ST. JOSEPH'S COLLEGE (AUTONOMOUS), DEVAGIRI, CALICUT 8

Syllabus

for

M.Sc. PHYSICS PROGRAMME

(UNDER SJCCSS SYSTEM)

(Effective from 2016 Admission)

M. Sc. PHYSICS PROGRAMME (SJCCSS)

w.e.f. 2016 admission

An over view

Dduration of the programme	**:**	**2 years**
Number of semesters	**:**	**4**
Credits for core courses	**:**	**52**
Credits for Elective courses	**:**	**12**
Credits for Practical course	**:**	**16**
Credits for Project work	**:**	**04**
Credits for Viva voce (2x2=4)	**:**	**04**
The total credits for the programme	**:**	**88**

The scheme and syllabus of the programme, consisting of sections (A) Courses in various semesters with Credits and Hours (B) Grading and Evaluation (C) Detailed syllabus (D) Model question papers are as follows:

A. Courses in various Semesters with hours/week and credits

Semester	Course Code	Course Title	Hours/ week	Credits
SEMESTER I	DPHY1B01T	Classical Mechanics	4	4
	DPHY1B02T	Mathematical Physics - I	4	4
	DPHY1B03T	Electrodynamics and Plasma Physics	4	4
	DPHY1B04T	Electronics	4	4
	DPHY2B09P	General Physics Practical -I	4	EXAM IN 2ND SEM
	DPHY2B10P	Electronics Practical -I	4	
	SEM. TOTAL	**CORE THEORY**		**17**
	SEMESTER TOTAL	**CORE PRACT** **VIVA VOCE**		**8** **2**

Semester	Course Code	Course Title	Hours/week	Credits
SEMESTER III	DPHY3B12T	Quantum Mechanics -II	4	4
	DPHY3B13T	Nuclear and Particle Physics	4	4
	DPHY3B14T	Solid State Physics	4	4
		Elective **-I**	4	4
	DPHY3E01T	Radiation Physics	Any one	
	DPHY3E02T	Experimental techniques		
	DPHY3E03T	Plasma Physics		
	DPHY3E04T	Foundations of Quantum Mechanics		
	DPHY4B16P	Modern Physics Practical-I	4	EXAM IN 4TH SEM
		Research Project	4	

SEMESTER I	**SEM. TOTAL**	**CORE THEORY**		**17**
SEMESTER IV	DPHY4B15T	Spectroscopy	4	4
		Elective –**II**	4	4
	DPHY4E05T	Lasers and Fibre Optics	Any one	
	DPHY4E06T	Electronic Instrumentation		
	DPHY4E07T	Materials Science		
	DPHY4E08T	Astrophysics		
		Elective -III	4	4
	DPHY4E09T	Microprocessors and Applications	Any one	
	DPHY4E10T	Physics of Semiconductors		
	DPHY4E11T	Quantum Field Theory		
	DPHY4E12T	Advanced Condensed Matter Physics		
SEMESTER I	DPHY4B16P	Modern Physics Practical –II	4	4
	DPHY4B17P	Computational Physics Practical	4	4
	DPHY4B18D	Research Project	4	4
	DPHY4B19V	Viva Voce		2
	Semester Total	**Core Theory** **Core Practical** **Project** **Viva vice**		**13** **8** **4** **2**

B. GRADING AND EVALUATION

1. Accumulated minimum credit required for successful completion of the course shall be 88.
2. A project work of 4 credit is compulsory and it should be done in III & IV semesters. Also a comprehensive Viva Voce for theory and practical papers may be conducted at the end of II and IV semester and carries 2 credits per semester. Thus a total of 4 credits for Viva Voce.
3. Evaluation and grading (indirect grading system followed)
   1. For each course, grade point is awarded based on the percentage of total marks (CIE+ESE) scored.

$$\text{Grade Point} = \frac{\text{Percentage of marks}}{10}$$

Maximum grade point is 10

2. All grading starting from the evaluation of papers is done on 7 point scale (A^+, A, B, B^+, C, D,

F) and SGPA and CGP between 0 to 10 and in two decimal points. An overall letter grade (Cumulative Grade) for the whole programme shall be awarded to the student based on the value of CGPA using a 7-point scale given below.

Overall Grade in a Programme

Grade Point	Overall Letter Grade
9 to 10	A^+
8 to below 9	A
7 to below 8	B^+
6 to below 7	B
5 to below 6	C
4 to below 5	D
Below 4	F

(4) Marks of Internal and External valuation:
The evaluation scheme for each course shall contain two parts (1) internal evaluation (2) external evaluation. Its weightages are as follows:

Evaluation	**Marks**
Internal	20%
External	80%

Both internal and external evaluation will be carried out using indirect Grading System

(5) Internal evaluation (must be transparent and fair):
Theory:

a) Tests - **10** marks (at least 2 tests with 50% Problems)
   The mark distribution for test paper

100 to 80%	Less than 80 to 60%	Less than 60 to 40%	Less than 40 to 20%	Less than 20 to 10%	Less than 10
5	4	3	2	1	0

b) Tutorial on assignments and Exercises – 3 marks
c) Seminar& Viva Voce - 4 marks(2+2)
d) Attendance – 3 marks
   The mark distribution for attendance

90% and above	Less than 90 to 80%	Less than 80 to 75%	Less than 75%
3	2	1	0

Practical:

a) Tests - 10marks
b) Lab. skill/quality of their results-5 marks
c) Viva Voce - 5marks

Project:

a) Monthly progress - 10marks
b) Regularity and attendance -5marks
c) Seminar and Viva Voce - 5marks

(6) External evaluation:

a) **Theory**: Every semester

Pattern of question Papers

Division	*Type*	*No.of Questions*	*Marks*	*Total Marks*
Part A	Short Answer	10 (No Choice)	2	20
Part B	Essay	2 out of 4	15	30
Part C	Problems	6 out of 9	5	30
Total marks for a question paper				80

Answer to each question may be evaluated based on

(i) Idea/knowledge –1/4 of max marks
(ii) Logic/steps – 1/4 of max marks
(iii) Analytic skill – 1/4 of max marks
(iv) Correctness – 1/4 of max marks

b) Practicals: At the end of II and IV semesters.

c) Project: End of IV semester.

Its evaluation is based on:
(i) Project Preparation & Report - 40marks
(ii)Presentation – 20marks
(iii) Project Viva –20marks

d) Comprehensive Viva-Voce Examination of theory and practical papers at the end of II & IV semesters.

Practical examination and project evaluation will be conducted by one external examiner and one internal examiner. Viva Voce examination will be conducted by external examiners.

(7) Theory papers must contain at least 4 lectures plus 1 Tutorial per week except for Research Methodology Course. The course Research Methodology is distributed spread over all the four semesters and the examination is only at the end of 4th semester (Internal question paper setting) Project is equivalent to one theory papers (6 hours) and one practical (8 hours).

(8) Directions for question paper setters:

Part A (Short answer type): Each questions to be answered in 4 minutes average and should extract the critical knowledge acquired by the candidate in the subject. (Covering all modules uniformly)

Part B (Essay type): Each questions to be answered in 30 minutes average. May be asked as a single question or parts. Derivation type questions can be also asked.

Part C (Problems): Each questions to be answered in 12 minutes average.

Blue Print Format for question paper setters.

Modules		1	2	3	4	5
Question Number						
Section A	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
Section B	11					
	12					
	13					
	14					
Section C	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
Total						

C. DETAILED SYLLABUS

SEMESTER - I

DPHY1B01T: CLASSICAL MECHANICS

1. Lagrangian and Hamiltonian Formulation:

Constraints and Generalized coordinates, D'Alemberts principle and Lagrange's equation, Velocity dependent potentials, Simple applications, Hamilton's Principle, Lagrange's equation from Hamilton's principle, Kepler problem, Scattering in a central force field, Transformation to lab coordinates, Legendre Transformation, Hamilton's canonical equations, Principle of least action, Canonical transformations, examples, Enough exercises (14 hours Max marks 28)

Text : Goldstein, Sections 1.3 – 1.6, 2.1 – 2.3, 3.10, 3.11, 8.1, 8.5, 8.6, 9.1, 9.2

2. The classical background of quantum mechanics:

Equations of canonical transformations, Examples, Poisson brackets and other canonical invariants, Equation of motion in Poisson bracket form, Angular momentum Poisson brackets, Hamilton -Jacobi equation, Hamilton's principal and characteristic function, H-J equation for the linear harmonic oscillator, Separation of variables, Action-angle variables, H-J formulation of the Kepler problem, H-J equation and the Schrödinger equation, Enough exercises. (15 hours Max marks 30)

Text :Goldstein, Sections 9.1, 9.2, 9.4 - 9.6, 10.1 – 10.5, 10.7,
10.8

3. The Kinematics and Dynamics of Rigid Bodies:

Space-fixed and body-fixed systems of coordinates, Description of rigid body motion in terms of direction cosines and Euler angles, Infinitesimal rotation, Rate of change of a vector, Centrifugal and Coriolis forces, Moment of inertia tensor, Euler's equation of motion, Force free motion of a rigid body, Enough exercises. (13 hours Max marks 26)

Text : Goldstein, Sections 4.1, 4.4, 4.8 –
4.10

4. Small Oscillations:

Formulation of the problem, Eigen value equation, Eigenvectors and Eigenvalues, Orthogonality, Principal axis transformation, Frequencies of free vibrations, Normal coordinates, Free vibrations of a linear tri atomic molecule, Enough exercises. (8 hours
Max marks 16)

Text : Goldstein, Sections 6.1 – 6.4

5. Nonlinear Equations and Chaos:

Introduction, Singular points of trajectories, Nonlinear oscillations, Limitcycles, Chaos : Logistic map, Definitions, Fixed points, Period doubling, Universality, Enough exercises.
(10 hours Max marks 20)

Text : Appropriate sections of Michael Tabor

Text Books :

1. Goldstein "Classical Mechanics" (Addison Wesley)

2 Michael Tabor : "Chaos and Integrability in Nonlinear Dynamics" (Wiley, 1989)

Reference : .

1. V.B.Bhatia : "Classical Mechanics" (Narosa Publications, 1997)

2. N.C.Rana and P.S.Joag : "Classical Mechanics" (Tata McGraw Hill)

3. R.G.Takwale and P.S.Puranik : "Introduction to Classical Mechanics" (Tata McGraw Hill)

4. Atam P. Arya : "Introduction to Classical Mechanics, (2nd Edition)" (Addison Wesley1998)

5. Laxmana : “Nonlinear Dynamics” (Springer Verlag, 2001)

6. Kibble, “Classical Mechanics”

For further reference: Classical Physics Video Prof. V. Balakrishnan IIT Madras http://nptel.iitm.ac.in/video.php?subjectId=122106027
Special Topics in Classical Mechanics Video Prof. P.C. Deshmukh IIT Madras http://nptel.iitm.ac.in/courses/115106068/
Physics I - Oscillations & Waves Video Prof. S. Bharadwaj IIT Kharagpur http://nptel.iitm.ac.in/video.php?subjectId=122105023
Chaos, Fractals & Dynamic Systems Video Prof. S. Banerjee IIT Kharagpur http://nptel.iitm.ac.in/video.php?subjectId=108105054

DPHY1B02T: MATHEMATICAL PHYSICS – I

1. Vectors

Rotation of coordinates, Orthogonal curvilinear coordinates, Gradient, Divergence and Curl in orthogonal curvilinear coordinates, Rectangular, cylindrical and spherical polar coordinates, Laplacian operator, Laplace’s equation – application to electrostatic field and wave equations, Vector integration, Enough exercises. (9 hours)

Text : Arfken & Weber , Sections 1.2, 1.6 -1.9, 1.10, 2.1 –2.5

2. Matrices and Tensors

Basic properties of matrices (Review only), Orthogonal matrices, Hermitian and Unitary matrices, Similarity and unitary transformations, Diagonalization of matrices, Definition of Tensors, Contraction, Direct products,, quotient rule, Pseudo tensors, Dual tensors, Levi Cevita symbol, irreducible tensors, Enough exercises. (9 hours)

Text : Arfken & Weber , Sections 3.2 -3.5, 2.6 –2.9

3. Second Order Differential Equations

Partial differential equations of Physics, Separation of variables, Singular points, Ordinary series solution, Frobenius method, A second solution, Self adjoint differential equation, eigen functions and values, Boundary conditions, Hermitian operators and their properties, Schmidt orthogonalization, Completeness of functions, Enough exercises. (12 hours)

Text : Arfken & Weber , Sections 8.1, 8.3 –8.6, 9.1 –9.4

4. Special functions

Gamma function, Beta function, Delta function, Dirac delta function, Bessel functions of the first and second kinds, Generating function, Recurrence relation, orthogonality, Neumann function, Spherical Bessel function, Legendre polynomials, Generating function, Recurrence relation, Rodrigues‟ formula, Orthogonality, Associated Legendre polynomials, Spherical harmonics, Hermite polynomials, Laguerre polynomials, Enough exercises. (20 hours)

Text : Arfken & Weber , Sections 10.1, 10.4, 1.15, 11.1 –11.3, 11.7, 12.1 –12.4, 2.6, 13.1, 13.2

5. Fourier Series

General properties, Advantages, Uses of Fourier series, Properties of Fourier series, Fourier integral, Fourier transform, Properties, Inverse transform, Transform of the derivative, Convolution theorem, Laplace transform, Enough exercises. (10 hours)

Text : Arfken & Weber , Sections 14.1 –14.4, 15.2 –15.5, 15.8

Textbook: 1. G.B.Arfken and H.J.Weber : "Mathematical Methods for Physicists (5th Edition, 2001)" (Academic Press)

Reference books:

1. J.Mathews and R.Walker : "Mathematical Methods for Physics" (Benjamin)
2. L.I.Pipes and L.R.Harvill : "Applied Mathematics for Engineers and Physicists (3rd Edition)" (McGraw Hill)
3. Erwin Kreyzig : "Advanced Engineering Mathematics -8th edition" (Wiley)
4. M. Greenberg : "Advanced Engineering Mathematics –2nd edition " (Pearson India 2002)
5. A.W. Joshi : Matrices and tensors
6. Mathematical methods in the physical sciences, 2nd edn, Mary L Boas, John Wiley & Sons
7. Elementary Differential Equations and boundary value problems, William E. Boyce, Richard C. DiPrima, John Wiley & Sons, Inc.
8. Mathematics of Classical and Quantum Physics, F. W. Byron and R. W. Fuller, Dover Publications, Inc., New York

For further reference:

Mathematics I Video Prof. Swagato K. Ray,Prof. Shobha Madan,Dr. P. Shunmugaraj http://nptel.iitm.ac.in/video.php?subjectId=122104017

Mathematics II Video Prof. Sunita Gakkhar, Prof. H.G. Sharma, Dr. Tanuja Srivastava IIT Roorkee http://nptel.iitm.ac.in/video.php?subjectId=122107036

Mathematics III Video Prof. P.N. Agrawal, Dr. Tanuja Srivastava IIT Roorkee http://nptel.iitm.ac.in/video.php?subjectId=122107037

DPHY1B03T: ELECTRODYNAMICS AND PLASMA PHYSICS

1. **Time varying fields and Maxwell's equations :**

Maxwell's equations, Potential functions, Electromagnetic boundary conditions, Wave equations and their solutions, Time harmonic fields, Enough exercises. (8 hours, Marks 16) Text : Cheng, Sections 7.3 – 7.7

