KANNUR UNIVERSITY

(Abstract)

M.Sc. Physics (Advanced Materials) Programme under Choice Based Credit Semester System in the University Department– Revised Scheme, Syllabus & Model Question Papers Implemented with effect from 2015 admission- Orders issued.

ACADEMIC 'C'SECTION

U.O. No.Acad/C4/ 11250/2014 Civil Station P.O, Dated, 31 -10-2015

Read: 1. U.O No.Acad/C3/2049/2009 dated 11.10.2010.
2. U.O No.Acad/C3/2049/2009 dated 05.04.2011.
3. Meeting of the Syndicate Sub-Committee held on 16.01.2015.
4. Meeting of the Curriculum Committee held on 10.04.2015.
5. Meeting of the Department Council held on 16.04.2015.
6. U.O No. Acad/C4/14536/2014 dated 29.05.2015.
7. Letter from the HOD, Dept. of Physics, Payyannur Campus
8. Meeting of the Curriculum Committee held on 03.09.2015.

ORDER

1.The Regulations for Post Graduate Programmes under Choice Based Credit Semester System were implemented in the Schools/Departments of the University with effect from 2010 admission as per the paper read (1) above and certain modifications were effected to the same vide paper read (2).

2. The meeting of the Syndicate Sub-Committee recommended to revise the Scheme and Syllabus of all the Post Graduate Programmes in the University Schools/Departments under Choice Based Credit Semester System (CCSS) with effect from 2015 admission vide paper read (3) above.

3. As per the paper read (4) above, the meeting of the Curriculum Committee recommended certain modifications/ additions to the Regulations for Post Graduate Programmes under Choice Based Credit Semester System and the Regulations were modified in the University w.e.f. 2015 admission vide paper read (6).

4. The Department Council vide paper read (5) above has approved the Scheme, Syllabus & Model Question Papers for M.Sc. Physics (Advanced Materials) Programme under Choice Based Credit Semester System(CCSS) for implementation with effect from 2015 admission.

5. The HOD, Dept. of Physics vide paper read (7) above, has forwarded the Scheme, Syllabus & Model Question Papers for M.Sc. Physics (Advanced Materials) Programme in line with the revised Regulations for Choice Based Credit Semester System for implementation with effect from 2015 admission.

P.T.O.

6. The meeting of the Curriculum Committee held on 03.09.2015 approved the Scheme; Syllabus & Model Question Papers for M.Sc. Physics (Advanced Materials) Programme under Choice Based Credit Semester System in the Department vide paper read (8)

7. The Vice Chancellor after considering the matter in detail, and in exercise of the powers of the Academic Council conferred under section 11(1) of KU Act 1996, and all other enabling provisions read together with, has accorded sanction to implement the Scheme, Syllabus & Model Question Papers for M.Sc. Physics (Advanced Materials) Programme under Choice Based Credit Semester System, offered in the University Department, w.e.f 2015 admission, subject to report to the Academic Council.

8. Orders are, therefore, issued accordingly.

9. The revised Scheme, Syllabus and Model Question Papers of M.Sc. Physics (Advanced Materials) effective from 2015 admission are appended.

JOINT REGISTRAR (ACADEMIC)
FOR REGISTRAR

To

The HOD, Department of Physics
Payyannur Campus, Payyannur

Copy To:

1. The Examination Branch (through PA to CE)
2. PS to VC/PA to PVC/PA to R/PA to CE/PA to FO
3. JR/AR I Academic
4. The Computer Programmer *(for uploading in the website)*
5. SF/DF/FC

Forwarded/By Order

SECTION OFFICER

KANNUR UNIVERSITY
CIVIL STATION P.O.
KANNUR
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THAVAKKARA

For more details: log on www.kannur university .ac.in

KANNUR UNIVERSITY

Regulation, Scheme and Syllabus

for

M Sc PROGRAMME

in

PHYSICS

(Advanced Materials)

Choice Based Credit Semester System
w.e.f 2015 Admission

KANNUR UNIVERSITY

School of Pure and Applied Physics

Scheme and Syllabus for

M. Sc. Physics (Advanced Materials) Programme (CCSS)

for the University Physics Department w.e.f. 2015 admission onwards

Eligibility for Admission:

Candidates who have passed and secured at least 55% marks in Physics (Main) in the B Sc Degree Examination with Mathematics as a subsidiary subject of this University or an equivalent examination of any other University are eligible for admission to M Sc Physics (Advanced Materials) programme of Kannur University. Regulation regarding the reservation of seats shall be as per rules framed by the Government/University from time to time. Candidates, who have passed their qualifying examination from Universities outside Kerala and those who passed their degrees with different nomenclature from the Universities within Kerala, should submit Recognition/Equivalency Certificate while seeking admission. The Recognition/Equivalency should be insisted based on the regulation of the Courses/Programmes for which the admission is sought.

Admission procedure:

Every year, Kannur University will publish the admission notification. Accordingly, filled-up application with sufficient documents and fee may be submitted to the Department. Eligible candidates have to appear for an entrance examination conducted by the Department of Physics. Admission to the Programme shall be based on the marks obtained in the entrance test conducted by the Department of Physics.

Duration of the programme:

The duration of the M. Sc. Physics (Advanced Materials) programme (CCSS) shall be **2 (two)** years. This programme consists of **17 (seventeen)** theory courses, **3 (three)** lab courses, **1(one)** study tour and **1 (one)** project spread over **4 (four)** semesters. A student can earn **20 (twenty)** credits in 1st, 2nd, 4th semester and **22 (twenty two)** credit in 3rd semester and total **82 (eighty two)** credits in four semesters. Indirect grading pattern with **40%** internal and **60%** external marks will be followed. The course structure is as follows:

Theory Courses: There are seventeen theory courses - each with 4 credits except for the two core courses in the third semester - spread over four semesters in the M. Sc. programme. The distribution of the theory courses is as follows: There are **14** (fourteen) **core** courses and **3** (three) **elective** courses in the programme. Semester I, Semester II and Semester III will have **4** (four) core courses and Semester IV will have **2** (two) core courses. **1** (one) elective course will come in Semester III and **2** (two) will come in Semester IV.

Practical Courses: The first three semesters will have a course on laboratory practical. Each course has a credit of **4** (four). A minimum of **16** (sixteen) experiments should be done and recorded in each semester. The practical examination will be conducted at the end of each semester at the Department by two examiners (one internal and the other external). The duration of the examination will be **6** (six) **hours**.

Project: In the fourth semester there will be a project of credit **4** (four). The project should be very relevant and innovative in nature. It should be aimed to motivate the inquisitive and research aptitude of the students. The type of the project can be decided by the student and the guide (a faculty of the Department or other Department/University/Institution). For the conduction of the project work sufficient span of time will be allotted for the students and its evaluation will be scheduled at the end of the fourth semester. The project will be evaluated by two examiners. The distribution of credits is as follows: 2 for the report and 2 for the presentation of project work done and comprehensive viva-voce.

The courses in various semesters and the detailed syllabus of the programme are given below.

COURSES IN VARIOUS SEMESTERS

SEMESTER I (20C)

PHY C 101: MATHEMATICAL PHYSICS I (4C)

PHY C 102: CLASSICAL MECHANICS (4C)

PHY C 103: SOLID STATE PHYSICS (4C)

PHY C 104: ELECTRONICS (4C)

PHY P 105: PRCTICAL I – ELECTRONICS AND COMPUTER PROGRAMMING (4C)

SEMESTER II (20C)

PHY C 201: MATHEMATICAL PHYSICS II (4C)

PHY C 202: QUANTUM MECHANICS I (4C)

PHY C 203: STATISTICAL MECHANICS (4C)

PHY C 204: ELECTROMAGNETIC THEORY (4C)

PHY P 205: PRACTICAL II – GENERAL PHYSICS (4C)

SEMESTER III (22C)

PHY C 301: QUANTUM MECHANICS II (4C)

PHY C 302: NUCLEAR PHYSICS (4C)

PHY C 303: OPTICS (2C)

PHY C 304: EXPERIMENTAL TECHNIQUES (2C)

PHY E 305: ELECTIVE I (4C)

PHY P 306: PRACTICAL III – MODERN PHYSICS (4C)

PHY C 307: STUDY TOUR REPORT (2C)

SEMESTER IV (20C)

PHY C 401: ATOMIC AND MOLECULAR SPECTROSCOPY (4C)

PHY C 402: PARTICLE AND ASTROPHYSICS (4C)

PHY E 403: ELECTIVE II (4C)

PHY E 404: ELECTIVE III (4C)

PHY C 405: PROJECT (4C)

LIST OF ELECTIVE PAPERS

Sl.No.	Name of the elective paper
1	SEMICONDUCTING MATERIALS AND DEVICES
2	POLYMERIC MATERIALS
3	THIN FILM TECHNOLOGY
4	PHOTOVOLTAIC ENERGY CONVERSION
5	CERAMIC MATERIALS
6	CONDENSED MATTER PHYSICS
7	COMPOSITE MATERIALS

Attendance:

The minimum attendance required for each course shall be 75% of the total number of classes conducted for that semester. Those who secure the minimum attendance in a semester alone will be allowed to register for the End Semester Examination.

