Revised Syllabus for
MSc Degree Programme in Physics

(with effect from 2014 admissions)
<table>
<thead>
<tr>
<th>Semester</th>
<th>Paper Code</th>
<th>Title of Paper</th>
<th>Contact hours per week</th>
<th>UE duration (h)</th>
<th>IA</th>
<th>UE</th>
<th>Total</th>
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<tr>
<td>I</td>
<td>PH 211</td>
<td>Classical Mechanics</td>
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<td>Electronics &amp; Computer Science Practicals</td>
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<td>Modern Optics &amp; Electromagnetic theory</td>
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<td>Thermodynamics, Statistical Physics &amp; Basic Quantum Mechanics</td>
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<td>Computer Science &amp; Numerical Techniques</td>
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|       | Grand Total                            | 72| 20| 28| 425|1375|1800|

* 10 marks for records

X: E (Electronics), M (Materials Science)
L: Lecture
IA: Internal Assessment
N: Nuclear Physics
S: Space Physics
T: Tutorial
UE: University Exam
P: Practical
T: Theoretical Physics
B: SPECIAL PAPERS FOR THIRD AND FOURTH SEMESTERS

<table>
<thead>
<tr>
<th>Special paper Category</th>
<th>Code Nos of Special Papers</th>
<th>Name of Special Papers</th>
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<tr>
<td>1  ELECTRONICS</td>
<td>PH 233 E</td>
<td>Advanced Electronics-I</td>
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<tr>
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<td>PH 243 E</td>
<td>Advanced Electronics-II</td>
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<td>2  MATERIALS SCIENCE</td>
<td>PH 233 M</td>
<td>Materials Science-I</td>
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<td>Materials Science-II</td>
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<td>3  NUCLEAR PHYSICS</td>
<td>PH 233 N</td>
<td>Advanced Nuclear Physics</td>
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<td>PH 243 N</td>
<td>Radiation Physics</td>
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<td>4  SPACE PHYSICS</td>
<td>PH 233 S</td>
<td>Space Physics and Plasma Physics</td>
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<td>PH 243 S</td>
<td>Advanced Astrophysics</td>
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<td>5  THEORETICAL PHYSICS</td>
<td>PH 233 T</td>
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<td>PH 243 T</td>
<td>Theoretical Physics-2</td>
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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 paper Category) may be chosen by a student for the third and fourth semesters of the MSc Programme in Physics. At present for all specialisations practical 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 student concerned. 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 evaluation and 25 marks allotted for Project based Viva Voce to be conducted along with General Viva Voce examination by the University.

D Pattern of University Question 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)

PH 261: Advanced Physics has two parts: Physics Experiment (5h, 45 marks)
Data Analysis of given scientific data (1h, 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)
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 candidate 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 questions. 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

**Lagrangian mechanics (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-differential 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)**
Equilibrium 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-Liouville’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-infinitesimal rotations as vectors-angular momentum and inertia tensor-Euler’s equations of motion of a rigid body-force free motion 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-Einstein’s 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-logistic map-strange attractors-Lyapunov exponent and Chaos-ideas of fractals and solitons

(Chapter 11 of Aruldas)

**Books for study**


References


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

**Unit I**

**Vector analysis and matrices (8 hours)**

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 matrices

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

**Complex analysis (8 hours)**

Cauchy-Riemann conditions-Cauchy’s integral theorem and formula-singularities and mapping-calculus of residues-dispersion relations

(Chapter 6 and 7 of Arfken and Weber)

**Fourier series and applications (8 hours)**

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

(Chapter 14 of Arfken and Weber)
Probability (12 hours)
Definitions and simple properties of probability-random variables-Chebychev inequality and moment generating function-discrete and continuous probability distributions-binomial distributions-Poisson distributions-Gauss Normal distribution-error analysis and least square fitting-chi-square and student ‘t’ distributions
(Chapter 19 of Arfken and Weber)

Unit II
Differential equations (16 hours)
(Chapter 9 of Arfken and Weber)

Special functions (20 hours)
Bessel functions of the first kind-orthogonality-Neumann functions-Hankel functions-modified Bessel functions-spherical Bessel functions-Legendre functions-generating function-recurrence relations and orthogonality-associated Legendre functions-spherical harmonics-Hermite functions-Laguerre functions-Chebyshev polynomials-hypergeometric functions
(Chapter 11,12,13 of Arfken and Weber)

Unit III
Tensor analysis (18 hours)
Notations and conventions in tensor analysis-Einstein's summation convention-covariant and contravariant and mixed tensors-algebraic operations in tensors-symmetric and skew symmetric tensors-tensor calculus-Christoffel symbols-kinematics in Riemann space-Riemann—Christoffel tensor.
(Chapter 49 in Dass and Verma, Chapter 2 of Joshi)