2. Plane electromagnetic waves :

Plane waves in lossless media, Plane waves in lossy media, Group velocity, Flow of electromagnetic power and the Poynting vector, Normal incidence at a plane conducting boundary, Oblique incidence at a plane conducting boundary, Normal incidence at a plane dielectric boundary, Oblique incidence at a plane dielectric boundary, Enough exercises. (10 hours, Marks 20) Text : Cheng , Sections 8.2 –

8.10

3. **Transmission lines, Wave guides and cavity resonators:**

Transverse electromagnetic waves along a parallel plane transmission line, General transmission line equations, General wave behaviour guiding structures, Rectangular wave guides, Cavity resonators, Enough exercises. (12 hours, Marks 24) Text : Cheng, Sections 9.2 - 9.3 , 10.2 ,10.4, 10.71

4. **Relativistic electrodynamics:**

Magnetism as a relativistic phenomenon, Transformation of the field, Electric field of a point charge moving uniformly, Electromagnetic field tensor, Electrodynamics in tensor notation, Potential formulation of relativistic electrodynamics, Enough exercises. (14 hours, Marks 28) Text : Griffiths, Sections 10.3.1 – 10.3.5

5. Plasma Physics :

Plasma - Definition, concepts of plasma parameter, Debye shielding, Motion of charged particles in an electromagnetic field - Uniform electric and magnetic fields, Boltzmann and Vlasov equations, their moments (First and Second moments)- Fluid equations(Basic ideas), Plasma oscillations, Enough exercises. (16 hours, Marks 32) Text : Chen, Sections 1.1 - 1.6, 2.2 - 2.2.2, 3.1 - 3.3.2, 4.3, 4.18, 4.19

Text Books :

1. David K. Cheng : " Field and Wave Electromagnetics" (Addisson Wesley)
2. David Griffiths : " Introductory Electrodynamics" (Prentice Hall of India, 1989)
3. F. F. Chen, Introduction to Plasma Physics and Controlled Fusion, Volume I and II, Plenum Press, recent edition

Reference books:

1. K.L. Goswami, Introduction to Plasma Physics – Central Book House, Calcutta
2. J.D.Jackson : "Classical Electrodynamics" (3rd Ed.) (Wiley,1999)

DPHY1B04T: ELECTRONICS

1. **Field Effect Transistor:**
   Biasing of FET, Small signal model, Analysis of Common Source and Common Drain amplifier,

High frequency response, FET as VVR and its applications, Digital MOSFET circuits, Enough exercises. (8 hours Max marks 16)

Text : Millman and Halkias : "Integrated Electronics" (Tata McGraw Hill 2002) Sections 10.4 - 10.11

Reference: Electronic devices and circuit theory, Robert L Boylstead & L. Nashelsky – Pearson Education (fifth Edition)

2. **Microwave and Photonic Devices :**

Tunnel diode, Transferred electron devices , negative differential resistance and devise operation,

radiative transitions and optical absorption, Light emitting diodes (LED) – visible and IR, semiconductor lasers - materials, operation (population inversion, carrier and optical confinement, optical cavity and feedback, threshold current density), Photodetectors - photoconductor (Light dependent resistor- LDR) and photodiode, p-n junction solar cells - short circuit current, fill factor and efficiency, Enough exercises. (11 hours , Max marks 22)

Text: "Semiconductor Devices- Physics and Technology" - S.M.Sze , John Wiley and Sons (2002) Sections 8.2, 8.4, 9.1, 9.2, 9.3 - 9.3.3, 9.4, 9.5 – 9.5.3

3. **Operational Amplifier and Its Applications:**

Basic operational amplifier characteristics, OPAMP differential amplifier, Emitter coupled differential amplifier, OPAMP parameters (Open loop gain, CMRR, Input offset current and voltage, output offset voltage, slew rate) and their measurement, .Frequency response, Principle of Bode plots, Phase and gain margins, OPAMP as inverter, scale changer, summer, V to I converter, Analog integration and differentiation, Electronic analog computation, Active low pass filter, High pass Butterworth filters, Band pass filter Enough exercises.

(16 hours Max marks 32)

Text : 1.Millman and Halkias : "Integrated Electronics" (Tata McGraw Hill 2002), Sections 15.1 – 15.4, 15.6,15.8 – 15.13,16.5-16.7, 16.15, 16.16.

2. Ramakant A. Gaekwad : "OPAMPS and Linear Integrated Circuits"

Reference : D. Roychoudhuri : "Linear Integrated circuits" – New Age International Publishers (1997)

4. **Transducers** :

Types of transducers,Strain gages-gage factor-unbounded strain gages. Displacement transducers-capacitive-inductive-LVDT-oscillation-potetiometric-velocity. Temperature measurements-Resistance thermometers-Thermocouples-Interfacing resistive transducers to electronic circuits-Thermistor applications. Photosensitive devices- phototubes- multiplier phototubes (8 hours

Max marks 16)

Text: Moden Electronic instrumentation and measurement techniques- Albert D Helfrick &William D Cooper (Prentice-Hall) Sections11.1 to11.6

Reference : 1.Electronic Instrumentation – Second edition – H.S. Kalsi (Tata Mc Graw Hill)

5. Digital Electronics :

Minimization of functions using Karnaugh map, Representation using logic gates, JK and MSJK flip-flops, Synchronous and asynchronous counters, MOD 3,5,10,16 counters, Cascade counters, Static and dynamic random access memory, CMOS, Non-volatile NMOS, Magnetic memories, Charge coupled devices, Microprocessor architecture, Organization of a general microcomputer, CPU architecture of 8 bit processor such as INTEL 8085,Overview of 8051 microcontroller; Enough exercises.

(17 hours Max marks 34)

Texts:

1. Malvino and Leach : "Digital Principles and Applications(3nd Ed.)" (Tata McGraw Hill, 1978) Sections 6.5 - 6.9, 7.2 - 7.5, Chapter 8 complete, 12.1, 12.4, 12.5
2. R.P.Jain : "Modern Digital Electronics" (Tata McGraw Hill) sections 11.9, 11.91 - 11.93 (For charge coupled devices)
3. B.Ram : "Fundamentals of Microprocessors and Microcomputers (Dhanapathi Rai & Sons) Sections 1.5 to 1.7, 3.1 – 3.1.6
4. Microcontrollers & Embedded systems by Muhammed Ali Mazidi & Janice Guillespie Mazidi (Prentice Hall)
5. Introduction to Microprocessors –A.P. Mathur (Tata-McGraw Hill).

Reference:

1. M.S.Tyagi ; "Introduction to Semiconductor Devices" (Wiley)
2. Millman and Halkias : "Integrated Electronics"
3. Gupta and Kumar : "Handbook of Electronics"

For further reference: Electronics Video Prof. D.C. Dube IIT Delhihttp://nptel.iitm.ac.in/courses/115102014/

Digital Integrated Circuits Video Prof. Amitava Dasgupta IIT Madras http://nptel.iitm.ac.in/video.php?subjectId=108106069

SEMESTER - II

DPHY2B05T: QUANTUM MECHANICS-I

1. **Mathematical tools of quantum mechanics**: linear vector space, Hilbert space, dimension and basis of a vector space, square integrable functions, Dirac notation, operators-general definition, hermitian adjoint, projection operator, commutator algebra, general uncertainty relation, functions of operators, inverse and unitary operator, eigen values and eigen vectors, matrix representation of kets, bras and operators, change of bases, matrix representation of the eigen value problem, position representation, momentum representation, connection between them, parity operator, matrix and wave mechanics(12 hours,10 wts): Chapter 2 of Book 1

2. **Postulates of quantum mechanics**: basic postulates, probability density, superposition principle, observables and operators, how measurements disturb systems, expectation values, complete set of commuting operators, measurement and uncertainty relation, time evolution operator, Schrödinger picture , Heisenberg picture and interaction picture, stationary states, time independent potentials, Schrödinger equation and wave packets, conservation of probability, time evolution of expectation values, infinitesimal and finite unitary transformations, symmetries and conservation laws, Poisson brackets and commutators, Ehrenfest theorem, quantum mechanics and classical mechanics, harmonic oscillator- Schrodinger method and operator method.(12 hours, 10 wts) : Chapter 3 of Book 1 and articles 4.7 and 4.8 of Book 2.

3. **Angular momentum**: orbital angular momentum, general formalism, matrix formulation, geometrical representation, experimental evidence of spin, general theory of spin, Pauli's spin matrices, eigen functions and eigen values of L_z and L^2, hydrogen atom, spherical harmonics, addition of two angular momenta, Clebsh – Gordon coefficients. (16 hours, 12 wts): Chapter 5 and articles 7.3.1 and 7.3.2 of Book 1.

4. **Identical particles:** Schrödinger equation, interchange symmetry, systems of distinguishable non interacting particles, identical particles in classical and quantum mechanics, exchange degeneracy, symmetrization postulate, constructing symmetric and anti symmetric functions, systems of identical non interacting particles, Pauli's exclusion principle (8 hours, 6 wts): Chapter8 of Book 1

5. **Scattering theory:** Scattering and scattering cross section, angles in lab and CM frames, cross sections in lab and CM frames, scattering amplitude of spin less particles, scattering amplitude and differential cross section, scattering amplitude, Born approximation, first Born

approximation, validity of first Born approximation, partial wave analysis for elastic and inelastic scattering, scattering of identical particles.(12 hours, 10 wts): Chapter 11 of Book 1

Books

1. Quantum Mechanics-concepts and applications: N Zettili (John Wiley& Sons)
2. Quantum Mechanics- V K Thankappan (Wiley Eastern)
3. Quantum Mechanics- G Aruldhas (Prentice Hall India)
4. Introduction to Quantum Mechanics- David J Griffith (Pearson)
5. Introductory Quantum Mechanics: Richard Liboff (Pearson)
6. Principle of Quantum Mechanics 2nd edition: R Shankar (Springer)

Web Resources

1. Quantum Physics Video- Prof V Balkrishnan, IIT Madras
2. Quantum Mechanics and Applications Video- Prof Ajoy Ghatak, IIT Delhi

DPHY2B06T: MATHEMATICAL PHYSICS-II

1. Functions of Complex Variables:

Introduction, Analyticity, Cauchy-Reimann conditions, Cauchy's integral theorem and integral formula, Laurent expansion, Singularities, Calculus of residues and applications
(15 hours Max marks 30)-Sections 6.1 to 6.5, 7.1, 7.2

2. Group Theory:

Groups, multiplication table, conjugate elements and classes, subgroups, direct product groups, isomorphism and homomorphism, permutation groups, distinct groups of given order, reducible and irreducible representations - Sections 1-1.8, Joshi.
Generators of continuous groups, rotation groups SO(2) and SO(3), rotation of functions and angular momentum, SU(2)-SO(3) homomorphism, SU(2) isospin and SU(3) eightfoldway (15 hours Max marks 30) - Sections 4.2, Arfken 5th edition.

3. Calculus of Variations:

One dependent and one independent variable, Applications of the Euler equation, Generalization to several independent variables, Several dependent and independent variables, Lagrange Multipliers, Variation subject to constraints, Rayleigh-Ritz variational technique.
(11 hours Max marks 22)- Sections 17.1 to 17.8

4. Integral equations:

Integral equations- introduction, Integral transforms and generating functions, Neumann series, separable kernel (10 hours Max marks 20)-Sections 16.1 to 16.3

5. Green's function:

Green's function, eigenfunction expansion, 1-dimensional Green's function, Green's function integral-differential equation, eigenfunction, eigenvalue equation Green's function and Dirac delta function, Enough exercises.

(9 hours Max marks 18) Section 9.51

Textbook :

1. G.B.Arfken and H.J.Weber : "Mathematical Methods for Physicists (5th Edition, 2001)" (Academic Press)

3. A.W.Joshi, Elements of Group theory for Physicists (New Age International (P).Ltd)

Reference books :

1. Mathematical Physics, P. K. Chattopadhyay, New age international publishers.
2. G.B.Arfken and H.J.Weber : "Mathematical Methods for Physicists (5th Edition, 2001)"
3. (Academic Press)
4. J.Mathews and R.Walker : "Mathematical Methods for Physics" (Benjamin)
5. L.I.Pipes and L.R.Harvill : "Applied Mathematics for Engineers and Physicists (3rd Edition)" (McGraw Hill)
6. Erwin Kreyzig : "Advanced Engineering Mathematics - 8th edition" (Wiley)
7. M. Greenberg : "Advanced Engineering Mathematics – 2nd edition " (Pearson India 2002)
8. Mathematical methods in the physical sciences, 2nd edn, Mary L Boas, John Wiley & Sons
9. Elementary Differential Equations and boundary value problems, William E. Boyce, Richard C. DiPrima, John Wiley & Sons, Inc.
10. Mathematics of Classical and Quantum Physics, F. W. Byron and R. W. Fuller, Dover Publications, Inc., New York

For further reference:

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Mathematics II Video Prof. Sunita Gakkhar, Prof. H.G. Sharma, Dr. Tanuja Srivastava IIT Roorkee http://nptel.iitm.ac.in/video.php?subjectId=122107036

Mathematics III Video Prof. P.N. Agrawal, Dr. Tanuja Srivastava IIT Roorkee http://nptel.iitm.ac.in/video.php?subjectId=122107037

DPHY2B07T: STATISTICAL MECHANICS

1. The Statistical Basis of Thermodynamics:

The macroscopic and the microscopic states – Contact between statistics and Thermodynamics: Expressing T, P and μ in terms of Ω – The classical Ideal gas - The entropy of mixing and the Gibbs paradox - Phase space of a classical system - Liouville‟s theorem and its consequences.

(12 Hours Max marks 24), Text : Pathria, Sections 1.1 – 1.6, 2.1 – 2.2

2. Microcanonical, Canonical and Grand Canonical Ensembles:

The microcanonical ensemble – Examples : (1) Classical Ideal gas, (2) Linear harmonic oscillator - Quantum states and the phase space – Equilibrium between a system and a heat reservoir- Physical significance of the various statistical quantities in the canonical ensemble- Alternative expressions for the partition function- Examples: (1) The classical systems: Ideal gas, (2) A system of harmonic oscillators, (3) The statistics of paramagnetism - Energy fluctuations in the canonical ensemble -Equipartition theorem - Virial theorem - Equilibrium between a system and a particle-energy reservoir- Physical significance of the various statistical quantities in the grand canonical ensemble- Example : Classical Ideal gas - Density and energy fluctuations in the grand canonical ensemble.

(18 Hours Max marks 36) - Text : Pathria, Sections 2.3 -2.5, 3.1, 3.3 - 3.9, 4.1, 4.3 – 4.5

3. Formulation of Quantum Statistics:

Quantum-mechanical ensemble theory: The density matrix- Statistics of the various ensembles- Example: An electron in a magnetic field - System s composed of indistinguishable particles- An ideal gas in a quantum-mechanical microcanonical ensemble- An ideal gas in other quantum-mechanical ensembles- Statistics of the occupation numbers

(14 Hours Max marks 28) Text : Pathria, Sections 5.1 - 5.4, 6.1 – 6.3

4. Ideal Bose Systems:

Thermodynamic behaviour of an ideal Bose gas- Thermodynamics of the blackbody radiation- The field of sound waves.

