager (CCD) and photoelectric/electronic recorder.

Unit II: Data Anaysis(*Five experiments to be done*)

1. Analysis of the given band spectrum
2. Analysis of given rotation-vibration spectrum
3. Interpretation vibration spectra of simple molecules using Raman and IR spectra
4. Dissociation energy of diatomic molecules
5. Analysis of powder XRD data
6. Study of stellar spectral classification from low dispersion stellar spectra
7. Study of HR diagram of stars
8. Radioactive material counting statistics

9. Interpretation of UV- visible spectra of materials
10. Weather and astronomy related image processing

PH 262 E Advanced Electronics Paracticals

Unit I-ELECTRONICS(*a total of seven experiments to be done***)**

Section A (*at least 5 experiments to be done***)**

1. Study of active filters using OP amps (a) low pass (b) high pass (c) band pass for both first order and second order-gain/ roll off determination

2. Wave form generation using OP amp circuits:

(a) astable and monostablemultivibrators (b) square,triangular and saw-tooth wave generation

3. IC 555 timer experiments (a) monsostable and astablemultivibrators(b) VCO

4. D/A convertor circuits using OP Amp 741

5. Differential amplifier circuits using transistors

6. Design of series pass voltage regulators using (a) transistors with load and line regulation
(b) OP Amp

Section B(at least 2 experiments to be done)

1 Study of IF tuned amplifier and Amplitude modulation (generation and detection) using
transistor,diode etc.

2. Frequency modulator and detector circuits.

3. Pulse modulation circuits using 555 timer (a) PAM (b) PWM

4. Digital modulation circuits (a) BFSK generation using 555 timer (b) BFSK detector using
555 timer and PLL (c) BPSK generation

5. Shift register and ring counter circuits using flip flops

6. Miscellaneous transistor applications (a) automatic night light with LDR
   (b) invertor circuit (transistors as a switch) (c) time delay circuit using SCR

7. BCD to decimal decoder and seven segment display using IC

8 Design of Electronic counters (up and down counters)

Unit II: Micorprocessor Based Experiments
(*Five experiments to be done*)

1. 8085 /8086 program to find out largest from a group of 8bit/16 bit numbers

2. Square wave generation using 8255A interface using 8085/8086

3. 8086 program for block additions

4. Interfacing LED display board with 8085/8086

5. 8086 program to convert binary to ASII and ASII to BCD

6. 8086 program to arrange a given data in ascending and decending order

7. 8086-simple traffic light controller

8. 8086 program for binary to BCD conversion and vice versa

9. Program of Fibonacci series using 8086