THE MARKS AND CREDITS FOR VARIOUS COURSES

Course Code	Title of the Course	Contact Hours/Week			Marks			Credits
		L	T/S	P	CE	ESE	Total	
Semester I								
PHY C 101	Mathematical Physics I	4	1	-	40	60	100	4
PHY C 102	Classical Mechanics	4	1	-	40	60	100	4
PHY C 103	Solid State Physics	4	1	-	40	60	100	4
PHY C 104	Electronics	4	1	-	40	60	100	4
PHY P 105	Practical I – Electronics and Computer Programming	-	-	10	40	60	100	4
Total for Semester I					**200**	**300**	**500**	**20**
Semester II								
PHY C 201	Mathematical Physics II	4	1	-	40	60	100	4
PHY C 202	Quantum Mechanics I	4	1	-	40	60	100	4
PHY C 203	Statistical Mechanics	4	1	-	40	60	100	4
PHY C 204	Electromagnetic Theory	4	1	-	40	60	100	4
PHY P 205	Practical II – General Physics	-	-	10	40	60	100	4
Total for Semester II					**200**	**300**	**500**	**20**

Course Code	Title of the Course	Contact Hours/Week			Marks			Credits
		L	T/S	P	CE	ESE	Total	
Semester III								
PHY C 301	Quantum Mechanics II	4	1	-	40	60	100	4
PHY C 302	Nuclear Physics	4	1	-	40	60	100	4
PHY C 303	Optics	2	1	-	20	30	50	2
PHY C 304	Experimental Techniques	2		-	20	30	50	2
PHY E 305	Elective - I	4	1	-	40	60	100	4
PHY P 306	Practical III – Modern Physics	-	-	10	40	60	100	4
PHY C 307	# Study Tour Report	-	-	-	100	-	100	2
Total for Semester III					**300**	**300**	**600**	**22**
Semester IV								
PHY C 401	Atomic and Molecular Spectroscopy	4	1	-	40	60	100	4
PHY C 402	Particle and Astrophysics	4	1	-	40	60	100	4
PHY E 403	Elective - II	4	1	-	40	60	100	4
PHY E 404	Elective - III	4	1	-	40	60	100	4
PHY C 405	Project	-	-	10	-	200	200	4
Total for Semester IV					**160**	**440**	**600**	**20**
Grand Total					**860**	**1340**	**2200**	**82**

Note: - PHY–Physics, C–Core Course, E–Elective Course, L–Lecture, T–Tutorial, S-Seminar and P–Practical

 # Those who could not participate in the study tour will lose marks, but the result will not be withheld.

OPEN COURSE

Course Code	Title of the Course	Contact Hours/Week			Marks			Credits
		L	T/S	P	CE	ESE	Total	
Semester III								
PHY O 309	Acoustics and Optics	3	-	-	20	30	50	3

Note: - PHY–Physics, O–Open Course, L–Lecture, T–Tutorial, S-Seminar and P–Practical

DETAILS OF GRADING SCHEME

1. An alphabetical Grading System is adopted for the assessment of a student's performance in the Course. The grade is based on a 6 point scale. The following table gives the range of marks, grade points and alphabetical grade.

Range of Marks	Grade Points	Alphabetical Grade
90 – 100	9	A+
80 – 89	8	A
70 – 79	7	B+
60 – 69	6	B
50 – 59	5	C
Below 50	0	F (Failed)

2. A minimum of grade point 5 (Grade C) is needed for the successful completion of a course.

3. Minimum credit to be fulfilled for the successful completion of the programme is 80 credits.
4. Performance of a student at the end of each Semester is indicated by the Grade Point Average (GPA) and is calculated by taking the weighted average of grade point of the Courses successfully completed. Following formula is used for the calculation. The average will be rounded off to two decimal places.

$$GPA = \frac{\text{Sum of (Grade Points in a Course Multiplied by its Credit)}}{\text{Sum of credits of Courses}}$$

5. The overall performance of a student is indicated by the Cumulative Grade Point Average (CGPA) and is calculated using the same formula given above.
6. Empirical formula for calculating the percentage of marks will be **CGPA×10+5**.
7. Based on the CGPA, the overall grade of the student shall be in the following way.

CGPA	Overall Letter Grade	Classification of Grade
8.5 and above	A+	First Class with Distinction
7.5 and above but less than 8.5	A	
6.5 and above but less than 7.5	B+	First Class
5.5 and above but less than 6.5	B	
4.5 and above but less than 5.5	C	Second Class

In the case of any inconsistency between the implemented regulations of Choice based Credit Semester system and its application to PG Programme in Physics (Advanced Materials) offered in the University Department, the former shall prevail.

DETAILED SYLLABUS

SEMESTER I

PHY C 101 MATHEMATICAL PHYSICS I

MODULE I

Vectors: Rotation of Coordinates – Orthogonal Curvilinear Coordinates: Rectangular Cartesian, Circular Cylindrical and Spherical Polar Coordinates – Differential Vector Operators in Different Coordinate Systems (Gradient, Divergence, Curl & Laplacian Operators) – Laplace's equation – application to electrostatic field and wave equations.

MODULE II

Homogeneous and Inhomogeneous Linear Equations – Matrices: Basic Properties (Review only) – Orthogonal, Hermitian and Unitary Matrices – Diagonalization of Matrices – Simultaneous Diagonalization – Definition of Tensors – Contraction – Direct Product – Quotient rule – Pseudo Tensors – Metric Tensors – Dual tensors – Irreducible tensors – Kronecker Delta and Levi-Civita Tensors.

MODULE III

Function of Complex Variables: Introduction – Analytic Function – Cauchy-Riemann Conditions – Cauchy Integral Theorem: Contour Integrals – Stoke's Theorem Proof – Multiply Connected Regions – Cauchy Integral Formula – Laurent Expansion: Taylor Expansion and Laurent Series – Singularities – Calculus of Residues and Applications.

MODULE IV

Frobeneus Method for Solving Second Order Ordinary Differential Equations with Variable Coefficients – Second Solution – Self-Adjoint Differential Equations – eigen functions and values, Boundary conditions, Hermitian operators and their properties, Schmidt orthogonalization, Completeness of functions – Special Functions: Gamma Function, Beta Function, Bessel Functions of First and Second Kinds: Generating Function, Recurrence Relations, Orthogonality, Neumann Function – Legendre Polynomials: Generating Function, Recurrence Relations, Rodrigue’s Formula, Orthogonality – Associated Legendre Polynomials – Spherical Harmonics – Hermite Polynomials – Laguerre Polynomials.

Textbooks:

1. Arfken G.B and Weber H.J., Mathematical Methods for Physicists, Prism Books.
2. P. K. Chattopadhyaya, Mathematical Physics, New Age International.

References:

1. L. I. Pipes and L. R. Harvill, Applied Mathematics for Physicists and Engineers, McGraw Hill.
2. Sathyaprakash, Mathematical Physics, S. Chand & Co.
3. R. Courant and D. Hilbert, Methods of Mathematical Physics, Wiley Eastern.

PHY C 102 CLASSICAL MECHANICS

MODULE I

Constraints and Generalized Coordinates – D' Alembert's Principle and Lagrange's Equations – Velocity Dependent Potentials – Simple Applications – Hamilton's Principle – Elementary Idea of Calculus of Variation – Euler-Lagrange Equation – Lagrange's Equation from Hamilton's Principle – Hamiltonian Function – Central Force Problem – Scattering in a central force field – Equivalent One Dimensional Problem and Classification of Orbits – The Kepler Problem.

Small Oscillations – Formulation of the Problem – Eigen Value Equation – Normal Coordinates – Free Vibrations of a Linear Triatomic Molecule.

MODULE II

Configuration Space and Phase Space – Legendre Transformation – Hamilton's Canonical Equations – Principle of Least Action – Applications of Hamilton's Equations: Two dimensional Isotropic Harmonic Oscillator and Charged Particle in an Electromagnetic Field – Canonical Transformations – Examples – Infinitesimal Canonical Transformation – Poisson Brackets: Properties – Equation of Motion in Poisson Bracket Form – Angular Momentum Poisson Bracket Relations.

MODULE III

Hamilton Jacobi Equation for Hamilton's Principal Function and Hamilton's Characteristic Function – Harmonic Oscillator Problem – Action Angle Variables – Hamilton Jacobi Formulation of Kepler Problem – Hamilton Jacobi Equation and Schrodinger Equation.

MODULE IV

Space Fixed and Body Fixed Systems of Coordinates – Description of Rigid Body Motion – Direction Cosines – Euler Angles – Infinitesimal Rotations – Rate of Change of a Vector – Centrifugal and Coriolis Forces – Moment of Inertia Tensor – Euler's Equation of Motion.