(6 Hours Max marks 12) Text : Pathria, Sections : 7.1 - 7.3

5. Ideal Fermi Systems:

Thermodynamic behaviour of an ideal Fermi gas- Magnetic behaviour of an ideal Fermi Gas:

(1) Pauli paramagnetism, (2) Landau diamagnetism – The electron gas in metals (Discussion of heat capacity only), Enough exercises.

(10 Hours Max marks 20) Text : Pathria, Sections : 8.1 – 8.3

Text Book:

1. Statistical Mechanics (2nd Edition), R. K. Pathria, Butterworth-Heinemann / Elsevier (1996)

Reference Books:

1. Statistical Mechanics(2nd edition), Kerson Haun, John Willey & sons
2. Statistical Mechanics : An Elementary Outline, Avijit Lahiri, Universities Press (2008)
3. An Introductory Course of Statistical Mechanics, Palash. B. Pal, Narosa (2008)
4. Statistical Mechanics : An Introduction, Evelyn Guha, Narosa (2008)
5. Statistical and Thermal Physics : An Introduction, S. Lokanathan and R.S.Gambhir, Prentice Hall of India (2000).
6. Introductory Statistical Mechanics (2nd Edition), Roger Bowley and Mariana Sanchez, Oxford University Press (2007)
7. Concepts in Thermal Physics, Stephen. J. Blundell and Katherine. M. Blundell, Oxford University Press (2008)
8. An Introduction to Thermal Physics, Daniel. V. Schroeder, Pearson (2006)
9. Statistical Mechanics, Donald. A. McQuarrie, Viva Books (2005)
10. Problems and Solutions on Thermodynamics and Statistical Mechanics, Ed. By Yung – Kuo Lim, Sarat Book House (2001)

For further reference:

Basic Thermodynamics Video Prof. S.K. Som IIT Kharagpur http://nptel.iitm.ac.in/video.php?subjectId=112105123

DPHY2B08T: COMPUTATIONAL PHYSICS

1. Introduction to Python Programming: - 12 hrs (24 marks)

Concept of high level language, steps involved in the development of a Program - Compilers and Interpreters - Introduction to Python language: Inputs and Outputs, Variables, operators, expressions and statements - ,Strings, Lists, Tuples, and Dictionaries, Conditionals, Iteration and looping, Functions and Modules -. Mathematical functions (math module), File input and Output, Pickling. Formatted Printing.

2. Tools for maths and visualisation in Python (The numpy and pylab modules): 12 hrs (24

marks)

Numpy module:- Arrays and Matrices – creation of arrays and matrices (arange, linspace, zeros, ones, random, reshape, copying), Arithmetic Operations, cross product, dot product , Saving and Restoring, Matrix inversion, solution of simultaneous equations, Data visualization- The Matplotlib, Module- Plotting graphs, Multiple plots, .Polar plots, Pie Charts, Plotting mathematical functions, Sine and other functions, Special functions – Bessel & Gamma, Fourier Series.

3. Numerical Methods 1: 12 hrs (24 marks)*

Interpolation: linear and polynomial interpolation, equidistant points - Newton's forward/backward difference, spline interpolation. Curve fitting- Least square fit- linear and exponential. Derivatives: Lagrange polynomials, Newton difference polynomials, finite difference approximations. Numerical integration: simple quadratures (trapezoid, Simpson). Solution of non-linear equations: closed domain methods (bisection and regula falsi. Monte Carlo Method – Simple Integration.

4. Numerical Methods-2 12 hrs (24 marks) *

Ordinary differential equations: Initial value problems: the first-order Euler method, the second-order single point methods (predictor), Runge-Kutta methods. Boundary value problems: the shooting method, the equilibrium method, the Numerov's method, the eigenvalue problems - the equilibrium method .

Fourier transforms: discrete Fourier transforms, fast Fourier transforms

5. Computational methods in Physics and Computer simulations 12 hrs (24 marks)- *:

Classical Mechanics: One Dimensional Motion: Falling Objects: Introduction – Formulation: from Analytical methods to Numerical Methods - Euler Method, Freely falling body, Fall of a body in viscous medium, Two dimensional motion: Projectile motion (by Euler method) and Planetary motion (R-K Method), Accuracy considerations, -, Oscillatory motion – Ideal Simple Harmonic Oscillator (Euler method), Motion of a damped oscillator (Feynmann-Newton method)., Logistic maps. Monte-Carlo simulations: value of π, simulation of radioactivity. Quantum Mechanics: 1D Schrodinger equation –wave function and eigen values.

(Visualisation can be done with matplotlib/pylab)

*(Programs are to be discussed in Python)

Text books for Numerical Methods:

1. Introductory methods of numerical analysis, S.S. Shastry , (Prentice Hall of India,1983)

2. Numerical Methods in Engineering and Science, Dr. B S Grewal, Khanna Publishers, New Delhi (or any other book)

3. Numerical Mathematical Analysis, J.B. Scarborough

References:

(For Python any book can be used as reference. Moreover a number of open articles are available freely in internet. Python is included in default in all GNU/Linux platforms and It is freely downloadable for Windows platform as well. However use of GNU/Linux may be encouraged).

1. www.python.org
2. Python Essential Reference, David M. Beazley, Pearson Education
3. Core Python Programming, Wesley J Chun, Pearson Education
4. Python Tutorial Release 2.6.1 by Guido van Rossum, Fred L. Drake, Jr., editor. This Tutorial can be obtained from website http://www.altaway.com/resources/python/tutorial.pdf
5. How to Think Like a Computer Scientist: Learning with Python, Allen Downey , Jeffrey Elkner , Chris Meyers, http://www.greenteapress.com/thinkpython/thinkpython.pdf
6. Numerical Recipes in C, second Edition(1992), Cambridge University Press
7. Numerical Recipes in Fortran 77, second Edition(1992), Cambridge University Press
8. Numpy reference guide, http://docs.scipy.org/doc/numpy/numpy-ref.pdf (and other free resources available on net)
9. Matplotlib , http://matplotlib.sf.net/Matplotlib.pdf (and other free resources available on net)
10. Numerical Methods, E Balagurusamy, Tata McGraw-Hill
11. Numerical Methods , T Veerarajan, T Ramachandran, Tat MCGraw-Hill
12. Numerical Methods with Programs I BASIC, Fortran & Pascal, S Balachandra Rao, C K Shantha. Universities Press
13. Numerical methods for scientists and engineers, K. Sankara Rao, PHI
14. Computational Physics, V.K.Mittal, R.C.Verma & S.C.Gupta-Published by Ane Books,4821,Pawana Bhawan,first floor,24 Ansari Road,Darya Ganj,New Delhi-110 002 (For theory part and algorithms. Programs must be discussed in Python)
15. Numerical Methods in Engineering with Python by Jaan Kiusalaas

PRACTICAL FOR SEMESTER I & II

DPHY2B09P (GENERAL PHYSICS - PRACTICAL)

Note :

1. All the experiments should involve error analysis. Internal evaluation to be done in the respective semesters and grades to be intimated to the controller at the end of each

semester itself. Practical observation book to be submitted to the examiners at the time of examination.

2. Eight experiments are to be done by a student in a semester. One mark is to be deducted from internal marks for each experiment not done by the student if the required total of experiments are not done in the semesters.
3. The PHOENIX/expEYES Experimental Kit developed at the Inter University Accelerator Centre, New Delhi, may be used for the experiments wherever possible.

(At least 16 experiments should be done, 8 each for I & II semesters)

1. Y and σ - Interference method (a) elliptical (b) hyperbolic fringes. To determine Y and σ of the material of the given specimen by observing the elliptical and hyperbolic fringes formed in an interference set up Y & σ by Koenig‟s method

3. Variation of surface tension with temperature-Jaegar‟s method. To determine the surface tension of water at different temperatures by Jaegar‟s method of observing the air bubble diameter at the instant of bursting inside water
4. Stefan's constant-To determine Stefan's constant
5. Thermal conductivity of liquid and air by Lee's disc method.
6. Dielectric constant by Lecher wire- To determine the wave length of the waves from the given RF oscillator and the dielectric constant of the given oil by measurement of a suitable capacitance b y Lecher wire setup.
7. Viscosity of a liquid - Oscillating disc method. To determine the viscosity of the given liquid by measurements on the time period of oscillation of the disc in air and in the liquid
8. Mode constants of a vibrating strip. To determine the first and second mode constants of a steel vibrating strip; Y to be measured by the Cantilever method and frequency of vibration by the Melde's string method
9. Constants of a thermocouple and temperature of inversion.
10. Study of magnetic hysteresis - B-H Curve using standard toroid / specimen in any form.
11. Maxwell's L/C bridge -To determine the resistance and inductance of the given unknown inductor by Maxwell's L/C bridge OR Anderson's Bridge – L/C and self inductance. . (The kit developed by Indian Academy of Science can also be used)
12. Susceptibility measurement by Quincke's and Guoy's methods - Paramagnetic susceptibility of salt and specimen
13. Michelson's interferometer - (a) λ and (b) d λ and thickness of mica sheet.
14. Photoelectric effect. Determination of Plank's constant
15. Frank Hertz experiment .To measure the ionization potential of Mercury by drawing current versus applied voltage.

16. Fabry Perot etalon -Determination of thickness of air film.
17. Elementary experiments using Laser: (a) Study of Gaussian nature of laser beam (b) Evaluation of beam spot size (c) Measurement of divergence (d) Diameter of a thin wire
18. Diffraction Experiments using lasers (a)Diffraction by single slit/double slit/circular aperture(b)Diffraction by reflection grating
19. Measurement of the thermal and electrical conductivity of Cu to determine the Lorents number.(The kit developed by Indian Academy of Science can also be used)
20. Passive filters .(The kit developed by Indian Academy of Science can also be used)
21. Microwave experiments - Determination of wavelength, VSWR, attenuation, dielectric constant.
22. Experiments with Lock-in Amplifier(a) Calibration of Lock In Amplifier (b) Phase sensitive detection (c) Mutual inductance determination (d) Low resistance determination. (The kit developed by Indian Academy of Science can also be used)
23. Cauchy's constants using liquid prism
24. Forbe's method of determining thermal conductivity
25. Zeeman effect using Fabry-Perot etalon.

Reference Books:

1. B.L. Worsnop and H.T. Flint - Advanced Practical Physics for students - Methusen & Co (1950)
2. E.V. Smith - Manual of experiments in applied Physics - Butterworth (1970)
3. R.A. Dunlap - Experimental Physics - Modern methods - Oxford University Press (1988)
4. D. Malacara (ed) - Methods of experimental Physics - series of volumes - Academic Press Inc(1988)
5. S.P. Singh –Advanced Practical Physics – Vol I & II – Pragati Prakasan, Meerut (2003) –13th Edition

DPHY2B10P (ELECTRONICS - PRACTICAL)

(At least 16 experiments should be done, 8 each for I & II semesters.)

1. MOSFET characteristics and applications: To study the characteristics of a MOSFET and use it as a common source amplifier. Study bode-plot and determine I/O impedances.

2. UJT characteristics and application as a relaxation oscillator & sharp pulse generator. Use of UJT in a time delay circuit.

3.Characteristics of Silicon Controlled Rectifier - half wave and full wave; use of SCR as a power control device.

4.Voltage Regulation using transistors with feedback (regulation characteristics with load for different input voltages and variation of ripple % with load) / Voltage regulation based on opt coupler feedback; study of load and line regulation characteristics.

5. Single stage RC coupled Negative feedback amplifier(input, output résistance, frequency response with & without feedback)

6. Two stage RC coupled amplifier; study of bode plots, input, output impedances & power gain.

7. Common source FET amplifier - frequency response, input &output impedance.

8. Design and construction of Complementary symmetry Class B push-pull power amplifier transformerless) for small power outputs (less than 10 W); study of I/O impedances, efficiency and frequency response.

9. Differential amplifier using transistors; study of I/O impedances, frequency response & CMRR.

10. Design of Amplitude modulation circuit. Detection using diodes. Determination of modulation index & recovery of modulating signal.

11. Darlington pair amplifier; study of gain, frequency response, input & output impedances.

12. Basic configurations of OPAMP IC 741 – Inverting, Non-inverting and Difference amplifiers: design and construction for specified gain; study of bode-plots.

13. Design and construction of Wien bridge oscillator using OPAMP for different frequencies.

14. Design and construction of astable and monostable multivibrators using OPAMPS.

15. Design and construction of Sawtooth generator using transistors/OPAMP for different frequencies.

16. IC 555 Timer – Astable & Monostable multivibrators,Voltage control oscillator, Saw tooth generator, Frequency modulator for sinusoidal signal.

17. Two stage IF amplifier; study of the performance of single stage and coupled stages.

18. Schmidt triggers using OPAMPS – for symmetrical and non-symmetrical LTP/UTP. Trace hysteresis curve.

19. Design and construction of Crystal Oscillator & evaluation of frequency stability against temperature variations.

20. Analog integration and differentiation using OPAMPS ; study the integrator and differentiator characteristics.

21. Analog computation using OPAMPS (LM 324) – solution of differential equations / simultaneous equations

22. Second order Butterworth Low pass, High Pass and Band Pass filters using OPAMP – study

of frequency response.

23. Negative resistance oscillator using Tunnel diode for high R.F frequencies.
24. Bootstrap Amplifier; study of frequency response, input & output impedance.
25. Organize M X N random access memory with basic memory unit(IC); 16 X 4/32 X 8; Verify READ and WRITE operations.
26. 4 bit D/A converter using R-2R ladder network. Realization of 4 bit A/D converter using D/A converter.
27. Study of 4 bit binary counter (IC 7493) and 4 bit decade counter(IC 7490) at various modes. Use of counters as frequency dividers.
28. Minimization of a three variable truth table using Karnaugh map and realization using NAND gates.
29. Microprocessors experiments; addition, subtraction, division and multiplication of 1 byte numbers using Intel 8085 kit.

Reference Books :

1. Paul B. Zhar and A.P. Malvino - Basic Electronics - A Text Book Manual – JMH publishing (1983)
2. A.P. Malvino - Basic Electronics - A text lab manual - Tata McGraw Hill (1992)
3. R. Bogart and J. Brown -Experiments for electronic devices and circuits – Merrill International series (1985)
4. Buchla - Digital Experiments - Merrill International series (1984)
5. S.P. Singh – Pragati Advanced Practical Physics – Vol I & II – Pragati Prakasan Meerut (2003) – 13th Edition

For further reference:

Basic Electronics and Lab Video Prof. T.S. Natarajan IIT Madras http://nptel.iitm.ac.in/video.php?subjectId=122106025

SEMESTER – III

DPHY3B12T: **QUANTUM MECHANICS –II**

1. Approximation methods for time-independent problems:

The WKB approximation, connection formulae, Bound state varification of Bohr-Somerfeld old quantum theory, Penetration of a potential barrier. Time-independent perturbation theory, Non-degenerate and degenerate cases, Anharmonic oscillator stark and Zeeman effects in hydrogen,. (16 hours)

Texts : Book 2, Sections 9.2, 9.4

2. Variational method :

The variational equation, ground state and excited states, application to ground state of the hydrogen and Helium atoms, (6 hours) Book 2, Sections9.3

3. Time dependent perturbation theory :

Transition probability, Harmonic perturbation, Interaction of an atom with the electromagnetic field, Induced emission and absorption, The dipole approximation, Enough exercises. (12 Hours) Texts : Book 2, Sections 10.3, 10.5

4. Relativistic Quantum Mechanics :

The Dirac equation, Dirac matrices, Solution of the free-particle Dirac equation, The Dirac equation with potentials, Equation of continuity, Spin of the electron, Non-realistic limit, spin-orbit coupling, Hole theory, The Weyl equation. The Klein Gordon equation, Charge and current densities, The Klein-Gordon equation(18 Hrs).