Group theory (18 hours)
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

References

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

Unit I

**Selections from electronic circuits (24 hours)**

Frequency response of an amplifier circuits-power and voltatge gain-imedence matching-Bode plots-Miller effects-rise time bandwidth relations-frequency analysis of BJT and FET amplifier 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 oscillator-
monostable and astable multivibrator 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-varactor diode-IMPATT diode-Gunn diode-applications of semiconductor microwave devices

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

**Unit II**

**Digital electronics**

*Arithmetic and data processing digital circuits (16 hours)*

Binary adder and subtractor-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 et al)

**Sequential digital circuits (20 hours)**


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

**Unit III**

**Optoelectronics (20 hours)**

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

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

**Electronic Instrumentation (16 hours)**

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

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

**Books for study**


**References**


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

**Unit I**

**Selections from modern optics (24 hours)**

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-acoustic-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 Chapters 17 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

(Chapters 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**

**Transmission lines (12 hours)**

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

(Chapter 10 of Sadiku)

**Wave guides (12 hours)**

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)

**Antennas (12 hours)**

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

(Chapter 12 of Sadiku)

**Books for study**


**References**


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

UNIT I
Thermodynamic relations and consequences (20 hours)


(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 Satyaprakash)

UNIT II
Quantum statistics (24 hours)


(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 Satyaparakash)

Unit III

Foundations of quantum mechanics (12 hours)


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

Paradoxes in quantum mechanics (8 hours)

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)

Exactly solvable problems in quantum mechanics (16 hours)

one dimensional eigenvalue 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, Statistical Mechanics, Kedarnath Ram Nath Publishers, Meerut and Delhi (2009)

**References**


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**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)

**Introduction to Python Programming (10 hours)**

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

(Chapter 1 to 9 of Peter Norton et al)

**Introduction to microprocessors (12 hours)**

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 variables-global 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-accsesing 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
Numerical Techiques( 36 hours)
( Chapters 4,5,6,7,8,9,11 and 12 of Vedamurty and Iyengar)

Books for study


References

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


4. P. Ghosh, Numerical Methods with computer programs in C++, PHI learning Pvt Ltd


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 perturbation 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 harmonic perturbation-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 $L_x^2$ and $L_y$ –general angular momentum-eigen values of $J_x$ and $J_y$-angular momentum matrices-spin angular momentum –spin vectors for a spin $\frac{1}{2}$ system-addition of angular momentum-Clebiss-Jordon coefficients

(Chapter 8 of Aruldas)

**Unit II**

**Symmetry and conservation laws (10 hours)**

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

(Chapter 7 of Aruldas)

**Quantum theory of scattering (12 hours)**

Scattering cross section and scattering amplitude-partial wave analysis and scattering by a central potential-scattering by attractive square well potential-scattering length-expression for phase shifts-Born approximation-scattering by Coulomb potential-Laboratory and centre of mass coordinate transformations

(Chapter 14 of Aruldas)

**System of identical particles (14 hours)**


**Unit III**

**Relativistic quantum mechanics (24 hours)**

Klein-Gordon equations and its relevance-particle in a Coulomb’s field-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 an electron-relativistic corrections of Hydrogen atom spectrum-spin orbit correction-Lamb shift

(Chapter 15 of Aruldas)

**Elements of Quantum Field theory (12 hours)**

Lagrangian and Hamiltonian formulation of classical fields-quantisation of fields-quantisation of the Schroedinger equation-Klein-Gordon and Dirac fields-quantisation of the electromagnetic field

(Chapter 16 of Aruldas)
Book for study

References
1 S. Devanarayanan, Quantum Mechanics, Sci Tech Publications (India) Pvt Ltd (2005)
6 J. J. Sakurai, Advanced Quantum Mechanics, Pearson Education Inc (2009)
8 Steven Weinberg, Quantum Theory of Fields (in Three Volumes), Cambridge University Pressss (2002)

PH 232: ADVANCED SPECTROSCOPY (611T)

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 spectrophotometers 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
**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 - characteristic IR spectra - vibrations of polyatomic molecules - anharmonicity - Fermi resonance - hydrogen bonding - normal modes of vibration in a crystal - interpretation 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 spectra - 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 - stimulated Raman scattering - coherent antistokes Raman scattering.

(Chapter 8 and 15 of Aruldas)

**Unit III**

**ESR and NMR spectroscopy (12 hours)**


(Chapters 10 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)

**Photoelectron and Photo-acoustic spectroscopy (16 hours)**

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

**Books for study**


**References**

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 analog continuous wave modulation-analog baseband signal transmission-signal distortions and equilization-linear continuous 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

**Digital communications (16 hours)**


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

**Optical fibre communications (20 hours)**

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 optical communication- optical solitons-soliton based optical communication systems

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

Unit III

**Mobile cellular communications (12 hours)**

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

(Chapters 19 and 20 of Tomasi)

**Digital Signal processing (24 hours)**

**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)

Trigonometric Fourier series-exponential form-Parseval’s identity-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-transforms (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)


(Chapter 7 of Salivahanan et al)