Text Books:

1. Goldstein, Classical Mechanics, Pearson Education.

References:

1. N. C. Rana and P. S. Joag, Classical Mechanics, Tata McGraw Hill.
2. R. G. Takwale and P. S. Puranic, Introduction to Classical Mechanics, TMH.
3. V. B. Bhatia, Classical Mechanics, Narosa Publishers.
4. A .J. Griffith, Classical Mechanics, McGraw Hill.
5. Kiran C. Guptha, Classical Mechanics of Particles and Rigid Bodies, New Age International.

PHY C 103 SOLID STATE PHYSICS

MODULE I

Periodic Arrays of Atoms – Symmetry elements of a crystal, Types of space lattices, Miller indices, Diamond Structure, NaCI Structure, BCC, FCC, HCP structures with examples_– Fundamental Types of Lattices – Index System for Crystal Planes – Simple Crystal Structures – Crystal Binding – Elementary Ideas of Point Defects and Dislocations – Generation and Absorption of X-rays – Diffraction of Waves by Crystals – Reciprocal Lattice – Scattered Wave Amplitude – Brillouin Zones – Fourier Analysis of the Basis – Structure Factor – Atomic From Factor – Vander Waals interaction, Cohesive energy of inert gas crystals, Madelung interaction, Cohesive energy of ionic crystals, Covalent bonding, Metallic bonding, Hydrogen - bonded crystals.

MODULE II

Vibration of Monatomic and Diatomic Linear Lattices – Quantization of Elastic Waves – Phonon Momentum – Phonon Heat Capacity – Density of States in One and Three Dimensions – Einstein and Debye Models of specific heat – Free Electron Gas – Drude-Lorentz Theory – Electrical Resistivity verses Temperature – Free Electron Gas in Three Dimension – Fermi Statistics and Fermi Dirac Distribution – Heat Capacity of the Free Electron Gas – Electrical Conductivity – Hall Effect.

MODULE III

Energy Spectra of Atoms, Molecules and Solids – Free Electron Model and Origin of Energy Gap – Bloch Theorem – Kronig-Penney Model – Equation of Motion of Electrons in Energy Bands – Holes – Effective Mass – Intrinsic Carrier Concentration in Conduction Band and Valance Band – Impurity Conductivity – Donor States – Acceptor States.

MODULE IV

Superconductivity: Experimental Survey – Occurrence – Meissner Effect – Heat Capacity – Energy gap – Isotope Effect – Theoretical Survey – Thermodynamics of the Superconducting Transition – London Equation – Coherence Length – BCS Theory of Superconductivity (qualitative only) – Tunneling – The Josephson Effect.

Diamagnetism: Langevin Equation – Quantum Theory of Paramagnetism – Paramagnetic Susceptibility of Conduction Electrons – Ferromagnetic Order: Curie Point and the Exchange Integral – Magnons – Ferromagnetism – Antiferromagnetism – Neel's Model of Antiferromagnetism and Ferrimagnetism, Spinwaves – Elementary Ideas of Piezo, Pyro and Ferro Electricity.

Text Books:

1. C. Kittel, Introduction to Solid State Physics, John Willey.
2. A. J. Dekker, Solid State Physics, Addison Wesley Macmillan.

References:

1. Omar M. A., Elementary Solid State Physics, Addison Wesley.
2. Wahab, Solid State Physics, Narosa Publications.
3. Asaroff V., Introduction to Solids, TMH.

PHY C 104 ELECTRONICS

MODULE I

Introduction to Operational Amplifiers – Equivalent Circuit – Ideal Characteristics – Inverting and Non-inverting Operational Amplifiers – Op-Amp Parameters – Concept of Virtual Ground – Voltage Gain – General Description of Various Stages in Op-Amp – Awareness of Type 741 Op-Amp – Frequency Response of Op- Amp – Open Loop and Closed Loop Frequency Response – General Idea of Frequency Compensation – Slew Rate and Slew Rate Equation.

MODULE II

Linear Applications of Op-Amp: Summing, Averaging and Scaling Amplifiers in the Inverting Mode – Summing and Averaging Amplifiers in the Non-Inverting Mode – Voltage to Current and Current to Voltage Converters – Integrator and Differentiator.

Non Linear Op-Amp Circuits: Voltage Comparators – Schmitt Trigger – Logarithmic Amplifiers – Square Wave, Saw Tooth Wave and Triangular Wave Generators.

Filters: Introduction and General Characteristics – Active Filters and their Designing: First Order and Second Order Low-Pass, High-Pass, Band-Pass, Band-Reject and All Pass Filters.

MODULE III

Multiplexer and Demultiplexer – Applications of Multiplexers

Flip Flops and Timing Circuits – Registers: Different Types of Registers and Applications of Shift Registers – Counters: Synchronous Counters, Asynchronous Counters, Decade Counters and Mod 8 Ripple Counter- A/D and D/A Converters: R-2R Ladder and Successive Approximation Type ADC.

MODULE IV

Microprocessors – Microcomputers – 8085 Microprocessor – Various Operations of Microprocessors – Microprocessor Communication and Bus Timing – 8085 Bus Structure – Pin Diagram of 8085 MPU.

Text books:

1. K. R. Botker, Integrated Circuits, Khanna Publishers.

2. Ramakant A. Gayakward, Op-Amps and Linear Integrated Circuits, Pearson Education.
3. Jacob Millman & Chritos C. Halkias, Integrated Electronics, McGraw Hill.
4. Ramesh Goankar, Microprocessor Architecture, Programming and Application with the 8085, Penram International Publishing Company.
5. Malvino & Leach, Digital Principles and Applications, TMH.

References:

1. A. Anandkumar, Fundamentals of Digital Circuits, Prentice Hall of India.
2. T. L. Floyd, Digital Fundamentals, Prentice Hall.
3. Teaodare F. Bograt Jr., Introduction to Digital Circuits, McGraw Hill.

PHY P 105 PRATICAL I - ELECTRONICS AND COMPUTER PROGRAMMING

(At least 16 experiments should be done; 8 from each part)

List of Experiments:

Part I:

1. FET Characteristics – To determine the characteristics of a JFET and the transistor parameters.
2. Voltage regulation using transistors with feedback (Regulation characteristic with load for different input voltages)
3. Characteristics of silicon controlled rectifier (half wave and full wave).
4. Two stage RC coupled amplifier (I/O resistance with and without feedback).
5. Negative feedback amplifier (I/O resistance with and without feedback).
6. RC coupled FET amplifier – Common source (frequency response & I/O resistance).
7. Differential amplifier using transistors (Frequency response and CMRR).
8. Amplitude modulation and detection using transistors (modulation index and recovery of modulating signal).
9. Darlington pair amplifier (gain, frequency response and I/O resistance)
10. Wein bridge oscillator using OPAMP (for different frequency distortions due to feedback resistance).
11. Saw tooth generator using transistors (for different frequencies)
12. Miller sweep circuits using OPAMP (for different frequencies)
13. IC 741 Inverting and Non-inverting amplifiers.
14. Schmitt trigger using OPAMP (Trace hysteresis curve, Determination of LTP and UTP).
15. Schmitt trigger using Transistor (Trace hysteresis curve, Determination of LTP and UTP).
16. OPAMP analog simulation and computation – To integrate the given second order differential equation.

17. OPAMP- Analog integration and differentiation (bode plot).
18. OPAMP- Low pass, High pass and band pass filters – frequency response curve.
19. Complementary symmetry amplifier – frequency response, I/O resistance.
20. Binary adders – HA and FA using Nand gates
21. D/A Converter - a) Binary weighted resistors b) R-2R ladder (Four bit or more) – To verify output for different digital inputs.
22. Study of flip-flops (RS and JK using 7400 IC) – To verify the truth tables.
23. IC 555 timer – Astable and Monostable multivibrators.
24. IC555 timers – Bistable multivibrators.
25. IC 555 timer – VCO and Saw tooth wave generators.

Part II:

(C language or Java or both of them can be used for doing the experiments)

1. Write a program for studying the variation of magnetic field along the axis of a coil
2. Write a program to generate random numbers using mid square method and to simulate random walk using these random numbers.
3. Write a program for generating square wave, triangular wave and saw tooth wave using Fourier technique.
4. Write a program to find the roots of non linear equation by Newton-Raphson method.
5. Write a program to interpolate the value of a function using Lagrange's interpolating polynomials.
6. Write programs for numerical integration by using Trapezoidal and Simpson's methods.
7. Write a program to perform matrix addition, subtraction and multiplication and to find the trace and transpose of a matrix.
8. Write a program to find the Taylor series expansion of the given function.
9. Write a program to find the solutions of first order differential equation using Runge-Kutta method.