Texts : Book 1 Sec. 10.1,10.2,10.2A,10.2B,10.3A

5. Quantization of fields :

The principles of canonical quantization of fields, Lagrangian density and Hamiltonian density, Second quantization of the Schrödinger wave field for bosons and fermions, Enough exercises.(12 Hrs.)

Texts: V.K.Thankappan Sec. 11.1,11.2,11.3

Textbooks :

1. V.K. Thankappan: "Quantum Mechanics" (Wiley Eastern)

2 .N. Zittili, , "Quantum Mechanics – Concepts and applications‟ (John Wiley & Sons, 2004)

3. P.M Mathews and Venkatesan., "A Textbook of Quantum Mechanics" (Tata McGraw Hill)

4. J.D. Bjorken and D. Drell : "Ralativistic Quantum Fields" (McGraw Hill 1998)

Reference books :

1. L.I. Schiff : Quantum Mechanics" (McGraw Hill)

2. J.J. Sakurai : "Advanced Quantum Mechanics " (Addison Wesley)

3. Stephen Gasiorowicz : "Quantum Physics"

For further reference:

Relativistic Quantum Mechanics Video Prof. Apoorva D Patel IISc Bangalore

http://nptel.iitm.ac.in/courses/115108074/

DPHY3B13T: NUCLEAR AND PARTICLE PHYSICS

1. Basic properties of nucleii and study of nuclear force:

Nuclear size, shape, mass and binding energy, semi empirical mass formula, Angular momentum and parity, nuclear electromagnetic moments, characteristics of nuclear force, the deuteron, nucleon-nucleon scattering the exchange force model.(10 Hours Max marks 20)

Texts: Introductory Nuclear Physics by Kenneth S Krane

Sections: - 3.1 →3.5, 4.1, 4.2, 4.4 & 4.5

Reference Books:

(1) Introduction to Nuclear Physics by Harald Enge

(2) Nuclear Physics by Roy&Nigam

2. Nuclear Models:

The shell model, shell model potential, spin-orbit potential, magnetic dipole moments, electric quadruple moments, valence nucleons, Even Z-even N nucleii and collective structure.

(10 Hours Max marks 20)

Text: Kenneth S Krane- Section 5.1 & 5.2

Reference: Harald Enge and Roy & Nigam

3. Nuclear Decays:

Beta decay, Energy release in beta decay, Fermi theory of beta decay, Experimental tests of the Fermi theory, angular momentum and parity selection rules, parity violation in beta decay. Energetics of gamma decay, classical electromagnetic radiation, transition to quantum mechanics, angular momentum and parity selection rules, Internal conversion.

(10 Hours Max marks 20)

Text: Kenneth S Krane - Sections 9.1 → 9.4 and 9.9, 10.1→ 10.4 - 10.6

Ref : Harald Enge and Roy & Nigam

4. Nuclear Reactions, Fission and Fusion:

Types of reactions and conservation laws, Energetics of nuclear reactions, reaction cross sections, compound nucleus reactions, Nuclear fission, characteristics of fission, energy in fission, Nuclear fusion: basic fusion processes, characteristics of fusion, solar fusion.(15 Hours Max marks 30)

Text: Kenneth S Krane - sections 11.1, 11.2, 11.4 and 11.10, 13.1, 13.2 and 13.3, 14.1, 14.2 and 14.3

References : Harald Enge and Roy & Nigam

5. Particle Physics

Basic forces and classification of particles: The four basic forces, The force of gravity, the electromagnetic force, the week force and electroweak theory, the strong force. Conservations laws: Conservation laws and symmetries, conservation of energy and mass, conservation of linear momentum, conservation of angular momentum, conservation of electric charge, conservation of baryon and lepton numbers, conservation of strangeness, conservation of isospin and its components, the TCP theorem, conservation of parity. Quark model: The eightfold way, discovery of omega minus, the quark model, the confined quarks, experimental evidences for quark model, coloured quarks, quantum chromodynamics and gluons, Enough exercises.

(15 Hours Max marks 30)

Text: The particle Hunters - Yuval Ne‟eman & Yoram kirsh

Sections : 6.1-6.3, 7.1-7.11 and 9.1-9.8.

References:

1. Introductory nuclear Physics by Samuel S.M. Wong, Chapter
2. Introduction to Elementary Particles-David Griffiths.

For further reference:

Nuclear Physics: Fundamentals and Applications Video Prof. H.C. Verma IIT Kanpur http://nptel.iitm.ac.in/courses/115104043/

DPHY3B14 T: SOLID STATE PHYSICS

1. Crystal Structure and binding:

Description of X-ray diffraction using reciprocal lattice, Brillouin zones, Vander Waals interaction, Cohesive energy of inert gas crystals, Madelung interaction, Cohesive energy of ionic crystals, Covalent bonding, Metallic bonding, Hydrogen-bonded crystals (6 hours Max marks 20)

2. Lattice Vibrations:

Vibrations of monatomic and diatomic lattices, Quantization of lattice vibrations, Inelastic scattering of neutrons, Einstein and Debye models of specific heat, Thermal conductivity, Effect of imperfection (8 hoursMax marks 16)

3. Electron States and Semiconductors:

Free electron gas in three dimensions, Specific heat of metals, Sommerfield theory of electrical conductivity, Wiedemann-Franz law, Hall effect, Nearly free electron model and formation of energy bands, Bloch functions, Kronig Penny model, Formation of energy gap at Brillouin zone boundaries, Number of orbitals in a band, Equation of motion of electrons in energy bands, Properties of holes, Effective mass of carriers, Intrinsic carrier concentration, Hydrogenic model of donor and acceptor states. Direct band gap and indirect band gap semiconductors (15 hours Max marks 30)

4. Dielectric, Ferroelectric and magnetic properties:

Theory of Dielectrics: polarization, Dielectric constant, Local Electric field, Dielectric polarisability, Polarisation from Dipole orientation, Ferroelectric crystals, Order-disorder type of ferroelectrics, Properties of Ba Ti O3, Polarisation catastrophe, Displasive type ferroelectrics, Landau theory of ferroelectric phase transitions, Ferroelectric domain, Antiferroelectricity, Piezoelectricity, Applications of Piezoelectric Crystals, Diamagnetism and Paramagnetism: Langevin‟s theory of diamagnetism, Langevin‟s theory of paramagnetism, theory of Atomic magnetic moment, Hund‟s rule, Quantum theory of magnetic Susceptibility Ferro, Anti and Ferri magnetism: Weiss theory of ferromagnetism, Ferromagnetic domains, Neel Model of Antiferromagnetism and Ferrimagnetism, Spinwaves, Magnons in Ferromagnets (qualitative) (22 hours Max marks 44)

5. Superconductivity:

Meissner effect, Type I and Type II superconductors, energy gap Isotope effect, London equation and penetration of magnetic field, Cooper pairs and the B C S ground state (qualitative, Flux quantization, Single particle tunneling, DC and AC Josepheson effects, High Tc Superconductors(qualitative) description of cuprates, Enough exercises.
(9 hours Max marks 18)

Text Books:

1. C.Kittel,: Introduction to Solid State Physics 5th edition (Wiley Eastern)
2. A.J.Dekker: Solid State Physics (Macmillian 1958)

Reference Books:

1. M.Ali Omar, Elementary Solid State Physics, Addison-Wesley Publishing Company
2. N.W.Ashcroft and Mermin : Solid State Physics (Brooks Cole (1976)
3. Elements of Solid State Physics, Srivastava J.P. Prentice Hall of India (2nd edn)
4. Ziman J.H. Principles of Theory of Solids - (Cambridge 1964)
5. Luth – Solid State Physics.

ELECTIVE- I

(Any one Elective can be selected from DPHY3E01T **-** DPHY3E04T**)**

DPHY3E01T: RADIATION PHYSICS

1. Radiation source :

Types of radiations, ionizing, non ionizing, electromagnetic, particles, neutral -gamma-neutrino- neutron, charged alpha, beta, gamma, and heavy ion sources, radioactive sources – naturally occurring production of artificial isotopes, accelerators–cyclotrons, nuclear reactors.
(9 hours Max marks 18)

1. G.F.Knoll, Radiation detection and measurement, John Wiley & sons, Newyork, (2000)
2. K.Thayalan, Basic radiological physics, Jaypee brothers medical Publishers, New Delhi, (2003)

2. Interaction of radiations with matter :

Interaction of Heavy charged particles – stopping power, energy loss characteristics, particle range, energy loss in thin absorbers,scaling laws. Interaction of fast electrons-Specific energy loss, electron range and trasmission curves, positron interactions. Intreaction of Gamma rays – Interaction mechanism – Photoelectric absorption, Compton scattering, Pair production, gamma ray attenuation, linear and mass absorption coefficients, absorption mass thickness. Interaction of Neutrons-General properties, slow and fast neutron interactions, Neutron cross sections, neutron attenuation and moderation.(15 hours Max marks 30)

1. G.F.Knoll, Radiation detection and measurements, Chapter 2 &10 .(John Wiley & sons, Newyork, 2000)
2. Nuclear physics principles and applications-John Lilley(John Wiley& sons)

3. Radiation quantities, Units and Dosimeters :

Particle flux and fluence, calculation of energy flux and fluence, curie, Becquerel, exposure and its measurements, absorbed dose and its relation to exposure, KERMA, Biological effectiveness, wighting factors, (WR and WT), Equivalent dose, Effective dose, Dosimeters, Primary and secondary dosimeters, Pocket dosimeter, Films and solid dosimeter (TLD and

RPL), Clinical and calorimetric devices , Radiation survey meter for area monitoring.
(12 hours Max marks 24)

1. K.Thayalan, Basic radiological physics, Jaypee brothers medical Publishers, New Delhi, (2003)
2. W.J. Meredith and J.B. Masse, Fundamental Physics of radiology, Varghese publishing house , Bombay (1992)

4. Biological effects and Uses of Radiation :

Effect of radiation, Interactons- Direct and indirect physical damage-indirect chemical damage. Effect of radiation on the body- internal radiation hazards-RBEand LET , secondary effects, deterministic effects, stochastic effects and genetic effects such as mutation and chromosomal abberations of ionizing radiation. Application of radiisotopes in Medicine,Cancer Therapy, Sterilization, food preservation.(12 hours Max marks 24)

1 G.F.Knoll, Radiation detection and measurements, Chapter 2 &10 .(John Wiley & sons, Newyork, 2000)
2 Source book of Atomic Energy -S. Glasstone-Chapter 17 & 18
3 M.A.S. Sherer, P.J.Visconti, E.R Ritenour, Radiation Protection in medical radiography, Mosbey Elsevier,(2006)

5. Radiation protection, shielding and transport :

Effective radiation protection, need to safeguard against continuing radiation exposure, justification and responsibility, ALARA, concept of radiologic practice. time distance and shielding, safety specifications. method of radiation control, Shielding factor for radiations, Choice of material, Primary and secondary radiations, Source geometry, Beta shielding, Gamma shielding, neutron shielding, Shielding requirements for medical, industrial and research facilities, handling of the source, sealing, transport and storage of sealed and unsealed sources. records, spills. waste disposal, Enough exercises. (12 hours Max marks 24)

1. W.J. Meredith and J.B. Masse, Fundamental Physics of radiology, Varghese publishing house , Bombay (1992)
2. M.A.S. Sherer, P.J.Visconti, E.R Ritenour, Radiation Protection in medical radiography, Mosbey Elsevier,(2006)
3. Lowenthal G.C and Airey P.L., Practical applications of radioactivity and

nuclear radiation sources, Cambridge University Press (2005)

DPHY3E02T: EXPERIMENTAL TECHNIQUES

Unit I - Vacuum Science and Technology (13 hoursMax marks 26)

Production of Vacuum-

Basic definitions and units, Expression for Pumping speed, Different vacuum regimes, Knudsen number, Classification of vacuum Pumps, Construction and working of Oil sealed rotary vane pump, Diffusion P ump, Turbo molecular Pump, Sorption Pump, Gettering Pump, Sputter-ion Pump, and Cryogenic Pump.

Pressure Measurement in Vacuum Systems-

Classification of Gauges, Mechanical Gauges-Bourdon Gauge and diaphragm Gauge, Liquid manometers-Open ended and Closed- ended U-tube manometers. Pirani gauge, Penning gauge, Thermocouple gauge, Hot and Cold Cathode ionization gauges. Vacuum Accessories –

Vacuum Valves -Diaphragm valve, Gate valve, Butterfly valve, Baffle and isolation valves, magnetic valves, adjustable valves, air inlet valves, Traps - Liquid nitrogen trap, Sorption traps, Flanges, Gaskets and O- Rings, Bellows, Couplings.

Text Books:

1. Vacuum Science and Technology, V.V. Rao, T.B. Ghosh, K.L. Chopra (Allied Publishers Limited, New Delhi)
2. Advanced Experimental Techniques in Modern Physics, K.M.Varier, Antony Joseph, P.P. Pradyumnan,(Pragati Prakshan, Meerut) Reference Books:

1. Basic Vacuum Technology, B.S. Halliday, A.Chambers, (Overseas Press India Limited)
2. High Vacuum Techniques -Theory and Practice, J.Yarwood (Chapman and Hall Limited)

Unit – II Thin film fundamentals
(10 hours Max marks 20)

Introduction, Nature and Applications of thin films, Distribution of deposit, Knudsen Cosine law

Thermal Deposition Techniques-

Resistive Heating, Flash Evaporation, Exploding wire, Electron Beam evaporation, Laser Evaporation, Arc Evaporation techniques

Sputter Deposition Technique-

Sputtering theory, Sputtering yield, Different parameters controlling sputter yield, Cathodic sputtering, Glow Discharge sputtering, Variables influencing glow discharge sputter deposition.

Thin film Thickness Measurement-

On line and off line measurement, Mechanical techniques-Microbalance and Quartz Crystal Oscillator methods, Electrical techniques-Wheatstone's Bridge method, Collinear Four-Probe method, Optical Techniques- Photometric, Spectro photometric, Interferometric methods

Multi layer thin film Optical Systems - Reflection and Anti reflection coatings (mathematical conditions), Interference filters.

Text Books:

1. Thin film fundamentals, A. Goswami, (New Age International Publishers, New Delhi)
2. Advanced Experimental Techniques in Modern Physics, K.M.Varier, Antony Joseph, P.P. Pradyumnan,(Pragati Prakshan, Meerut) Reference Books:

1. Thin film phenomena – K.L. Chopra, (Mc Graw Hill International)
2. Text Book of Optics, Brijlal, Subrahmaniam, Avadhanulu (S-Chand Company)

Unit – III Cryogenic techniques:

(14hours Max marks 28)

Introduction,

Review of history, General techniques of Liquefaction of gases – Internal and external work methods, Adiabatic Expansion, Joule-Kelvin effect, Isenthalpic curve, Inversion curve, Regenerative cooling.