Books for study

2. W. Tomasi, Electronic communications systems: Fundamentals through advanced, Dorling Kindlerly (India) Pvt Ltd (2009)

References


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- 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-Soft materials

Classification of materials.- Functional classification of materials


Imperfections in crystals


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

Reference Books
1. Introduction to solids –L.V.Azaroff Tata Mc Graw Hill
7. Solid State Physics, S.L. Gupta and V.Kumar, Pragati Prakashan.
12. Elementary solid State physics M.Ali Omar-Pearson

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

Unit I

Nuclear properties and structure (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  

**Nuclear reactions and Particle Physics (36 hours)**

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
3. Sathya Prakash Nuclear Physics & particle Physics, S Chand 2005

**References**

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)


[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)

[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


sensing by radio propagation – Experimental technique for ionospheric studies –
Ionosonde technique – Incoherent scatter technique. [Ref 4, 6 & 10. ]

References

3. Tamas I. Gombosi: Physics of the Space Environment (Cambridge University
   Press, 1998)
6. Ratcliffe: Introduccion to ionosphere and magnetosphere (CUP, 1972)
7. Robert G. Fleagle and Joost A. Businger: An Introduction to Atmospheric Physics,
10. Michael D. Pappagiannis: Space Physics and Space Astronomy, Gordon and

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**

**Statistical Physics (36 hours)**

• **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, fluorescence microphotolysis [ Ref 13]

**Unit III - General relativity (36 hrs)**

• **Differential geometry**
Tensors, differentiable manifolds, geodesics, curvature, Riemannian tensor [ Ref 3, 4, 17, 18]

• **Relativity**
Principle of equivalence, Einstein equations, centrally symmetric gravitational fields, Schwarzschild solution, singularities [ Ref 17, 18]

**References**


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)


(Chapters 7 and 9 of Wahab)
Free electron and band theory (16 hours)
(Chapters 10, 11 and 12 of Wahab)

Unit II
Semiconductors (12 hours)
Free carrier concentration in semiconductors-mobility of charge carriers-temperature 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-Ferroelectric 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
**Introduction to nano science and technology (16 hours)**

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


**References**


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

**Unit I**

**Nuclear forces (10 hours)**

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)

**Nuclear models (12 hours)**

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 reactions-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 laboratory-conditions for the construction of nuclear fusion reactor-critical ignition temperature-Lawson criterion-plasma confinement in fusion- principles of pinch, magnetic and inertial confinements.

(Chapter 7 of Verma et al)

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**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 et al)

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

(Chapter 15 of Krane)
**Elementary particle physics (16 hours)**

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

(Chapter 18 of Krane)

**Books for study**


**References**

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 movement instructions-arithmetic 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)**


( 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)
**Advanced artificial intelligence systems (16 hours)**


(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**

**Television (14 hours)**

Television broadcasting fundamentals-scanning, blanking and synchronizing pulses-video bandwidth-video signal characteristics-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 color TV system

(Chapter 1 to 5 of Veera Lakshmi and Srivel)

**Radar (12 hours)**

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

(Relevant chapters of Skolni, Chapter 4 of Nagaraja)

**Satellite communications (10 hours)**

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**

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

Unit I

**Functional materials and properties (36 hrs)**

Electronic, Magnetic and photonic materials and properties

transmission-Selective absorption and transmission-Emission phenomenon-luminescent and phosphorescent materials-Fibre optic communication system.

**Unit II**

**Nanostructured materials and properties (36 Hrs)**


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), Introduction 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 study only(Non evaluative)**

Reference Books


11. Elementary solid State physics M.Ali Omar-Pearson


14. Nano The Essential-T Pradeep; Mc Graw Hill Education


17. Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons and Burkhard Raguse “Nanotechnology”, Overseas Press New Delhi 2005


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

Unit –I

Interaction of radiation with matter ( 36 hours)
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 rays and neutrons.

Particle flux and fluence, 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

Radioactivity, detection and dosimetry (36 hours)

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.


Unit III

Biological effects of radiation (36 hours)


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

References

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

UNIT I
General features of observational astronomy (36 hours)

UNIT II
Stellar physics and Stellat evolution (36 hours)


UNIT III

Galactic Physics and elements of Cosmology (36 hours)


References


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

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. Determination of elastic constants by 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 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. Young’s 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. Experiments using Phoenix Kit
    (a) Capacitor charging/discharging experiments (b) Dielectric constant of glass

**PH 252 Electronics and Computer Science Practicals**

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

**Section 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 Astable multivibrator 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
Unit II Computer 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)

Unit I: Physics experiments

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 Susceptibility of a liquid using Quincke’s method
6. Ferromagnetic studies using Guoy’s method
7. Hall effect in a semiconductor
8. Rydberg constant determination 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 using UV 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 Analysis (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

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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 monostable multivibrators (b) square, triangular and saw-tooth wave generation
3. IC 555 timer experiments (a) monostable and astable multivibrators (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) inverter 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: Microprocessor 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 ASCII and ASCII to BCD

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