10. Write a program to plot the Maxwell-Boltzmann distribution and to prove the equipartition theorem.
11. Write a program to plot Bose-Einstein distribution and to prove the Stefan-Boltzmann law and Wein's displacement law.
12. Write a program to plot Fermi-Dirac distribution.
13. Write a program to draw i-d and i_1-i_2 curve for 80^0, 60^0, 45^0 and 10^0 prisms using equations by assuming refractive index.
14. Write a program to simulate the charged particle in an electromagnetic field.
15. Write a program for least square method for curve fitting.
16. Write a program to study the resonance in an LCR circuit.
17. Write a program to study the trajectory of an ion in Cyclotron Accelerator.
18. Write a program to study the barrier penetration (wave function outside and inside a barrier)
19. Write a program to plot the trajectory of a particle undergoing random motion in one and two dimensions.
20. Write a program to plot momentum versus position for the following systems (i) damped (ii) undamped oscillations

References:

1. Paul B. Zbar and Malvine A. P., Basic Electronics, Tata McGraw Hill.
2. Begrat R. Brown J., Experiments for Electronic Devices and Circuits, Merill International Series.
3. Buchla, Digital Experiments, Merill International Series.
4. Jain R.P. and Anand M.M.S., Digital Electronics Practice Using ICs, Tata McGraw Hill.
5. Subramanian V. S., Experiments in Electronics, McMillan.

6. Poorna Chandra Rao and Sasikala B., Hand Book of Experiments in Electronics and Communication Engineering.
7. Balagurusamy E, Programming in ANSI C, Tata McGraw Hill.
8. Yashavant Kanetkar, Let Us C, BPB Publications.
9. Balagurusamy E,Numerical Methods, Tata McGraw-Hill

SEMESTER II

PHY C 201 MATHEMATICAL PHYSICS II

MODULE I

Fourier Series – Introduction and Problems – Integral Transforms – Properties – Fourier Transform and Properties – Fourier Transform of Derivatives – Convolution Theorem –Laplace Transform and Properties – Laplace Transform of Derivatives – Convolution Theorem – Inverse Laplace Transform – Convolution Theorem.

MODULE II

Integral Equations: Transformation of a Differential Equation into an Integral Equation – Integral Transforms and Generating Functions – Neumann Series – Separable Kernal Method – Hillbert-Schmidt Theory.

Green's function: Properties – One Dimensional Green's Function – Problems – Eigen Function Expansion.

MODULE III

Groups: General Properties – Multiplication Table – Consequences – Symmetry Group of Square and Triangle – Permutation Group – Subgroups – Conjugate Elements and Classes – Direct Product Groups – Isomorphism and Homomorphism – Cyclic Group – Factor Group – Representation of a Group – Types of Representation – Schur's Lemmas – Orthogonality Theorem and Proof – Geometrical Interpretation – Character of a Representation – Character Table – Basic Ideas of Continuous Groups – SU(2) and SU(3) Groups.

MODULE IV

Chaos: Introduction – Logistic map – Critical Points and Bifurcations – Feigenbaum Number – Fractals – Examples.

Text books:

1. Arfken G. B and Weber H. J., Mathematical Methods for Physicists, Prism Books.
2. A. W. Joshi, Group Theory for Physicists, Wiley Eastern.

3. K. F. Riley and Hobson, Mathematical Methods for Physicists and Engineers, Cambridge.
4. Kathleen T. Aligood, Tim and James, Chaos: An Introduction to Dynamical Systems, Springer.
5. Michel Tabor, Chaos and Integrability in Nonlinear Dynamics, Wiley Eastern.

References:

1. Pipes and Harvil, Applied Mathematics for Physicists and Engineers, McGraw Hill.
2. Sathyaprakash, Mathematical Physics, S. Chand & CO
3. R. Courant and D. Gilbert, Methods of Mathematical Physics, Wiley Eastern.
4. M. Kumar, Deterministic Chaos, University Press.

PHY C 202 QUANTUM MECHANICS I

MODULE I

Linear Vector Space – Ortho Normal Basis – Unitary Space – Hilbert Space – Completeness – Closure Property – Operators: Different Types – Commuting operators – Dirac Notation – Matrix Representation of Vectors, Operators and Bases – Unitary Transformations – Change of Basis – Coordinate and Momentum Representation.

Fundamental Postulates – The Equation of Motion – Schrodinger, Heisenberg and Interaction Pictures – Uncertainty Principles – Time Energy Uncertainty Relation – Linear Harmonic Oscillator in Schrodinger and Heisenberg Pictures.

MODULE II

Definition of Angular Momentum – Eigen Values And Eigen Vectors – Angular Momentum Matrices – Pauli Spin Matrices – Orbital Angular Momentum – Angular Momentum and Rotation – Euler Angles – Addition of Angular Momenta – Clebsch Gordon Coefficients – Theory of Hydrogen Atom.

MODULE III

Space-time Symmetries – Displacement in Space and Time – Space Rotation – Space Inversion – Time Reversal – Identical Particles – Symmetric and Anti symmetric Wave Functions – Pauli's Exclusion Principle – Spin and Statistics – Two Electron Systems – Helium Atom.

MODULE IV

Variational Method for Bound States – Ground state of Helium Atom – Time Independent Perturbation Theory – Non degenerate Case – Degenerate case – Anharmonic Oscillator – Stark and Zeeman Effects in Hydrogen Atom.

Text Books:

1. V. K. Thankappan, Quantum Mechanics, Willey Eastern.
2. Ghatak and Lokanathan, Quantum Mechanics, MacMillan.
3. Amit Goswami, Quantum Mechanics, Wm. C. Brown Publishers.

4. Bransden and Joachain, Introduction to Quantum Mechanics, ELBS.
5. G. Aruldas, Quantum Mechanics, PHI.

References:

1. L. L. Schiff, Quantum Mechanics, McGraw Hill.
2. J. J. Sakurai, Modern Quantum Mechanics, Addison Wesley.
3. Powell and Crasemann, Quantum Mechanics, Addison Wesley.
4. Stephen Gasirowicz, Quantum Physics, Wiley Eastern.
5. A. Messiah, Quantum Mechanics, John Wiley & Sons.
6. Cohen Tannoudji, C. Diub and Laloe, Quantum Mechanics, Wiley Eastern.
7. Eugence Merzbacher, Quantum Mechanics.
8. P. A. M. Diarc, Principles of Quantum Mechanics.

PHY C 203 STATISTICAL MECHANICS

MODULE I

The Macroscopic and Microscopic States – Contact Between Thermodynamics and Statistics – Classical Ideal Gas – Gibbs Paradox – Phase Space – Liouville's Theorem.

MODULE II

Ensembles: Micro Canonical Ensemble – Quantization of Phase Space – Canonical Ensemble: Equilibrium Between System and Reservoir – Boltzmann distribution – Physical Significance of Statistical Quantities – Classical Systems – Energy Fluctuations – Equipartition Theorem and Virial Theorem – Grand Canonical Ensemble: Equilibrium Between System and Reservoir – Gibbs distribution – Significance of Statistical Quantities – Energy and Density Fluctuations.

MODULE III

Density Operator – Statistics of Various Ensembles – Ideal Gas in a Quantum Mechanical Micro Canonical Ensemble.

Behavior of Ideal Bose Gas – Bose-Einstein Condensation – Planck's Theory of Blackbody Radiation – Debye Theory of Specific Heat.

MODULE IV

Behavior of an Ideal Fermi Gas – Fermi Temperature and Fermi Energy – Electron Gas in Metals – Landau diamagnetism – de Hass van Alphen Effect – Temperature Dependent Specific Heat of Metals – Statistical Equilibrium of White Dwarfs.

Dynamical Model of Phase Transitions – Definition of Ising Model – The Lattice Gas and Binary Alloy – Ising Model in the Zeroth and First Approximation – Critical Exponents – Ising Model in One Dimension.

Textbook:

1. R. K. Pathria, Statistical Mechanics, Butterworth Heinemann.

References:

1. Kerson Huang, Statistical Mechanics, John Wiley & Sons.
2. Landau & Lifeshitz, Statistical Physics, Pergman.
3. F. Reif, Fundamentals of Statistical and Thermal Physics, McGraw Hill.

PHY C 204 ELECTROMAGNETIC THEORY

MODULE I

Electromagnetic Waves in Linear Media – The Flow of Electromagnetic Energy – Poynting Vector – Boundary Conditions – Plane Monochromatic Waves – Polarization of Plane Waves – Linear, Circular, Elliptic etc.

Reflection and Refraction of Electromagnetic Waves at a Plane Surface Between Dielectric Media: Normal Incidence and Oblique Incidence – Brewster's Angle – Critical Angle – Complex Fresnel Coefficients – Reflection From a Conducting Plane – Reflection and Transmission by a Thin Layer Interface.

MODULE II

Propagation of Electromagnetic Waves Between Parallel Conducting Plates – Transverse Electromagnetic Waves (TEM) – Equation for TE Modes – TM or E Mode – TE or M Mode – Properties of the TE and TM Modes – TE Modes for Rectangular Wave Guides – TM Mode for Rectangular Wave Guide – Resonant Cavities – Resonant Frequencies for a Cylindrical Cavity – TM and TE Modes – Power Losses and Q Value for a Cavity – Cylindrical Dielectric Wave Guide.