Liquefiers-

Linde's Air Liquefier, Dewar‟s Hydrogen liquefier, Kammerlingh Onne's helium Liquefier, Uses of Liquefied gases, Special properties of Liquid Helium-Super fluidity, Lambda point-HeliumI and Helium II. Maintenance of Cryogenic Temperatures –Dewar flask, Henning cryostat, Hydrogen vapour cryostat.

Production of Sub Kelvin Temperatures -Adiabatic Demagnetization of Paramagnetic Salts (working and thermodynamic equations), Nuclear Adiabatic demagnetization to produce micro Kelvin temperatures, He^3-He^4 Dilution Refrigerator, Magnetic Refrigerator.

Measurement of low temperatures -

Primary and Secondary Thermometers, Gas thermometers and corrections, Resistance thermometers, (Relevant equations),Vapour pressure thermometer, Thermo-Electric thermometers, Magnetic Thermometer. Text Books:

1. Matter and Methods at Low Temperatures (Frank Pobell, Springer-Verlag,Third Indian Edition,)
2. Advanced Experimental Techniques in Modern Physics, K.M.Varier, Antony Joseph, P.P. Pradyumnan,(Pragati Prakshan, Meerut)

Reference Books:

1. Heat, Thermodynamics and Statistical Physics, Brijlal, Subrahmanyam, Hemne, (S-Chand and Company, New Delhi, 2010 Multi coloured edition)
2. Heat and Thermodynamics by Zemansky and Dittman (Tata Mc Graw Hill)
3. Low temperature Physics, L.C.Jackson (John Wiley & Sons)

Unit – IV Charged Particle Accelerator techniques: (10 hours Max marks 20)

DC accelerators-

General set up of an accelerator installation, Cock-Croft Walton accelerator, Van de Graff accelerator, Tandem Van de Graff accelerator, Pelletron. AC accelerators-Construction and working principles of Linear accelerator, Cyclotron, Sector focussed cyclotron, Synchro - cyclotron, principle of phase stability, Microtron, Betatron, Electron and Proton Synchrotron, Particle smashers (Colliders)qualitative idea only.

Ion sources –

Ionization processes, simple ion source, Duoplasmatron, RF ion source, important applications of accelerators, and Major accelerator installations in India (general awareness).

Text Books:

1. Nuclear and Particle Physics, S. Kakani, Shubhra Kakani, (VIVA Books New Delhi)
2. Introduction to Nuclear and Particle Physics,(Chapter 6) V.K.Mittal, R.C.Verma (PHI Learning Private Limited, New Delhi)

Reference Books:

1. An Introduction to Particle accelerators, E.J.N. Wilson, (Oxford University Press, ISBN 0-19-850829-8)
2. Advanced Experimental Techniques in Modern Physics, K.M.Varier, Antony Joseph, P.P. Pradyumnan,(Pragati Prakshan, Meerut)
3. Nuclear Physics, S.N. Ghoshal, (S. Chand & Company Ltd, New Delhi)

Unit – V Material Analysis Techniques:

(13 hours Max marks 26)

Introduction, Salient features of an effective elemental analysis, General Experimental set up-source, sample, detectors etc, mathematical basis of quantitative estimate, Nuclear reaction kinematics.

Rutherford Backscattering Spectrometry (RBS) – Introduction, Kinematic factor, Energy Straggling, Differential scattering cross section, Experimental set up, typical RBS spectrum analysis, Applications.

Neutron Activation Analysis (NAA) – Types of neutrons, Interaction of neutrons with nucleus, Prompt and Delayed analysis, Sources of Neutrons for NAA, Instrumentation, Yield equations, typical spectrum, Applications.

Proton Induced X-ray Emission Spectroscopy (PIXE) – Principle, Yield equations, Instrumentation,

Applications of PIXE to water samples, biological samples, Aerosol samples, Limitations of PIXE.

XRD Technique - Introduction, Lattice planes and Bragg‟s Law, Diffractometer-Instrumentation, Single crystal and Powder diffraction, Scherrer equation, Debye-Scherrer Camera, Applications of XRD-Crystallinity, Unit Cell Parameters, Phase transition studies, thin film studies, Rietveld Structure Refinement (qualitative ideas only), Awareness on Powder Diffraction File (PDF) of the International Centre for Diffraction Data.

***(With sufficient number of Exercises from each unit)*

Text Books:

1. Advanced Experimental Techniques in Modern Physics, K.M.Varier, Antony Joseph, P.P. Pradyumnan,(Pragati Prakshan, Meerut)
2. Solid State Physics, N.W.Ashcroft, N.D.Mermin (Thomson Book India Ltd, 2006 Edition) for XRD.

Reference Books-

1. Nuclear Physics – Principles and Applications, J.S. Lilley, (John Wiley & Son Ltd, Indian Edition)
2. Particle-Induced X-Ray Emission Spectrometry (PIXE) Johansson, A. E. Campbell, (ISBN 978-0-471-58944-0 - John Wiley & Sons)
3. Introductory Nuclear Physics,(Chapter 20) Kenneth S. Krane, (Wiley India Private Ltd)
4. Useful Link for XRD-http://pd.chem.ucl.ac.uk/pdnn/powintro/whatdiff.htm
5. Materials Science and Engineering, V.Raghavan, Prentice Hall India Ltd.

DPHY3E03T: PLASMA PHYSICS:

1. Introduction to Plasma Physics :

Existence of plasma,Definition of Plasma, Debye shielding 1D and 3D, Criteria for plasma,Applications of Plasma Physics (in brief), Single Particle motions -Uniform E & B fields, Nonuniform B field, Non uniform E field, Time varying E field, Adiabatic invariants and applications (14 hours Max marks 28)

Text : Chen, Sections 1.1 to 1.7.7, 2.1 to 2.8.3

2. Plasma as Fluids and waves in plasmas :

Introduction –The set of fluid equations, Maxwell‟s equations, Fluid drifts perpendicular to B, Fluiddrifts parallel to B, The plasma approximations, Waves in Plasma - Waves, Group velocity, Phase velocity, Plasma oscillations, Electron Plasma Waves, Sound waves, Ion waves, Validity of Plasma approximations, Comparison of ion and electron waves, Electrostatic electron oscillations parallel to B, Electrostatic ion waves perpendicular to B, The lower hybrid frequency, Electromagnetic waves with B0 , Cutoffs and Resonances, Electromagnetic waves parallel to B0, Experimental consequences, Hydromagnetic waves, Magnetosonic waves, The CMA diagrams (16 hours Max marks 32)

Text : Chen, Sections 3.1 to 3.6, 4.1 to 4.21

3. Equilibrium and stability :

Hydro magnetic equilibrium, The concept of b, Diffusion of magnetic field into plasma, Classification of instability, Two stream instability, the gravitational instability, Resistive drift waves, the Weibel instability (10 hours Max marks 20)

Text : Chen, Sections 6.1 to 6.8

4. Kinetic Theory :

The meaning of f(v), Equations of kinetic theory, Derivation of the fluid equations, Plasma oscillations and Landau damping, the meaning of Landau damping, Physical derivation of Landau damping, Ion Landau damping, Kinetic effects in a magnetic field

(10 hours Max marks 20)

Text : Chen, Sections 7.1 to 7.6.2

5. Introduction to Controlled Fusion :

The problem of controlled fusion, Magnetic confinements such as Toruses, Mirrors, Pinches, Laser Fusion, Plasma heating, Fusion Technology.

(10 hour Max marks 20)

Text : Chen, Sections 9.1 to 9.8

Text Book : .F. F. Chen, Introduction to Plasma Physics and Controlled Fusion, Volume I and II, Plenum Press, recent edition.

DPHY3E04T: FOUNDATIONS OF QUANTUM MECHANICS

1. Basic Concepts: ((8 Hours Max marks 16)

Reflections on the uncertainty principle, Complementarity principle, Information, Theory of quantum beats, The Aharonov – Bohm effect.

Chapter 3.3, 3.4 and 4.1 to 4.5 of George Greenstein & Arthur G. Zajonc

2. The EPR Experiment And Bell's Thorem: (12 Hours Max marks 24)

The EPR argument, The BKS theorem, The hidden variable theories, The Bell‟s theorem and its proof, Tests of Bell's inequalities, Alain Aspect's experiments.

Chapter 5.1 to5.3 and 6.1 of George Greenstein & Arthur G. Zajonc & 12.2 of David J Griffiths.

3. Nonlocality: (10 Hours Max marks20)

Bohm's nonlocal hidden variable theory, The Mystery of the EPR correlations, Nonlocality and principle of relativity, Quantum Nonlocality.

Chapter 6.2 to 6.5 & 6.7 of George Greenstein & Arthur G. Zajonc

4. Decoherence (14 Hours Max marks 28)

Schrödinger‟s cat, Super positions and mixtures, Non-observation of quantum behaviour in macrosystems, Decoherence, Watching decohrence

Chapter 7.1 to 7.6 of George Greenstein & Arthur G. Zajonc

5. The measurement problem in quantum mechanics: (16 hours, Max marks 32)

The measurement problem, The collapse of wave function, The infinite regress, The active nature of measurement in quantum mechanics, Decoherence and measurement problem, Elementary ideas of quantum cryptography and quantum teleportation

Chapter 8 complete & 9.1 to 9.3 of George Greenstein & Arthur G. Zajonc

Text Book : The Quantum Challenge: Modern Researches on the foundations of Quantum Mechanics - George Greenstein & Arthur G. Zajonc, Narosa

References:
1.Introduction to Quantum Mechanics: David J Griffiths, Pearson Education
2.Understanding Quantum Mechanics: Roland Omnes, Prentice-Hall, India
3.Quantum Theory and Measurement: J. A. Wheeler and W. H. Zurek, Princeton University Press, Princeton
4.Quantum Mechanics: V.K.Thankappan, Wiley Eastern

For further reference:
Quantum Mechanics and Applications Video Prof. Ajoy Ghatak IIT Delhi http://nptel.iitm.ac.in/courses/115102023/
Quantum Physics Video Prof. V. Balakrishnan IIT dras http://nptel.iitm.ac.in/video.php?subjectId=122106034

PRACTICAL FOR SEMESTERS III & IV
A) DPHY4B16P (MODERN PHYSICS)

*At least **10** experiments are to be done from **Part A** and **2** each from the **optional papers**. If no practical have been given for the particular optional papers, two more experiments from Part A should be done. It may be noted that some experiments are given both in Part A and B – of course such experiments can be done only once: either as included in A or in B. Internal evaluation to be done and grades to be intimated to the controller at the end of the semester itself. One mark is to be deducted from internal marks for each experiment not done by the student if the required total of experiments are not done in the semesters. The PHOENIX Experimental Kit developed at the Inter University Accelerator Centre, New Delhi, may be used for experiments wherever possible.*

PART A

1. G.M. Counter plateau and statistics of counting - To obtain the plateau, operating voltage and to verify the distribution law satisfied by the radioactive decay
2. Absorption coefficient for beta & gamma rays -To determine the absorption coefficient of the given materials using a G.M.Counter
3. Feather analysis – End point energy - To determine the end point energy of the beta particles from a given source using Feather analysis
4. Scintillation counter - To calibrate the given gamma ray (scintillation) spectrometer using standard gamma sources and to determine the energy of an unknown gamma ray source

5. Compton scattering - To verify the theoretical expression for the energy of the Compton scattered gamma rays at a given angle using a Scintillation gamma spectrometer / determine the rest mass energy of the electron
6. Half life of Indium – thermal neutron absorption - To determine the half life of In-116 by irradiation of In foil and beta counting using a GM counter
7. Photoelectric effect in lead - To get the spectrum of X rays emitted form lead target by photo electric effect using Cs-137 gammas
8. Conductivity, Reflectivity, sheet resistance and refractive index of thin films
9. Hall effect in semiconductors-To determine the carrier concentration in the given specimen of semiconducting material
10. ESR spectrometer – Determination of g factor
11. Rydberg constant determination
12. Absorption spectrum of KMnO4 and Iodine. To determine the wavelength of the absorption bands of KMnO4 and to determine the dissociation energy of iodine molecule from its absorption spectrum.
13. Ionic conductivity of KCl/NaCl crystals
14. Curie Weiss law -To determine the Curie temperature
15. To study the Thermoluminescence of F-centres of Alkali halides
16. Variation of dielectric constant with temperature of a ferroelectric material (Barium Titanate)
17. Polarization of light and verification of Malu‟s law.
18. Refractive index measurement of a transparent material by measuring Brewster‟s angle
19. Measurement of the thermal relaxation time constant of a serial light bulb.
20. Dielectric constant of a non polar liquid
21. Vacuum pump – pumping speed
22. Pirani gauge – characteristics
23. Ultrasonic interferometer. To determine the velocity and compressibility of sound in liquids.
24. Study of LED characteristics - Determination of wavelength of emission, I-V characteristics and variation with tempearture, variation of output power vs. applied voltage
25. Optical fibre characteristics - To determine the numerical aperture, attenuation and band width of the given optical fibre specimen
26. Band gap energy of Ge by four probe method.-To study bulk resistance and to determine band gap energy.
27. Thomson’s e/m measurement.-To determine charge to mass ratio of the electron by Thomson‟s method.
28. Determination of Band gap energy of Ge and Si using diodes.

29. Millikan's oil drop experiment .To measure the charge on the electron

30. Zener voltage characteristic at low and ambient temperatures – To study the variation of the Zener voltage of the given Zener diode with temperature

31. Thermionic work function – To determine the thermionic work function of the material of the cathode of the given vacuum diode/triode from the characteristic at different filament currents

PART B

I. ADVANCED ELECTRONICS

1. Simple temperature control circuit
2. Binary rate multiplier
3. Optical feedback amplifier
4. Frequency modulation and pulse modulation
5. Binary multiplier
6. Write ALP and execute using 8085 kit for generating a square wave of desired frequency using PPI 8255 interfacing. observe the output on CRO and measure frequency.
7. Write ALP to alternately switch on/off a green and a red LED within a given small time interval. Execute using 8085 kit.
8. Write ALP to convert a given d.c voltage (between 0 and 5 V) using ADC 0800/0808 interfaced to 8085 microprocessor. Execute using the given kit and check the result.