MODULE III

Uniform E and B Fields – Non uniform Fields – Diffusion Across Magnetic Fields – Time Varying E and B Fields - Adiabatic Invariants: First, Second and Third Adiabatic Invariants.

Geometry of Space-Time – Lorentz Transformation as an Orthogonal Transformation – Covariant Form of Electromagnetic Equations – The Electromagnetic Field Tensor – Transformation Law for Electromagnetic Field – The Field of Uniformly Moving Point Charge.

MODULE IV

Derivation of Moment Equation from Boltzmann Equation – Plasma Oscillations – Debye Shielding – Plasma Parameters – Magneto Plasma – Plasma Confinement – Fundamental Hydro-Dynamical Equations – Hydro Magnetic Waves – Magneto sonic and Alfen Waves.

Textbooks:

1. Capri A. Z. and Pant P.V., Introduction to Electromagnetics, Narosa Publications.

2. John R. Reitz, Frederic J. Milford and Robert W. Christy, Foundations of Electromagnetic Theory, Narosa Publications.
3. David .J. Griffiths, Introductions to Electrodynamics, Prentice Hall.
4. Chen. F. F., Introduction to Plasma Physics and Controlled Fusion, Plenum.

References:

1. Jackson J.D, Classical Electrodynamics, 3rd Edition, John Wiley.
2. David Cheng, Field and Wave Electromagnetics, Pearson Education Asia.
3. Sadique, Electromagnetics.
4. Puri S. P, Classical Electromagnetics, 2^{nd} Edition, Tata McGraw Hill.
5. Loud B. B, Electromagnetics, 4^{th} Edition, Wiley Eastern.
6. Chopra K. K. and Agarwal G. C., Electromagnetic Theory, 4^{th} Edition, K. Nath and Co., Meerut.

PHY P 205 PRACTICAL II – GENERAL PHYSICS

(At least 16 experiments should be done)

List of experiments:

1. Meyer's oscillating disc – To determine the viscosity of the given liquid.
2. Cornu's hyperbolic fringes – Determination of Y, σ and K with Pyrex.
3. Cornu's elliptical fringes – Determination of Y, σ and K with glass.
4. Stefan's constant – Determination of Stefan's constant.
5. Thermocouple – Constants, neutral and inversion temperatures.
6. Lee's disc – K of a liquid/ powder and air using thermocouple.
7. Hysteresis – B-H curves.
8. Maxwell's LC bridge – Determination of R and L of a given coil and C of a condenser.
9. Frequency Bridge – Construction of an oscillator and determination of frequency.
10. Quincke's method – Susceptibility of a liquid at different concentrations.
11. Guoy's method – Susceptibility of glass and aluminum.
12. Cauchy's constants – Determination of Cauchy's constants of sodium light.
13. Laser – Diameter of a thin wire.
14. Laser – Determination of slit width.
15. Laser – Determination of refractive index of a mirror substrate.
16. Laser – Study of intensity distribution and divergence of the beam.
17. Laser – Determination of the pitch of a screw.
18. Fabrey-Perot Etalon – λ and thickness of air film.
19. Koenig's method – Determination of Y and σ.
20. Searle's optical interferometer – Determination of Y.
21. Vibrating strip – Determination of mode constants.
22. Expansion of crystal – By optical interference method.
23. Hydrogen spectrum – Series limits and Rydberg constant.
24. Photoelectric effect – Electronic charge and work function of metal
25. Photoelectric cell – Study of elliptically polarized light using deadbeat galvanometer, quarter wave plate, and nicol prism.
26. Fresnel's formula – Verification of Fresnel's formula for the reflection.

References:

1. Worsnop B. L. and Flint H. T., Advanced Practical Physics for Students, Methusen & Co.
2. Gupta S. L. and Kumar, Practical Physics, Pragathi Prakashan.
3. Smith E.V., Manual of Experiments in Applied Physics, Butterworth.
4. Dunlap R. A., Experimental Physics, Academic Press.
5. Malacara D., Methods of Experimental Physics, Oxford University Press.

SEMESTER III

PHY C 301 QUANTUM MECHANICS II

MODULE I

Spin-Orbit Interaction – Fine Structure of Hydrogen Atom – Anomalous Zeeman Effect – The Hartee Equation for Atoms – Molecular Structure – Born-Oppenheimer Approximation – Molecular Orbital Method and Valence Bond Method – Hydrogen Molecule Ion and Hydrogen Molecule as Examples.

MODULE II

Time Dependent Perturbation Theory – Transition Probability – Constant Perturbation – Harmonic Perturbation – Interaction of an Atom with an Electromagnetic Field – Induced Emission and Absorption – Dipole Approximation – Born Approximation and Scattering Amplitude.

Scattering: Scattering Cross Section and Scattering Amplitude – Low Energy Scattering by a Central Potential – Method of Partial Waves – Phase Shifts – Optical Theorem – Scattering by a Square Well Potential – The Born Approximation.

MODULE III

Relativistic Quantum Mechanics: Introduction – The First Order Wave Equations – Dirac Equations – Dirac Matrices – Solution of the Free Particle Dirac Equation – Spin of the Electron – Equation of Continuity – Non-relativistic Limit – Spin Orbit Coupling – Dirac Equation of Hydrogen Atom – Covariance of the Dirac Equation – Bilinear Covariants – The Hole Theory – The Weyl Equations for the Neutrino – The Second Order Wave Equations: The Klein-Gordon Equation – Wave Equation of the Photon – Charge Conjugation for Dirac and Klein-Gordon Equations – CPT Theorem.

MODULE IV

Quantization of Fields: Principles of Canonical Quantization of Fields – Lagrangian Density and Hamiltonian Density – Second Quantization of the Schrödinger Wave Field for Bosons and Fermions.

Textbooks:

1. V. K. Thankappan, Quantum Mechanics, Wiley Eastern.
2. Ghatak and Lokanathan, Quantum Mechanics, MacMillan.
3. Amit Goswami, Quantum Mechanics, Wm. C. Brown Publishers.
4. Bransden and Joachain, Introduction to Quantum Mechanics, ELBS.

References:

1. L. L. Schiff, Quantum Mechanics, McGraw Hill.
2. J. J. Sakurai, Modern Quantum Mechanics, Addison Wesley.
3. Powell and Crasemann, Quantum Mechanics, Addison Wesley.
4. Stephen Gasirowicz, Quantum Physics, Wiley Eastern.
5. A. Messiah, Quantum Mechanics, John Wiley & Sons.
6. Cohen Tannoubji, C. Diub and Laloe, Quantum Mechanics, Wiley Eastern.
7. Eugence Merzbacher, Quantum Mechanics.
8. P. A. M. Diarc, Principles of Quantum Mechanics.
9. S. N. Biswas, Quantum Mechanics.

PHY C 302 NUCLEAR PHYSICS

MODULE I

Radioactivity: Radio Active Decay Law – Types of Decays – Alpha particle Decay – Heavy Particle Decay or Cluster radioactivity - Natural Radioactivity – Radioactive Dating – Gamma Transitions – Measurement of Gamma Ray Energy – Lifetimes – Multiple Moments – Decay Rate Formula – Selection Rules – Angular Correlation and Internal Conversion – Beta Decay – Simple Theory of Beta Decay – Fermi-Kurie Plot – Comparative Half-Life – Allowed and Forbidden Transitions – Selection Rules – Parity Violation in Beta Decay – Neutrinos. Double Beta Decay (qualitative).

MODULE II

Nuclear Forces: Properties – General Characteristic of Nuclear Forces – The Deuteron and Two Nucleon Scattering Cross Sections – Low Energy n-p Scattering – Partial Waves – Phase Shift – Singlet and Triplet Potentials – Effective Range Theory – p-p Scattering – Yukawa's Theory of Nuclear Forces(qualitative) – Nuclear Binding Energy – Semi Empirical Mass Formula.

MODULE III

Nuclear Models: Liquid Drop Model – Shell Model – Spin Orbit Coupling – Spin and Parities of Ground States – Magnetic Moments – Quadrupole Moment and Schmidt Limits- Isospin Symmetry – Single Particle Orbits in a Well – Collective Model: Rotational and Vibration States – Nilsson Model.

MODULE IV

Nuclear Reactions and Applications: Nuclear Fission – Characteristics of Fission – Mass Distribution of Fission Fragments – Energy in Fission – Neutrons Released in Fission – Cross Sections – Fission Reactors Operating with Natural Uranium as Fuel – Fission and Thermonuclear Energy – Breeder Reactor – Controlled Fusion Energy – Qualitative Treatment of Applications of Nuclear Fusion – Diagnostic Nuclear Medicine and Therapeutic Nuclear Medicines.

Textbooks:

1. Kenneth S. Krane, Introduction to Nuclear Physics, John Wiley.

2. J. S. Lilley, Nuclear Physics: Principles and Applications, John Wiley.
3. G. F. Knoll, Nuclear Radiation Detector and Measurement, Wiley.
4. Herald A. Engel, Introduction to Nuclear Physics, Addison Wesely.
5. S. B. Patel, An Introduction to Nuclear Physics, New Age International.