II. MATERIAL SCIENCE / CONDENSED MATTER PHYSICS

1. Curie-Weiss law – (To determine the Curie temperature)
2. Solid-liquid phase transitions – measurement of resistivity of metals
3. Growth of a single crystal from solution and determination of structural, electrical and optical properties
4. Study of colour centres – Thermoluminiscence glow curves
5. Ionic conductivity in KCl/NaCl crystals
6. Thermoluminiscence spectra of alkali halides
7. Thermo emf of bulk samples (Al/Cu)
8. Electron spin resonance
9. Strain guage – Y of a metal beam
10. Variation of dielectric constant with temperature of a ferro electric material (Barium titanate)
11. Ferrite specimen – variation of magnetic properties with composition

111. NUCLEAR PHYSICS and RADIATION PHYSICS

1. Half-life of Indium – thermal neutron absorption - To determine the half-life of In-116 by irradiation of In foil and beta counting using a GM counter
2. Alpha spectrometer - To calibrate the given alpha spectrometer and determine the resolution
3. Photoelectric effect in lead - To get the spectrum of X rays emitted form lead target by photo electric effect using Cs-137 gammas
4. Inner bremsstrahlung - To study the intensity spectrum of inner bremsstrahlung from given gamma source
5. Coincidence circuits - To construct and study the performance of series and parallel coincidence circuits using transistors and to determine the resolving time
6. Single channel analyzer - Study of characteristics of a SCA using precision pulser
7. Ionization chamber - Study of variation of pulse height with applied voltage and to obtaing the pulse height spectrum of X-rays
8. Proportional counter - Study of variation of pulse height with applied voltage and to obtaining the pulse height spectrum of X-rays
9. Track detector – track diameter distribution - To measure the diameters of the alpha tracks in CR-39 track detector
10. Beta ray spectrometer - To plot the momentum distribution of beta particles from given beta sources
11. Range of alpha particles in air and mylar - To determine the range of alpha particles from Am-241 source in air and in mylar using either a surface barrier detector or a GM counter

1V. EXPERIMENTAL TECHNIQUES

1. Rydberg constant – hydrogen spectrum
2. ESR – Lande g factor
3. IR spectrum of few samples
4. Vacuum pump – pumping speed
5. Vacuum pump – Effect of connecting pipes
6. Absorption bands of Iodine
7. Vibrational bands of AlO
8. Pirani gauge – characteristics
9. Thin films – electrical properties (sheet resistance)

(5) Thin films – optical properties (Reflectivity, transmission, attenuation, refractive index)

V. ELECTRONIC INSTRUMENTATION

1. Strain gauge
2. Simple servomechanism
3. Temperature control
4. Coincidence circuits
5. Multiplexer
6. IEEE 488 Electrical interface
7. Single channel analyzer
8. Differential voltmeter
9. Frequency synthesizer – Signal generator
10. Silicon controlled rectifier – characteristics
11. Silicon controlled rectifier – power control

VI. LASER AND FIBRE OPTICS

1. Optical fibre characteristics (Numerical aperture, attenuation and bandwidth)
2. Optical feed back circuit (Feedback factor, gain and frequency response
3. Determination of size of lycopodium particles by Laser diffraction

Reference Books for PHY 305 & PHY 405 :

1. B.L. Worsnop and H.T. Flint – Advanced Practical Physics for students – Methusen & Co (1950)

2. E.V. Smith – Manual of experiments in applied Physics – Butterworth (1970)

3. R.A. Dunlap – Experimental Physics – Modern methods – Oxford University Press (19884. D. Malacara (ed) – Methods of experimental Physics – series of volumes – Academic Press Inc (1988)

4. Experiments in Modern Physics: Mellissinos

SEMESTER IV

DPHY4B15T: ATOMIC AND MOLECULAR SPECTROSCOPY

1. Atomic Spectroscopy: (10 hours Max Marks 20)

Vector Atom model – L S coupling & J J coupling effect of electric & magnetic field on atoms and molecules; Zeeman effect, Paschen Back effect and stark effect

Text: Sections10.1to10.11, 12.1to12.10, 13.1 to13.9, 20.1to 20.8 –Introduction to atomic spectra by H E White

2. Microwave and Infrared spectroscopy: (14 hours Max marks 28)

The spectrum of non rigid rotator, e.g. of HF, spectrum of symmetric top molecule e.g. of CH3Cl, Instrumentation for Microwave Spectroscopy Stark Modulator, Information derived from Rotational Spectrum: I R Spectroscopy: Born –Oppenheimer approximation, Effect of Breakdown of Born Oppenheimer approximation, Normal modes and vibration of H2O and CO2. Instrumentation for I R Spectroscopy – Fourier transformation I R Spectroscopy

Text: Sections 6.6 ,6.7,6.8,6.9 6.11,6.13,6.14 7.1 to 7.71,7.12,7.15,7.16,7.17,7.18 Molecular structure and

Spectroscopy by G.Aruldas

3. Raman Spectroscopy: (12 hours Max marks 24)

Rotational Raman Spectrum of Symmetric top molecules, e.g. of CHCL3 Combined use of Raman & IR Spectroscopy in structure determination e.g. of CO2 and NO3. Instrumentation for Raman Spectroscopy, Non-linear Raman effects, Hyper Raman effect, stimulated Raman effect and Inverse Raman Effect

Text: Sections 8.32, 8.4, 8.5, 8.6, 8.7, 8.10, 15.1, 15.215.3, 15.4 Molecular structure and Spectroscopy by

G.Aruldas

4. Electronic Spectroscopy of molecules: (10 hours Max marks 20)

Vibrational Analysis of band systems, Deslander‟s table, Progressions & sequences, Information Derived from vibrational analysis, Franck Condon Principle. Rotational fine structure and P R and R Branches, fortrat Diagram, Dissociation Energy, Example of Iodine molecule Text: Sections 9.1 to9.9 Molecular structure and Spectroscopy by G.Aruldas

5. Spin Resonance Spectroscopy: (14 hours Max marks 28)

Interaction of nuclear spin and magnetic field, level population Larmour precession, Resonance Conditions, Bloch equations, Relaxation times, Spin-spin and spin lattice relaxation. The chemical shift, Instrumentation for NMR spectroscopy, Electron Spin Spectroscopy of the unpaired e, Total Hamiltonian, Fine structure, Electron Nucleus coupling, and hyperfine spectrum ESR spectrometer. Mossbauer Spectroscopy, Resonance fluroscence of γ-rays, Recoilless emission of γ-rays and Mossbauer effect, Chemical shift, effect of magnetic field. Eg. of Fe57 Experimental techniques, Enough exercises.

Text: Sections 10.1 to 10.9, 11.1 to11.5.4, 13.1 to13.5 Molecular structure and Spectroscopy by G.Aruldas

Text Books:

1. Molecular Structure & Spectroscopy G Aruldas
2. C N Banwell & E.M. Mccash – Fundamentals of Molecular Spectroscopy
3. Atomic Spectroscopy – White

References:

1. Straughan and Walker Spectroscopy Volume I, II and III
2. G.M.Barrow – Introduction to Molecular Spectroscopy
3. H.H. Willard, Instrumental Methods of Analysis,7th Edition , CBS-Publishers, New Delhi.
4. Atomic Spectroscopy –K P Rajappan Nair ,MJP Publishers, Chennai
5. Elements of spectroscopy Gupta &Kumar –Pragati Prakasan ,Meerut

Electives -II

(Any one elective can be chosen from DPHY4E05T - DPHY4E08T)

DPHY4E05T: LASERS AND FIBRE OPTICS

1. Basic Laser Theory and Optical Resonators:

Einstein coefficients, Evaluation of transition rates, Line broadening mechanisms, Laser rate equations for three level system, Cavity Modes, Q of cavity, Q Switching, Mode locking , Confocal Resonator. (16Hrs Max marks32)

2. Types Of Lasers And Applications:

Ruby laser, Helium-Neon laser, Four level solid state lasers, CO_2 lasers Dye lasers, Semiconductor lasers, Spatial frequency filtering and holography, Laser induced fusion, Second Harmonic Generation. (14Hrs Max Marks 28)

3. Optical Fibers:

Introduction, What are optical fibers, Importance, propagation of light in optical fibers, Basic structure, Acceptance angle, Numerical aperture, Stepped index monomode fibers, disadvantages, Graded index monomode fibers, Optical fibers as cylindrical waveguides, Scalar wave equation and the modes of a fiber, Modal analysis for a step index fiber, Single mode fibers.

(15 Hrs Max Marks 30)

4. Fiber Losses:

Attenuation in optical fibers, Absorption losses, Leaky modes, Radiation induced losses, Inherent defect losses, Inverse square losses, Core and cladding losses.

(6 Hrs Max Marks 12)

5. Measurement On Fibers:

Measurement of numerical aperture and its related terms, measurement of fiber attenuation, Insertion loss method and by optical time domain reflectometer, Measurement of refractive index by reflection method and transmitted near field method, Enough exercises.

(9 Hrs Max Marks 18) Books:

1. K.Thyagarajan and Ajoy. K. Ghatak, Lasers : Theory and Application, Macmillan
2. Ajoy Ghatak and K. Thyagarajan, Optical Electronics, Foundation Books (Cambridge University)
3. Subirkumar Sarkar, Optical Fiber and Fiber Optic Communication Systems, S. Chand & Co.
4. Optics and Spectroscopy by R Murugeshan and Kiruthinga Sivaprased, S Chand Publications

Reference Books:

1. William T. Silfast, Laser Fundamentals
2. Ajoy Ghatak and K.Thayagarajan, Introduction to Fiber Optics, Cambridge.
3. John. M.Senior, Optical Fiber Communications: Principles and Practice

DPHY4E06T: ELECTRONIC INSTRUMENTATION

1. Electronic Instrumentation for measuring basic parameters:

Electronic DC voltmeters, DC voltmeter circuit with FET, amplified voltage and current meter, chopper stabilized amplifier, electronic AC voltmeters (average responding, peak responding and true rms responding types), electronic multimeters , differential voltmeters –digital voltmeters (ramp and staircase type), RF millivoltmeter, Q meter (basic circuit and measurement methods, sources of error), bolometer and RF power measurement (12 hours Max Marks 24)

2. Signal generators and Oscilloscopes:

Standard signal generator, laboratory signal generator, AF sine wave and square wave generator, function generator and pulse generator, Block diagram of general purpose CRO, CRT circuits , vertical deflection system , delay line, multiple trace, horizontal deflection system, oscilloscope probes and transducers, oscilloscope technique, storage oscilloscopes, sampling oscilloscopes. (14 hours Max Marks 24)

3. Fibre optic measurements and Transducers:

Sources and detectors, fibre optic power measurement, stabilized light sources, optical time domain reflectometer, Classification of transducers – strain gauges – displacement transducers – temperature measurements – photosensitive devices - Radiation detectors – solid state and scintillation detectors – neutron detectors, ECG and EEG (brain imaging – X ray, CT, MRI and nuclear imaging) (15 hours Max Marks30)

4. Computer controlled test systems:

Testing an audio amplifier – testing a radio receiver – instruments used in computer controlled instrumentation – IEEE 488 electrical interface – digital control – signal timing in a microprocessor based measurement. (9 hours Max Marks18)

5. Power control: SCR

Control of current in rectifiers with an inductive load – triggering control by phase shifting –saturable reactor control – combined d.c. and phase control – on off pulse control of the SCR – SCR supply for d.c. motor – speed regulation by armature voltage and current control -–armature current limiting control of low torque a.c. motors (10 hours Max Marks 20)

Books:

1. Modern Electronic instrumentation and measurement technique – Albert D Helfrick and William D Cooper (Tata Mc Graw Hill) for modules 1, 3, 4 and second part of 2
2. Electronic Instrumentation – Second edition – H.S. Kalsi (Tata Mc Graw Hill) for modules 1 and first part of module 2
3. Principles of Medical electronics and bio medical instrumentation – C Rajarao and S.K. Gupta (Universities Press) for Transducers
4. Bio Instrumentation – John G Webster (Wiley student edition) – for Transducers
5. "Introduction to Experimental Nuclear Physics", Singru,R.M., (Wiley Eastern, 1972). For transducers
6. "Engineering Electronics", 2nd Edition,Ryder, J.D., (McGraw Hill, 1967). for module 5

DPHY4E07T: MATERIALS SCIENCE

1. **Crystal Imperfections**- (6 Hours Max Marks 12)

Point imperfections- The geometry of dislocations- Other properties of dislocations- Surface imperfections

Text book: „ Materials Science and Engineering – A First Course‟ – IV th Edition- V.Raghavan (Prentice-Hall of India- 1988) (Sections: 6.1 to 6.4)

2. **Phase Diagrams & Diffusion In Solids** - (12 Hours Max marks 24)

The phase rule- Single component system- Binary phase diagrams- The Lever rule- Some typical phase diagrams and applications

Text book: „ Materials Science and Engineering – A First Course‟ – IV th Edition- V.Raghavan (Prentice-Hall India- 1988) **(**Sections: 7.1 to 7.7)

Fick's law and solutions- Applications based on the second law solution- The Kirkendall effect- The atomic model of diffusion- Other diffusion processes

Text book: "Materials Science and Engineering – A First Course" – IV th Edition- V.Raghavan (Prentice-Hall of India- 1988) **(**Sections: 8.1 to 8.6)

3. **Plastic Deformation And Fracture Of Materials**-(10 Hours MaxWeightage 9).

The tensile stress- Strain curve- Plastic deformation by slip- Shear strength of perfect and real crystals- The stress to move a dislocation- Dislocation multiplication-Work hardening- The effect of grain size and precipitate particles on dislocation motion- Mechanism of creep.

Text book: " Materials Science and Engineering – A First Course"– IV th Edition- V.Raghavan (Prentice-Hall India- 1988) **(**Sections: 11.1, 11.2, 11.3, 11.4, 11.6,11.7, 11.8, 11.10 & 11.11)

Ductile fracture- Brittle fracture- Fatigue fracture- Methods of protection against fracture.

Text book: „ Materials Science and Engineering – A First Course‟ – IV th Edition- V.Raghavan (Prentice-Hall of India- 1988) **(**Sections: 12.1, 12.2, 12.5 & 12.6

4. **Engineering Materials- (**22 Hours Max marks44)

Giant molecules-Linear polymers- Three dimensional polymers-Deformation of plastics-Electrical behavior of polymers-Stability of polymers

Text book : „Elements of Materials Science‟ –IIIrd Edition – Lawrence H. Van Vlack (Addison- Wesley Publishing Company Inc.1964.) (Sections : 7.1, 7.2, 7.4, 7.5, 7.6 & 7.7)

Ceramic phases- Silicate structures- Glasses- Electromagnetic behavior of ceramics- Mechanical behavior of ceramic materials.

Text book : "Elements of Materials Science" – IIIrd Edition – Lawrence H. Van Vlack (Addison- Wesley Publishing Company Inc. 1964.)(Sections : 8.1, 8.5, 8.6, 8.7 & 8.8) (16 Hours Max marks 32)

Growth techniques of nanomaterials- Top-down Vs.Bottom-up technique-Lithographic process and its limitations- Nonlithographic techniques-Plasma arc discharge-Sputtering-Evaporation-Thermal evaporation- e- beam evaporation – Chemical vapor deposition-Molecular beam epitaxy-Other processes.

Text book : " Introduction to Nanoscience & Technology - K.K.Chathopadhyay, A.N.Banerjee (Prentice-Hall of India -2011.) (Sections 6.2, 6.3, 6.4, 6.4.1, 6.4.2,6.4.3, 6.4.3.1, 6.4.3.2, 6.4.4, 6.4.6 & 6.4.9.)

(6 Hours Max marks 12)

5. **Characterization Of Nanomaterials- (**10 Hours Max Marks 20)

Characterization tools of Nanomaterials-Scanning probe microscopy- Tunnelling current- Local barrier height-Applications of STM- AFM- Scanned –Proximity probe microscopes-Laser beam deflection-AFM cantilevers-piezoceramics-feedback loop-Alternative imaging modes-AFM and biology-Electron microscopy- Resolution vs. magnification-Scanning Electron microscope-SEM techniques-Electron gun-Specimen interactions-Environmental SEM- Transmission electron microscopy-Buckminsterfullerene-Carbon nanotube. Text book : „ Introduction to Nanoscience & Technology ‟-K.K.Chathopadhyay, A.N.Banerjee (Prentice-Hall of India -2011.) (Sections 7.1.2, 7.1.3.1, 7.1.3.2, 7.1.3.5, 7.2.1,7.2.2, 7.2.3, 7.2.4, 7.2.5, 7.2.6, 7.2.7, 7.3.1, 7.3.2, 7.3.3, 7.3.4, 7.3.5, 7.3.6, 7.3.7, 7.4, 8.2.1 & 8.2.2) References:

1. "Solid State Physics"- A.J.Dekker (MacMillan India Ltd.- 1958)
2. "Principles of the Solid State"- H. V.Keer (Wiley Eastern – 1993)
3. "Solid State Physics: Structure and Properties of Materials"- M.A.Wahab (Narosa- 2007).
4. "Materials Science and Processes" – S.K. Hajra Choudhury (Indian Book Publishing Co.- 2009)
5. "Nanotechnology"- Richard Booker, Earl Boysen (Wiley Publishing Inc. 2005).

DPHY4E08T: ASTROPHYSICS

1.Radiative Process:

Theory of Black Body Radiation-Photoelectric Effect-Pressure of Radiation -Absorption and Emission spectra - Doppler Effect - Zeeman Effect- Bremsstrahlung - Synchrotron Radiation - Scattering of Radiation - Compton Effect - and Inverse Compton effect (8 Hours Max marks 16)

Text : Baidyanath Basu, Ch 2

2. Variable stars:

Classification of Variable stars – Cepheid variables – RV Tauri variables - Mira variables – Red Irregular and Semi-regular variables – Beta Canis Majoris Variables–U Geminorum and Flare stars–Theory of Variable stars. (8 hours Max marks 16)

Text : Baidyanath Basu, Ch. 8

3. Galaxies:

The Milkyway galaxy - Kinematics of the Milkyway – Morphology – Galactic Centre – Morphological classification of galaxies – Effects of environment – Galaxy luminosity function – The local group – Surface photometry of galaxies - ellipticals and disk galaxies – Globular cluster systems – Abnormal galaxies-Active galactic nuclei.

(18 Hours Max marks 36)

Text : Binney & Merrifield, Ch.4

4. General Relativity:

General Considerations - Connection Between Gravity and Geometry - Metric Tensor and Gravity - Particle Trajectories in Gravitational field - Physics in curved space-time – Curvature - Properties of Energy and momentum Tensor - Scwarzchild Metric - Gravitational Collapse and BlackHoles – Gravitational Waves. (16Hours Max marks 32)

Text : Padmanabhan, Vol 2, Ch.11

5. Cosmology:

Cosmological Principle - Cosmic Standard Coordinates - Equivalent Coordinates – Robertson-Walker Metric - The Red Shift - Measures of Distance - RedShift Versus Distance Relation - Steady State Cosmology. (10Hours Maxmarks 20)

Text : Narlikar, Sections 3.1-3.8

Books Suggested:

1. Gravitation & Cosmology-Steven Weinberg- John Wiley (1972) ISBN: 0-471-92567-5
2. Theoretical Astro Physics Vol 1 and 2- T. Padmanabhan- Cambridge University Press (2000) ISBN: 0-521-56240-6, 0-521-56241-4
3. Quasars and Active Galactic Nuclei- Ajit K Kembhavi and Jayat V Narlikar-Cambridge University Press (1999) ISBN:0-521-47477-9
4. The Physical Universe, An Introduction to Astronomy-F. Shu-Oxford University Press- (1982) ISBN: 0-19-855706-X
5. A Different Approach to Cosmology - Fred Hoyle, Geoffrey, Jayant V Narlikar Cambridge University Press (2000) ISBN:0-521-66223-0

6. An Introduction to AstroPhysics - Baidyanath Basu- Prentice Hall India (1997) ISBN:81-203-1121-3

7. Discovering the Cosmos-R.C. Bless - University Science Books (1996) - ISBN:0-935702-67-9

8. Text Book of Astronomy and Astrophysics with Elements of Cosmology- V.B. Bhatia- Narosa publications (2001)ISBN:81-7319-339-8

9. Modern Astrophysics - B.W. Carroll & D.A. Ostille - Addison Wesley (1996) ISBN:0-201-54730-9

10. Galactic Astronomy – J. Binney & M. Merrifield, Princeton University Press

11. Galactic Dynamics – J. Binney & S. Tremaine, Princeton University Press

12. An Introduction to Cosmology, Third Edition- J. V. Narlikar, Cambridge University Press (2002)

For further reference:

Astrophysics & Cosmology Video Prof. S. Bharadwaj IIT Kharagpur http://nptel.iitm.ac.in/courses/115105046/

ELECTIVEs -III

(Any one elective can be chosen from DPHY4E09T - DPHY4E12T)

DPHY4E09T: MICROPROCESSORS AND APPLICATIONS

1. Microprocessor, Microcomputer and Assembly Language Programming:

Organization of microcomputers, microprocessor as CPU, Organization and internal architecture of the Intel 8085, instruction set, Assembler Programming. Examples of Assembly Language Programming: Addition, Subtraction of two 8 bit & 16 bit numbers, One's compliment, Two's compliment, Shifting of 8 bit & 16 bit numbers, Square from Lookup table, Largest and Smallest in a data array, sorting of numbers in ascending and descending order, Sum of a series of 8 bit & 16 bit numbers, 8 bit multiplication a nd division,Multi byte addition and subtraction.

(16 hrs Max Marks 32)

Text: 1. Introduction to Microprocessors–A.P. Mathur (Tata-McGraw Hiill).

2. Fundamentals of Microprocessors and Micro Computers"– B. Ram- Dhanapati Rai

2. Microprocessor Timings, Interfacing Memory and I/O Devices :

Timing and control unit, Timings of Intel 8085, Address space partitioning, Memory interfacing, Data transfer schemes, Programmed Data transfer, Direct Memory Access Data

Transfer, Serial data transfer. (12 hrs Max Marks24)

Text: "Introduction to Microprocessors" –A.P. Mathur (Tata-McGraw Hill).

3. Peripheral Devices and Interfacing:

Generation of control signals for memory and I/O devices, Programmable peripheral interface-8255, Programmable DMA controller 8257, Programmable interrupt Controller 8259, Programmable communication interface-8251, Programmable interval timer -8253, Programmable Keyboard/Display interface– 8279.(14 hrs Max Marks 28)

Text 1. Fundamentals of Microprocessors and Micro Computers– B. Ram -Dhanapati Rai

2. Introduction to Microprocessors –A.P. Mathur (Tata-McGraw Hill).

3. Microprocessors – Architecture, Programming and Applications with 8085 - R.S.Gaonkar (Wiley Eastern)

4. Applications of Microprocessors:

Microprocessor based data acquisition system: Analog to Digital converter, Clock for A/D conversion, Sample and Hold circuit, Analog multiplexer, ADC 0800, Digital to Analog Converter, DAC 0800, Realization of A/D Converter using D/A Converter, 7 segment LED displays, decoders/drivers-7448, Interfacing of 7 segment display, Display of decimal and alphanumeric characters, Measurement of frequency, Voltage, Current, Resistance; Temperature measurement and control, Generation of square wave using microprocessor.

(12 hrs Max Marks24)

Text : Fundamentals of Microprocessors and Micro Computers - B. Ram, Dhanapati Rai

5. Micro controllers:

Overview of 8051 microcontroller; Inside 8051; 8051 register and stack, Enough exercises.

(6 hrs Max Marks 12)

Text : 1. Microcontrollers & Embedded systems by Muhammed Ali Mazidi & Janice Guillespie Mazidi (Prentice Hall)

2. Introduction to Microprocessors –A.P. Mathur (Tata-McGraw Hill). Reference Books:

1. Microprocessors – Architecture, Programming and Applications with 8085- R.S.Gaonkar(Wiley Eastern)

2..Microprocessors and programmed logic, Kenneth L. Short (Prentice Hall India).

3. Digital System from Gates to Microprocessors, S.K. Bose (Wiley Eastern)

4. Microprocessors and Microcomputer system design, M. Rafiquazzaman (Universal Book Stall , New Delhi).

5. Microprocessor (8085) and its applications- A.Nagoor Kani (RBA Publications)

DPHY4E10T: PHYSICS OF SEMICONDUCTORS

1. Band structural aspects :

Effects of temperature and electric field on band structure, Frank-Keldysh effect, Localized states of impurities: theoretical models and experimental probes (Capacitive and spectroscopic techniques), optical properties : allowed and forbidden, and phonon assisted transitions and their spectral shapes, Burstein Moss effect, excitons : free and bound excitons. (12 hours Max Marks24)

2. Statistical thermodynamics of carriers:

Fermi level in intrinsic and doped materials, Non stoichiometric semiconductors, role of structural defects, Heavy doping and degeneracy, electrical conductivity, Hall effect – two band model, mobility of carriers, Mechanisms of scattering, measurements of mobility, recombination process, Boltzmann equation for electron transport, equilibrium and non equilibrium processes, effective mass and its measurement, Thermoelectric power, magneto resistivity. (14 hours Max Marks 28)

3. Metal-semiconductor contacts :

Schottky barrier, P-N junctions, theory of carrier transport in p-n junctions, characteristics of practical junctions and deviations from ideality, capacitance effects, space charge and diffusion capacitance, impurity profiling through capacitance measurements, tunnel diode and applications

(12 hours Max Marks 24)

4. Photoconductivity :

Role of traps and recombination, photo voltaic devices for solar cells and radiation detection, luminescence, light emitting diodes and laser action in p-n junction diodes.

(8 hours Max Marks 16)

5. Surface states :

Band bending and effect on bulk properties, Thin film structures, low dimensional semiconductors, Quantum wells, multiple quantum well structures, quantum dot structures, methods of preparation, special characteristics and devices based on quantum wells, Quantum Hall effect, high electron mobility transistor , Enough exercises. (14 hours Max Marks 28)

References :

1. R.A Smith – Semiconductors, Academic Publishers, Calcutta (1989)
2. A.B. Lev – Semiconductors and electron devices, Prentice Hall (1987)
3. M. Shur – Physics of Semiconductor devices, Prentice Hall (1990)
4. S.M. Sze – Physics of Semiconductor devices, Wiley Eastern (1991)
5. W. Schockley – Electrons and Holes in semiconductors, D. Van Nostrand (1950)
6. W.C. Dunlop – An introduction to semiconductors, Wiley (1957)

DPHY4E11T: QUANTUM FIELD THEORY

1. Classical Field Theory :

Harmonic oscillator, The linear chain- classical treatment, the linear chain – quantum treatment, classical field theory, Hamiltonian formalism, Functional derivatives , Canonical quantization of nonrelativistic fields, Lagrangian and Hamiltonian for the Schroedinger field, Quantization of fermions and bosons, Normalization of Fock states (12 hoursMax Marks 24))

Text Book : "Field Quantization" Greiner and Reinhardt (Spinger-Verlag -1996), Sections 1.3 – 1.5, 2.2, 2.3, 3.1 – 3.3, Exercise 3.

2. Canonical quantization of Klein Gordon and photon fields :

The neutral Klein – Gordon field Commutation relation for creation and annihilation operators, Charged Klein – Gordon field, Invariant commutation relations, Scalar Feyman propagator, Canonical quantization of photon field - Maxwells equations, Larangian density for the Maxwell field, Electromagnetic field in the Lorentz gauge, Canonical quantization of the Lorentz gauge – Gupta-Bleuler method, Canonical quantization in the Coulomb gauge (14 hours Max Marks 28)

Text Book : "Field Quantization" Greiner and Reinhardt (Spinger-Verlag -1996), Sections 4.1, 4.2, 4.4, 4.5, 7.1 – 7.4, 7.7

3. Canonical quantization of spin ½ fields :

Lagrangian and Hamiltonian densities for the Dirac field, Canonical quantization of the Dirac field, Plane wave expansion of the field operator, Feyman propagator for the Dirac field (12 hours Max Marks 24) Text Book : "Field Quantization" Greiner and Reinhardt (Spinger-Verlag -1996), Sections 5.1 – 5.4

4. **Interacting quantum fields and Quantum Electrodynamics :**

The interaction picture, Time evolution operator, Scattering matrix, Wick‟s theorem, Feynman rules for QED, Moller scattering and Compton scattering (10 hours Max Marks 20)

Text Book : "Field Quantization" Greiner and Reinhardt (Spinger-Verlag -1996), Sections 8.2 – 8.6, Example 8.4

5. The path integral method :

Path integrals in non-relativistic Quantum Mechanics, Feynman path integral, Multidimensional path integral, Time ordered product and n-point functions, Path integrals for scalar quantum fields, The Euclidian field theory, The Feynman propagator, Generating functional and Green‟s function, Generating functional for interacting fields, Enough exercises.

(12 hours Max Marks 24)

Text Book : "Field Quantization" Greiner and Reinhardt (Spinger-Verlag -1996), Sections 11.2 – 11.5, 12.1 ,12.5

References :

1. "Quantum Field theory", Lewis H. Ryder (Cambridge University Press -1995)
2. "Field Theory – A modern primer" – Pierre Ramond (Bengamin – 1996)
3. "Quantum Field theory", Itzyskon and Zuber (McGraw Hill – 1989)
4. "Quantum Field theory", Karson Huang (Wiley)

DPHY4E12T: ADVANCED CONDENSED MATTER PHYSICS

1. Elementary Excitations in Solids

Interacting electron gas- Hatree Fock approximation; Plasmons and electron plasmon interactions; Linhard equation for dielectric constant of electron gas; Electron Hole interactions-excitons; Block and Wannier representations, Frenkel excitons, Ion-ion interactions,-classical equations of motion- Energy in lattice vibrations;Phonon dispersion relations-density of states Spin-spin interactions-magnons.

(12 hours Max Marks 24)

Text: Introduction to solid state theory O Madlung Springer Ny1978

2. Alloying phenomenon:

Physics of alloy formation-Phase diagrams and alloy formation-Ternary groups and quaternary groups- band structure calculation of alloys superstructures-quantum well structures-super lattices.

(12 hours Max Marks 24)

Text: Semiconductor physics and Devices: S S IslamOxford.

3. **Defects in solids and strength of materials:**

Diffusion in solids, Vacancies, dislocations and mechanical strengths, ionic conductivity etching, photo graphic processes, radiation damage in solids, Fracture, Ductile and brittle fractures, Fracture mechanics, Fatigue, Crack initiation and propagation, Creep, Generalized creep behaviour, Stress and temperature effects.(12 hours Max Marks 24)

Text: Elementary solid state physics, Ali Omar; Pearson and Mechanical properties of matter: AH Cortell, Wiley NY.