References:

1. Samuel M. Wong, Introductory Nuclear Physics, Prentice Hall of India.
2. S. G. Nilson & I. Regnarsson, Shapes and Shells and Nuclear Structure, Cambridge University Press.
3. Marmier & Sheldon, Physics of Nuclei and Particles, Vol. II, Academic Press.
4. Burcharm & Jobes, Nuclear and Particle Physics, Longman.
5. Roy R. K. and Nigam P. P., Nuclear Physics, Tata McGraw Hill.
6. Cohen B. L., Concepts of Nuclear Physics, Tata McGraw Hill.

PHY C 303 OPTICS

MODULE I

Lasers: Introduction – Properties of Lasers: Intensity, Monochromaticity, Directionality and Coherence – Einstein's Coefficients – Semi-classical Treatment of Stimulated Emission – Gain Coefficient – Concept of Population Inversion – Line Broadening Mechanisms: Natural, Collision and Doppler Broadening – Rate Equations: Three Level and Four Level Systems – Temporal Coherence and Spatial Coherence – Ruby Laser – Argon-Ion Laser – CO_2 Laser – Dye Laser – Semiconductor Laser – Spatial Frequency and Holography – Laser Induced Fusion.

MODULE II

Fibre Optics: Introduction – Fibre Optic Communication System – Advantages of Fibre-Optic Systems – Ray Propagation in Step-Index Fibres – Ray Propagation in Graded Index Fibres – Effect of Material Dispersion – The Combined Effect of Multipath and Material Dispersion – Calculation of rms Pulse Width – Wave Propagation in Planar Waveguides – Planar Optical Waveguide – TE Modes of a Symmetric Step-Index Planar Waveguide – Single Mode Fibres (SMF) – Characteristic Parameters of SMFs – Dispersion in Single Mode Fibres.

Textbooks:

1. William Silfvast, Laser Fundamentals, Cambridge University.
2. Laud B. B., Lasers and Non-Linear Optics, Wiley Eastern.
3. Ghatak and Thyagarajan, Optical Electronics, Cambridge.
4. R. P. Khare, Fibre Optics and Optoelectronics, Oxford University Press.

References:

1. J. T. Vadeyan, Laser Electronics, Prentice Hall of India.
2. Ghatak and Thayagarajan, Lasers: Theory and Applications, McMillan.
3. J. M. Senior, Optical Fiber Communications, Prentice Hall.
4. B. P. Pal, Fundamentals for Fiber Optics in Telecommunication, Wiley.
5. R. G. Husperger, Integrated Optics, Springer Verlag.

PHY C 304 EXPERIMENTAL TECHNIQUES

MODULE I

Measurements of Fundamental Constants (e, h and c) – Measurement of High and Low Resistance, Inductance and Capacitance – Emission and Absorption Spectroscopy – Detection of X Rays, Gamma Rays, Charged Particles – Neutrons – Ionization Chamber – Proportional Counter – GM Counter – Scintillation Detector – Solid State Detectors – Measurements of Energy and Time Using Electronic Signals from the Detectors and Associated Instrumentation – Signal Processing – A/D Conversation and Multichannel Analyzers.

MODULE II

Concept of Vacuum – Properties of Gases at Low Pressures – Gas Pressure – Velocity Distribution of Gas Molecules – Mean Free Path – Interaction of Gas Molecules with Surfaces – Adsorption Time – Saturation Pressure – Gas Flow – Conductance – Flow Calculations – Equation for Viscous Flow – Equation for Molecular Flow – Knudsen's Formulation.

Vacuum Pump Function – Basics – Gas Transport – Through put – Performance Parameter – Pumping Speed – Pump Down Time – Low Vacuum and High Vacuum Pump – Diffusion Pumps – Cryogenic Pump – Measurement of Flow Pressure – Direct Reading Gauges and Indirect Reading Gauges.

Textbooks:

1. Guthrie A, Vacuum Technology, John Wiley, 1963.
2. Rao V. V., Ghosh T. B., Chopra K.L., Vacuum Science and Technology.
3. Varier K. M., Pradyumnan P. P. and Antony Joseph, Advanced Experimental Techniques in Modern Physics, Pragati Edition, 2006.

References:

1. S. Dushman and J. M. Laffer, Scientific Foundations of Vacuum Techniques.
2. L. C. Jackson, Low Temperature Physics, John Wiley & Sons Inc., 1962.
3. Dennis Heppel, Vacuum System Design.

PHY E 305 SEMICONDUCTING MATERIALS AND DEVICES

MODULE I

Carrier Drift – Drift Current Density – Mobility Effects – Conductivity – Velocity Saturation – Carrier Diffusion – Diffusion Current Density – Total Current Density – Graded Impurity Distribution – Induced Electric Field – The Einstein Relation.

Reciprocal Lattice – Bragg Reflection of Electron Waves – Brillouin Zones – Important Features of Energy Bands of Si, Ge and GaAs (derivation not included).

MODULE II

Intrinsic, Extrinsic and Compound Semiconductors – Electrons and Holes – Semiconductor Statistics – Electron and Hole Mobilities and Drift Velocities – Hall Effect – Magneto resistance – Quasi Fermi Levels – Generation and Recombination of Carriers.

p-n Junction under Zero Bias Condition – Depletion Capacitance – Diffusion Capacitance – Tunneling and Tunnel Diodes – Junction Breakdown – Schottky Barriers – Ohmic Contacts.

MODULE III

Bipolar Junction Transistor: Principles of Operation – Doping Profile – Electron Diffusion Current in the Base – BJT as a Switch – Bipolar Transistors in Integrated Circuits.

FET: Basic Principles – Surface Charge in Metal Oxide Semiconductor Capacitors – MOSFET: Principles of Operation – Charge Coupled Devices – Advanced MOS Devices

MODULE IV

Crystalline Solar Cells – Conversion Efficiency – p-n Junction Solar Cells – Spectral Response – Equivalent Circuit – Amorphous Silicon Solar Cells – Photo Detectors – PIN Diode Detectors – Electroluminescence of Electromagnetic Waves in Two Level Systems – LEDs – Semiconductor Lasers: Optical Gain – Integrated Optoelectronics.

Textbooks:

1. Michael Shur, Physics of Semiconductor Devices, Prentice Hall of India, 1995.
2. Donald A. Neaman, Semiconductor Physics and Devices, Tata McGraw Hill.
3. Sze S. M., Physics of Semiconductor Devices, John Wiley & Sons, 1993.

References:

1. S. S. Islam, Semiconductor Physics and Devices, Oxford University Press.
2. Karl Hess, Advanced Theory of Semiconductor Devices, Prentice Hall of India.
3. Jasprit Singh, Semiconductor Devices: An Introduction, McGraw Hill, 1994.

PHY P 306 PRACTICAL – III MODERN PHYSICS

(At least 16 experiments should be done and preference to be given for material science experiments)

1. G.M counter – Plateau and statistics of counting, operating voltage and to verify the distribution law satisfied by the radioactive decay.
2. Absorption coefficient of "gamma" rays – To determine the absorption coefficient of a given material for CS 137 gamma rays using GM counter.
3. Absorption coefficient of "beta" rays – To determine the Absorption coefficient of a given material for beta ray source using GM counter.
4. Feather analysis – To determine the end point energy of beta particles from the given source by feather analysis method.
5. Scintillation Counter – To calibrate the given gamma ray (Scintillation) spectrometer using standard gamma ray source and to determine the energy of an unknown source.
6. 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 and to determine the rest mass energy of electron.
7. Hydrogen spectrum – To photograph the spectrum and hence to determine the Rydberg constant.
8. Absorption spectrum of $KMnO_4$ – To photograph the absorption spectrum and to determine the wavelengths of the absorption band.
9. Absorption spectrum of Iodine – To photograph the iodine spectrum and to determine the dissociation energy.
10. Vibration bands of Al_2O_3 – To photograph the emission of Al_2O_3 spectrum and to identify the band heads.
11. Nuclear magnetic resonance – To determine g-factor.
12. Carbon arc – To photograph the emission spectrum and to identify the spectral lines of iron, copper and potassium.

13. Hall Effect in semiconductors – To determine the carrier concentration in the given specimen of semiconductor material.
14. Determination of band gap energy in silicon.
15. Determination of band gap energy in germanium.
16. Zener voltage characteristics at low and ambient temperatures – To study the variation of Zener voltage of a given diode with temperature.
17. Ultrasonic Interferometer – To determine the velocity of ultrasonic waves in the given liquids.
18. Thin films – To determine the electrical conductivity, reflectivity, sheet resistance and refractive index.
19. Thomson’s experiment – To determine e/m ratio of an electron.
20. Optical fibre characteristics – To determine the numerical aperture, attenuation and bandwidth.
21. Frank Hertz experiment – To determine the ionization potential.
22. Four probe method – To study the bulk resistance and the band gap energy of the given semiconductor.
23. LED characteristics – Determination of wavelength of emission, current-voltage characteristics and variation with temperature, variation of output power with applied voltage etc.
24. Photoelectric effect – Determination of Plank’s constant (White light and filters or LEDs of different colours may be used).
25. Growth of a single crystal from the solution and determination of their structural, electrical and optical properties.
26. Study of colour centers – Thermo luminescence and glow curves.
27. Ionic conductivity in KCl and NaCl crystals.
28. Strain gauge – Y of a metal beam.