4. Nano scale science and technology

Nano materials and Quantum mechanics- quantum dots-Three dimensional Systems(bulk materials)- two dimensional systems(films)-one dimensional systems(quantum wires)-Zero dimensional systems(quantum dots)- Energy levels of quantum dots-nano wires and nano tubessynthesis and applications.(12 hours Max Marks 24)

Text: Nano technology- Principles and fundamentals: Ed G nter ũ
Schmid, Wiley

5. Thin Film Technology and Applications

Thin film Growth process- Nucleation & film growth- Semiconducting thin films-Vapour deposition techniques- Solution deposition techniques- Optoelectronic applications of thin films- Micro electronic applications, Enough exercises.(12 hours Max Marks24)

Texts: Thin film devises and applications: Chpora & I Kaur,
Plenum Press

Thin Film Fundamentals: A Goswami New Age Publishers

Text and Reference books:

1. Solid State Physics: Structure and Properties of Materials by A. M. Wahab (Narosa Publishing House, India) 2nd Edition 2005
2. Elements of Solid State Physics (second Edition) by J. P. Srivatsava (Printice Hall of India) 2001
3. Introductory Solid State physics by H. P. Myers (Taylor & Francis Ltd, London) 2nd Edition 1998
4. Solid State Physics by Ashcroft & Mermin 1st edition 2003
5. Solid State Physics by C. M. Kachhava (Tata McGraw-Hill) 1st Edition 1996
6. Solid State Physics by Kittle (Wiley, 7th Edition) 2004

DPHY4B17P: COMPUTATIONAL PHYSICS

The programs are to be executed in Python. For visualization Pylab/matplotlib may be used. At least ***ten*** *experiments are to be done, opting* *any **five** from **Part A** and another **five** from **Part B**. The Practical examination is of 6 hours duration.*

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Part A

1. Interpolation : To interpolate the value of a function using Lagrange's interpolating polynomial
2. Least square fitting :To obtain the slope and intercept by linear and Non-linear fitting.
3. Evaluation of polynomials. Bessel and Legendre functions: Using the series expansion and recurrence relations.
4. Numerical integration : By using Trapezoidal method and Simpson's method
5. Solution of algebraic and transcendental equations .Newton Raphson method, minimum of a function
6. Solution of algebraic equation by Bisection method
7. Matrix addition, multiplication, trace, transpose and inverse
8. Solution of second order differential equation- Runge Kutta method
9. Monte Carlo method : Determination of the value of π by using random numbers
10. Numerical double integration
11. Solution of parabolic/elliptical partial differential equations
(eg: differential equations for heat and mass transfer in fluids and solids, unsteady behaviour of fluid flow past bodies, Laplace equation etc.,)

Part B

1. To plot the trajectory of a particle moving in a Coulomb field (Rutherford scattering) and to determine the deflection angle as a function of the impact parameter
2. Generate phase space plots - To plot the momentum v/s position plots for the following systems: (i) a conservative case (simple pendulum) (ii) a dissipative case (damped pendulum)
3. Simulation of the wave function for a particle in a box - To plot the wave function and probability density of a particle in a box; Schrödinger equation to be solved and eigen value must be calculated numerically.
4. Simulation of a two slit photon interference experiment: To plot the light intensity as a function of distance along the screen kept at a distance from the two slit arrangement.
5. Trajectory of motion of (a) projectile without air resistance (b) projectile with air resistance
6. Logistic map function – Solution and bifurcation diagram
7. Experiment with Phoenix/expEYES kit - Time constant of RC circuits by curve fitting. *
8. Experiment with Phoenix/expEYES kit - Fourier analysis of different waveforms

captured using the instrument. *(*If Phoenix is not available, data may be given in tabulated form)

9. Simulation of Keplers‟ orbit and verification of Kepler‟s laws.
10. Simulations of small oscillations in simple molecules:: Diatomic molecule/Triatomic molecule for various lengths(any one case)
11. Simulation of random walk in 1D/2D and determination of mean square distance.
12. Simulation of magnetic field - To plot the axial magnetic field v/s distance due to a current loop carrying current.
13. Simulation of the trajectory of a charged particle in a uniform magnetic field.
14. Simulation of polarisation of electromagnetic waves.
15. Simulation of coupled oscillators - Phase space portraits.

Text Books :

1. Computational Physics -An introduction., R.C.Varma, P.K.Ahluwalia and K.C.Sharma, New Age International Publishers

2. Numpy Reference guide, http://docs.scipy.org/doc/numpy/numpy-ref.pdf (also, free resources available on net)

3. Matplotlib , http://matplotlib.sf.net/Matplotlib.pdf (and other free resources available on net)

4. Numerical Methods in Engineering and Science, Dr. B S Grewal, Khanna Publishers, Ne Delhi (or any other book)

5. Numerical Methods, E Balagurusamy, Tata McGraw-Hill

6. Numerical Methods , T Veerarajan, T Ramachandran, Tat MCGraw-Hill

7. Numerical Methods with Programs I BASIC, Fortran & Pascal, S Balachandra Rao, C K Shantha. Universities Press

8. Numerical methods for scientists and engineers, K. Sankara Rao, PHI

9. Introductory methods of numerical analysis, S.S.Shastry , (Prentice Hall of India,1983)

10. Numerical Methods in Engineering with Python by Jaan Kiusalaas

Note: Experiments from Part A can be done with data from physical situations where ever possible. For example consider the following cases.

a) The load W placed on a spring reduces its length L. A set of observations are given below. Calculate force constant and length of the spring before loading

W (kg)	0.28	0.51	0.67	0.93	1.15	1.38	1.60	1.98
L (m)	6.62	5.93	4.46	4.25	3.3	3.15	2.43	1.46

a) The displacements of a particle at different instants are given below. What is the time instant at which the displacement is 70.2 m

T (s)	1.0	2.2	301	4.5	5.8	6.7	7.6	8.3	9.4
s(m)	3.0	10.56	19.07	37.12	59.16	77.38	98.04	115.78	146.6

D). MODEL QUESTION PAPERS

DEPARTMENT OF PHYSICS, ST. JOSEPH'S COLLEGE, DEVAGIRI
M Sc (PHYSICS) EXAMINATION
DPHY1B01T – CLASSICAL MECHANICS

Time: 3:00 hours Maximum Marks: 80

SECTION A (Answer all questions ; 10 × 2 marks = 20 marks)

1. State and explain the principle of least action.
2. Define Poisson's Brackets and obtain the Hamilton's equation of motion in Poisson's bracket form
3. Discuss briefly are Action-Angle variables.
4. Show with suitable example that quantization principle has roots in classical mechanics.
5. What is meant by infinitesimal canonical transformation? Explain how motion of a particle can be described using this.
6. What are limit cycles? Distinguish between stable limit cycle and semi-stable limit cycle.
7. What do you meant by period doubling?
8. What are normal coordinates and normal frequencies
9. Explain stable, unstable equilibria on the basis of potential function
10. What are the Euler equation of motion for a rigid body with a fixed point

SECTION B (Answer any two questions; 2 × 15 marks = 30 marks)

11. Discuss the properties of Poisson's brackets. Show that Poisson's brackets are invariant under canonical transformations.

12. Obtain Hamilton Jacobi equation in Hamilton's Principal function and Hamilton's characteristic function and discuss the separation of variables. Discuss the one dimensional harmonic oscillator problem using H-J equation

13. Derive the secular equation for the vibrations of a linear triatomic molecule. Solve the secular equation to obtain the eigen vectors, highlighting their physical interpretation.

14. Obtain the non-linear equation for a pendulum. Derive the exact solution of the equation in terms of elliptic integral.

SECTION C (Answer any Six questions; 6 × 5 marks = 30 marks)

15. Obtain the Lagranges equation and hence explain the motion of a projectile. (Air resistance may be neglected)

16. Find the values of α and β if the transformations given by $Q = q^{\alpha} \cos \beta p$ and $Q = q^{\alpha} \sin \beta p$ is canonical using Poisson's bracket method.

17. Prove the following:

(a) $[J_x, P_y] = P_z$ (b) $[J_x, P_z] = -P_y$

(c) $[J_y, P_x] = P_y$ (d) $[J_y, P_z] = P_x$

18. Derive the equation for frequency of oscillation of a simple harmonic oscillator using Action-Angle variable method.

19. Using H-J formalism, obtain the equation of motion for a body falling freely under gravity.

20. Find the normal modes of the system with Lagrangian $L = \frac{1}{2}(\dot{x}^2 + \dot{y}^2) - \frac{1}{2}(2x^2 + 2y^2 - 2xy)$

21. Calculate the inertia tensor for the system of four point masses 1g, 2g, 3g and 4g, located at the points (1,0,0), (1,1,0), (1,1,1) and (1,1,-1) cm.

22. Find the horizontal component of the Coriolis force acting on a body of mass 1.5kg moving northward with horizontal velocity of 100 m/s at 30 deg latitude on earth.

23. Show that eigen vectors corresponding to the two distinct eigen frequencies are orthogonal

MODEL QUESTION PAPER

I Semester M. Sc (Physics) Programme

DPHY1B02T – Mathematical Physics

Total Marks: 60 Time: 3 Hours

Section A

Answer all questions, each has 2 marks

1. Express arc length in general orthogonal curvilinear coordinate system.
2. Resolve circular cylindrical unity vectors into cartesian components.
3. Show that Kronecker delta is a second rank mixed tensor.
4. What is a metric tensor? Determine the metric tensor in spherical polar coordinate system.
5. Show that every square matrix can be uniquely expressed as the sum of a hermitian and a skew hermitian matrix.
6. Show that the trace of a matrix is invariant under similarity transformation.
7. Explain the Schmidt orthogonalisation procedure of constructing an orthonormal set of functions from a non orthogonal set.
8. What is a singular point as applied to a differential equation? Explain different types of singular points.
9. Define Γ function. By direct integration show that $\Gamma_{n+1} = n\Gamma_n$.
10. Explain the essential conditions to be satisfied for a function to be expanded in a Fourier series.

Section B

Answer any two questions, each has 15 marks

11. Obtain the expression for gradient and divergence in general curvilinear coordinates. Hence deduce the expression for gradient and divergence in spherical polar coordinates.
12. What are Hermitian and Unitary matrices? Show that the eigenvalues of a Hermitian matrix are real and eigenvectors are orthogonal to each other.
13. Outline the technique of solving partial differential equations by variable separation method. Apply the method to solve three dimensional wave equation in spherical polar coordinates.
14. Establish the orthonormality relation $\int_{-1}^{+1} P_m x P_n x dx = \frac{2\delta_{mn}}{2n+1}$

Section C

Answer any six questions, each has 5 marks

15. Evaluate $\nabla \times (\boldsymbol{r}r^n)$.
16. By successive applications of the *del* operator, obtain the wave equation for the scalar potential.
17. Find the eigen values and the normalized eigen vectors of the matrix $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 1 \\ 0 & 1 & 1 \end{pmatrix}$.
18. The double summation $K_{ij} A_i B_j$ is invariant for any two vectors A_i and B_j. Prove that K_{ij} is a second rank tensor.
19. Deduce the metric for the spherical polar coordinate system.
20. Find the power series solution for the hermite differential equation

    $y'' + 2xy' + 2ny = 0.$
21. Prove the recurrence relation for the Bessel function $J_{(n+1)}(x) + J_{(n-1)}(x) = \frac{2n}{x} J_n(x)$
22. If $L_n(x)$ represents the Laguerre polynomial of order n , prove that

    $$\int_0^\infty e^{-x} L_m(x) L_n(x) dx = \delta_{mn}$$
23. Using Fourier sine and cosine transform, evaluate

    a) $\int_0^\infty \frac{\cos nx}{a^2+b^2} dx$ and b) $\int_0^\infty \frac{n \sin nx}{a^2+n^2} dx$

DEPARTMENT OF PHYSICS, ST. JOSEPH'S COLLEGE, DEVAGIRI
M Sc (PHYSICS) EXAMINATION
DPHY1B04T – ELECTRONICS

Time: 3:00 hours Maximum Marks: 80

SECTION A (Answer all questions ; 10 × 2 marks = 20 marks)

1. Draw the structure of a P-channel enhancement type MOSFET. Show its symbol. What are its advantages over JFET
2. Explain the design and working of a MOSFET NOR circuit.
3. Discuss the action of the memory cell used in RAM.
4. What is race around condition in flip-flops? How it is solved in MS JK flip-flops
5. Explain the importance of Karnaugh map..
6. Draw the basic OPAMP integrator circuit and show that the circuit is able to perform analog integration.
7. Bring out the idea of virtual ground in relation to OP-AMP circuits.
8. Distingush between active and passive trasducers . Give examples.
9. What is transferred electron effect? How does this effect lead to negative differential resistivity?
10. Discuss the light dependence of resistance in LDRs. Construct a circuit showing the application of LDR

SECTION B (Answer any two questions; 2 × 15 marks = 30 marks)

11. (a)Briefly sketch the working of an n-channel JFET. (b) Draw the circuit diagram of common source FET amplifier with unby-passed source resistance and explain. (c) Draw the low frequency small signal FET equivalent circuit and obtain expressions for the voltage gain and output resistance.

12. (a)What are the different registers in INTEL 8085 microprocessor? Explain their functions. (b) With a block diagram, explain the architecture of INTEL 8085 microprocessor.
13. Discuss the tunnel diode operation on the basis of energy band diagrams for different biasing conditions. Explain the nature of the I - V characteristics. Give a brief account of any one application.
14. Discuss the design, working and circuit analysis of an emitter coupled differential amplifier.

SECTION C (Answer any Six questions; 6 × 5 marks = 30 marks)

15. An FET with rd =50 K , Rs = 2 K and gm =2500 A/V is used in a common drain circuit shown in figure. Calculate the voltage gain and output impedance of the circuit.
16. Calculate the photon current and carrier transit time for a photoconductor from the followingdata. Quantum efficiency = 75%, number of photons reaching per second = 1010, mobility = 3000 cm2 /V-s,effective electric field = 5 KV/cm, L = 10µm, carrier life time 0.7 ns.
17. A Truth table has output 1s for these inputs: A B C D= 0 0 1 1 , A B C D= 0 1 1 0 , A B C D= 1 0 0 0 , A B C D= 1 1 0 0 , Draw the Karnaugh map . Using the map,find the simplified Boolean equation for the truth table and the logic circuit.
18. Draw the logic diagram of Mod 6 counter with 000 and 001 as omitted states. Write down the Truth table and show the timing diagram.
19. Calculate the gain at 2KHz and cut-off frequency of a first order high pass filter shown in the figure. Sketch the nature of the frequency response curve. How do you convert it into a second order filter? What would be the nature of the curve?
20. A MOSFET has a drain-circuit resistance Rd of 120 K and Operates at 10 KHz . Calculate the Voltage gain of this device as a single-stage transistor amplifier. The MOSFET parameters are gm = 1.5 mA/V ; rd = 47K ; Cgs = 3pf ; Cds = 1 pf and Cgd = 2.4 pf

21. A resistance strain gage with a gage factor of 2.4 is mounted on asteel beam whose modulus of elasticity is $2x10^6$ kg/cm^2. The strain gage has an unstrained resistance of 120 Ω which increses to 120.1Ω when the beam is subjected to a stress. Calculate the stress at the point where the strain gage is mounted.
22. Design a second order Butterworth low pass filter with a -3dBfrequency of 125 Hz and a pass band gain of unity.
23. Determine the output voltage of an op amp for input voltages of v_1=200µV and v_2= 140µV. The amplifier has a differential gain Ad=6000 and the value of CMRR is a) 200 and b) 10^5.