29. Solar cell – Spectral response and I-V characteristics.
30. Dielectric constant of a liquid by LCR Bridge.
31. Study of junction capacitance with voltage of P-N junction (Si, Ge and GaAs)
32. Michelson Interferometer – Determination of I1 and I2 of sodium light.
33. Michelson interferometer – Determination of thickness of a mica sheet.
34. Thermo luminescence spectra of Alkali halides.
35. Variation of dielectric constant with temperature of a Ferro electric material (Barium titanate).
36. Ferrite specimen – Variation of magnetic properties with composition.
37. Advanced Laser Experiments – Experiments with Hologram.
38. Zeeman Effect – To study the Zeeman splitting of the green mercury line using Fabry Perot etalon for the normal transverse and longitudinal configuration.
39. X ray Apparatus – To study diffraction of X rays.

PHY E 308 POLYMERIC MATERIALS

Module 1

Fundamental concepts of polymers: Monomers – Functionality – Classification of polymers – Polymerisation – addition, condensation – mechanism and kinetics of free radical polymerization only – types of copolymers. Polymerization techniques – bulk, solution, suspension and emulsion. molecular weight: Number average and weight average – molecular weight average – molecular weight distribution – ploydispersity – determination of molecular weight – osmometry, light scattering, viscometry and gel permeation chromatography.

Module 2

Solid state thermal properties: Amorphous state – crystalline state – degree of crystallinity – determination of crystallinity - factors affecting crystallizability. Glass transition and melting temperature – factors affecting tg – measurements by DSC, DTA and TMA. Thermal stability by TGA.

Module 3

Polymer processing: Compounding of plastics – fillers, plasticizers, colorants – steblizers. Injection moulding, compression moulding, low moulding – extrusion, calendaring and film casting. Thermoforming and foaming.

Module 4

Mechanical properties and testing of polymers: Stress- strain relationship, measurement of tensile and bending strength, impact resistance – abrasion resistance – dielectric strength. plastics, elastomers and fibers: Plastics – thermoplastics and thermosetting. Elastomers – natural and synthetic rubbers – advantages. Fibers – requirements for fibre forming – melt, dry and wet spinning.

Engineering and speciality polymers: Polyamides – ABS – polycarbonates – polyesters – preparation, properties and uses. Speciality polymers – conducting polymers, liquid crystalline polymers and biodegradable polymers.

Text books:

1. Billimeyer F. W. ‘Polymer Science’, John- Wiley and Sons,1998
2. Joel R. Fried ‘Polymer Science and Techno;logy’ , Prentice Hall of India Pvt Ltd., 1999
3. V.R. Gowarikar, N. V. Viswanathan and Jayadev Sreedhar, ‘Polymer Science’, Wiley Eastern Ltd ., 1991

References:

1. J. A. Brydson, Plastic Materials, Butterworth Heinemann, 1995
2. Macromolecules: An introduction to Polymer Science, Bovery F. A. & Winslow F. H., Academic Press, 1979
3. Encyclopaedia of Polymer Science and Technology, Mark H. F., Interscience Publications

SEMESTER IV

PHY C 401 ATOMIC AND MOLECULAR SPECTROSCOPY

MODULE I

Spectra of Hydrogen Like Ions – Alkali Spectra – Many Electron Systems – L-S and j-j Coupling – Space Quantization – Stern-Gerlach Experiment – Zeeman Effect – Normal and Anomalous Zeeman Effect – Lande-g Formula – Paschen-Back effect – Stark Effect – Hyperfine Structure of Spectral Lines.

MODULE II

Review of Rotation and Vibration Spectra – Breakdown of Born-Oppenheimer Approximation – Vibrations of Polyatomic Molecules – Rotational and Vibrational Spectra of Polyatomic Molecules – Linear and Symmetric Top Molecules – FTIR – Electronic Spectra of Diatomic Molecules – Vibration Coarse Structure – Progressions – Frank-Condon Principle – Rotational Fine Structure of Electronic Vibrational Transitions – The Fortrat Diagram – Dissociation and Pre-dissociation.

MODULE III

Classical Theory of Raman Effect – Pure Rotational Raman Spectra of Linear and Symmetric Top Molecules – Vibration Raman Spectra – Raman Activity of Vibrations – Rules of Mutual Exclusion – Example of H_2O and CO_2 – Vibration Raman Spectra of Symmetric Top Molecules – Structure Determination Using IR and Raman Spectroscopy – Molecules of type XY_2, XY_3 and XY_4.

MODULE IV

Interaction Between Nuclear Spin and Magnetic Field – Larmour Precession – Resonance Condition – Chemical Shift – Example of CH_3OH – NMR Spectrometer – Application in Medicine (MRI) – Principle of ESR – Principles of Mossbauer Spectroscopy – Doppler Shift – Mossbauer Spectrometer –Applications of Mossbauer Spectroscopy.

Textbooks:

1. B. P. Straughn & S. Walker, Spectroscopy-Vol. I& II, Chapman & Hall.
2. C. N. Banwell & E. M. Mc Cash, Fundamentals of Molecular Spectroscopy, TMH.

3. G. Herzberg, Molecular Spectra and Molecular Structure Vol I, II & III, VAN Nostrand Company.

References:

1. H. E. White, Introduction to Atomic Spectra, McGraw Hill.
2. G. Aruldas, Molecular Structure and Spectroscopy, Prentice Hall.

PHY C 402 PARTICLE AND ASTRO PHYSICS

MODULE I

Strong and Weak Nuclear Forces – Yukawa's Proposal – Production, Properties and Modes of Decay of Pions and Muons – The Muon – The Real Pion – Isotopic Spin – Strange Particles – Gell Mann-Nishijima Formula – Extremely Short Lived Particles – Resonances and Their Quantum Numbers with Special Reference to Pions – Nucleon Scattering.

Conservation Laws – Intrinsic Quantum Numbers Associated with Elementary Particles – Theory of Weak Interaction – Parity Non-conservation – The TCP Theorem – Unification of Weak Electromagnetic Interaction – The Glashow-Weinberg-Salam Model.

MODULE II

Quark Model – The Sakata Model – The Eight Fold way – GellMann-Okubo and Coleman-Glashow Equations – Quarks and Quark Models – Different Types – The Confined Quarks – Experimental Evidence for the Existence of Quarks – Coloured Quarks – Charm, Truth and Beauty.

MODULE III

Absolute Magnitude and Distance Modulus – Colour Index of Stars – Luminosities of Stars – Stellar Parallax – Units of Stellar Distance – Celestial Sphere and Celestial Coordinate Systems – Harward System of Classification of Stars – Spectroscopic Parallax – The Hertzsprung – Russel Diagram.

MODULE IV

Interstellar Dust and Gas – The Formation of Proto Stars – Pre-main Sequence: Evolution – Evolution of the Main Sequence – Late Stages of Degenerate Matter – The Chandrasekhar Limit – The Cooling of White Dwarfs – Neutron Stars – Pulsars – Quasars – Black Holes.

Comets, Asteroids and Meteorites – The Formation of Solar System.

Textbooks:

1. G. D. Coughlan and J. E. Dodd, The Ideas of Particle Physics, Cambridge University Press, 1991.

2. Yuval Ne'eman and Yoram Kirsh, Particle Hunters, Cambridge University Press, 1996.
3. David Griffith, Introduction to Elementary Particle Physics, John Wiley & Sons.
4. M. P. Khanna, Introduction to Particle Physics, Prentice Hall of India.
5. Bardley W. Carrol & Dale A. Ostile, An Introduction to Modern Astrophysics, Addison Wesley.
6. Baidyanath Basu, An Introduction to Modern Astrophysics, Prentice Hall of India.

References:

1. Narlikar J. V. and Ajith K. Kembhavi, Quasars and Active Galactic Nuclei.
2. Narlikar J. V., Introduction to Cosmology.
3. Sinha B. C., Srivastava D. K., Viyogi Y. P., Physics and Astrophysics of Quark-Gluon, Narosa Publishing House, New Delhi.
4. Hughes, Elementary Particles – 2nd Edition, Cambridge University Press.

PHY E 403 THIN FILM TECHNOLOGY

MODULE I

Thin Film Physics: Mechanism of Thin Film Formation – Formation Stages of Thin Films – Condensation and Nucleation – Thermodynamic Theory of Nucleation – Growth and Coalescence of Islands – Influence of Various Factors on the Final Structure of Thin Films – Crystallographic Structure of Thin Films.

MODULE II

Methods of Preparation/Synthesis of Thin Films: Vacuum Evaporation: Resistive Heating, Electron Beam Evaporation and Laser Beam Evaporation – Sputtering: Glow Discharge, Radio Frequency and Magnetron Sputtering – Chemical Methods: LCVD, PCVD and PECVD – Spray Method: Spray Hydrolysis and Spray Pyrolysis – Langmuir Blochet Technique – Sol-gel Deposition.

Thickness Measurements: Resistance, Capacitance, Microbalance, Quartz Crystal Thickness Monitor, Optical Absorption, Multiple Beam Interference, Interference Colour and Ellipsometry Methods.

MODULE III

Optical Properties of Thin Films: Reflection and Transmission at an Interface – Reflection and Transmission by a Single Film – Optical Constants and Their Measurement Techniques – Reflectivity Variation with Thickness – Antireflection Coatings: Single and Multilayer – Reflection Coatings – Interference Filters.

Electrical Properties of Metallic Thin Films: Sources of Resistivity – Sheet Resistance – TCR – Theories of Size Effect – Theory of Conduction in Discontinuous Films.

Dielectric Properties: Simple Electrical Theory – DC Conduction Mechanism – AC Conduction Mechanism.

MODULE IV

Characterization/Analysis of Materials and Devices (Basic Principles): X-Ray Diffraction (XRD) – Transmission Electron Microscopy (TEM) – Scanning Electron Microscopy (SEM) – Energy Dispersive Analysis of X-rays (EDAX) – UV-VIS Spectroscopy – Fourier Transform Infrared

(FTIR) Spectroscopy – Electron Spin Resonance (ESR) – X-ray Photoelectron Spectroscopy (XPS) – Scanning Tunneling Microscopy (STM) – Atomic Force Microscopy (AFM).

Applications: Thin film resistors: Materials and Design of thin film resistors (Choice of resistor and shape and area) – Trimming of Thin Film resistors – Sheet Resistance Control – Individual Resistor Trimming – Thin Film Capacitors – Thin Film Field Transistors – Fabrication and Characteristics – Thin Film Diodes.

Textbooks:

1. Maisel L. I. and Glang R., Hand Book of Thin Film Technology, McGraw Hill, 1970.
2. Chopra K. L., Thin Film Phenomena, McGraw Hill, 1969.
3. Goswami A., Thin Film Fundamentals, New Age International Ltd., 1996.
4. Joy George, Preparation of Thin Films, Dekker.
5. Khangoankar P. R., An Introduction to Materials Characterization, Pen ram International Publishing.

References:

1. Donald L. Smith, Thin Film Deposition: Principles and Practice, McGraw Hill, Singapore, 2001.
2. Holland L., Vacuum Deposition of Thin Films, Chapman and Hall, 1956.
3. Heavens O. S., Thin Film Physics, Butterworth Scientific Publication, 1955.
4. Berry R. W. and Others, Thin Film Technology, McGraw Hill, 1970.
5. Rao V. V., Ghosh T. B. ,Chopra K. L., Vacuum Science and Technology, Allied Publication, 1998.
6. Guthrie A., Vacuum Technology, John Wiley & Sons, 1963.

PHY E 404 PHOTOVOLTAIC ENERGY CONVERSION

MODULE I

Solar Energy – The Solar Constant – Solar Intensity on Earth's Surface – Direct and Diffuse Radiation – Apparent Motion of Sun – Solar Insolation Data.

MODULE II

p-n Junction I-V Relation: Quantitative Analysis – p-n Junction under Illumination: Generation of Photo Voltage(PV) and Light Generated Current – I-V Equation for Solar Cells – Solar Cell Characteristics.

Design of Solar Cells: Upper Limit of Solar Cell Parameters: Short Circuit Current, Open Circuit Voltage, Fill Factor and Efficiency – Losses in Solar Cells – Model of Solar Cells – Effect of Series and Shunt Resistance – Solar Radiation and Effect of Temperature on Solar Cell Efficiency – Solar Cell Design – Design for High Short Circuit Current – Choice of Junction Depth and Orientation – Minimization of Optical Losses and Recombination – Design for High Open Circuit Voltage – Design for High Fill Factor.

MODULE III

Thin Film Solar Cell Technologies: Generic Advantages of Thin Film Technologies – Materials for Thin Film Technologies – Thin Film Deposition Techniques – Common Features of Thin Film Technology – Amorphous Si Solar Cell Technology – Cadmium Telluride Solar Cell Technology – Thin Film Crystalline Solar Cells.

MODULE IV

Solar Photovoltaic Applications: Solar Photovoltaic (SPV) Modules – SPV from Solar Cells – Series and Parallel Connections – Mismatch in Cell Module – Mismatch in Series Connection – Hot Spots in Modules – Bypass Diode – Mismatch in Parallel Connection – Design and Structure of PV Modules – Number of Solar Cells – Wattage of Modules – PV Module Power Output – I-V Equation for PV Modules – I-V and Power Curves of Module – Effect of Solar Irradiation and Temperature.

Textbooks:

1. S. P. Sukhatma, Solar Energy, Tata McGraw Hill.

2. Chetan Singh Solanki, Solar Photovoltaic: Fundamentals, Technologies and Applications, PHI, 2^{nd} Edn, PHI, 2^{nd} Edn.

References:

1. G. Busch and Schade, Lectures on Solid State Physics, Pergamon Press.
2. B. O. Seraphin, Solar energy conversion, Springer.
3. S. R. Das and K. L. Chopra, Thin Film Solar Cells, Springer.
4. Harold J. Hovel, Semiconductors and Semimetals-Vol.II, Academic Press.
5. Martin A. Green, Solar Cells, Prentice Hall Series.
6. Tom Markvart and Luis Castner, Handbook of Solar Cells, Springer.

PHY E 406 CERAMIC MATERIALS

Module 1

Crystal structures: Pauling's rule – oxide structures – silicate structures – clay mineral structures, displacive and reconstructive structural transformations in phase transitions. Structure of glasses: Zachariasen's rule – network formers and modifiers – glass transition. Glazes and enamels – method of applications – glass ceramics – phase transformations – concept of spinoidal decomposition – Vycor process – Vitreous shaping methods – annealing and tempering of glasses – outline of the principles and procedures of crystallization.

Module II

Ceramic forming methods: Principles of pressure fabrication – maximizing packing fraction and minimizing wall and particle friction in dry pressing – hydroplastic forming – slip casting – drying – consequences – sintering procedures – dimensional changes and other consequences – ceramic coating – plasma spraying, PVD (qualitative treatment only).

Module III

Outline of mechanical properties: Moulds of elasticity of 2-phase and porous ceramics – Grifith's theory – abrasives – Knoop's scale – Ceramic cutting tools cermets.

Outline of electrical properties: Conductivity of ceramic materials – ceramic semiconductors and their uses as fixed resistors, heating elements, thermistors and varistors – piezoelectric ceramics – insulators.

Outline of magnetic properties: Ferromagnetics – ceramic magnets – squareness ratio.

Outline of optical properties: Refractive index, birefringence, dispersion, reflectance, color, luminescence of ceramic materials – lasers.

Outline of thermal properties: Characteristics of refractory systems – phase diagrams of Al_2O_3 – SiO_2 system and consequences – corrosion of refractories by molten slags – powder reactions – Hedvall effect.

Module IV

Outline of the uses of UO_2 and its binary solid solutions as a ceramic nuclear fuel – BeO as moderator – radiation shielding and waste disposal- elementary treatment only.

Text books:

1. Kingery, 'Introduction to Ceramics', John- Wiley Publications, 1991
2. Van Vlack , 'Physical Ceramic for Engineers', Addison Wiley, 1964

References:

1. William F. Smith, 'Foundations of Material Science and Engineering', McGraw Hill Book Co., 2000
2. Michel W Barsoum, 'Fundamentals of ceramics', McGraw Hill Book Co., 1997

PHY E 407 CONDENSED MATTER PHYSICS

Module I

Density operator and its correlation function – Liquids and gases, Crystalline solids, Liquid Crystals, Incommonsurate structures, Qyasicrystals and random isotropic fractals

Module II

Review of Thermodynamics and Stastical Mechanics, Spatial correlations in classical systems. Ordered systems, Discrete symmetries, continuous symmetries.
Phase transitions – Mean field theory: bragg-Williams theory, Landau theory, the Ising and n-vector models. Examples of meanfield transitions, the first order nematic to isotropic transition, He^3 – He^4 mixtures and metamagnets – Tricritical points. Liquid – solid transition.

Module III

Fluctuations of order parameter and Breakdown of mean field theory. Critical exponents and sealing relations. The Kandanoff Construction. The one dimensional Ising model.Momentum shell renormalization group.

Module IV

The depended correlation functions, Response functions, Kramers relations, sound waves in an elastic continuum, acoustic phonons in a lattice, Green function for the Diffusion equation, Einstein relations, Langevin theory for the correlation for diffusion, Fluctuation – Dissipation Theorem, Fokker – Planck equation.
Example of kinks and walls in Ising lattice, Analytic solution for a kink, the Sine – Gordon solution, the Frenkel Kentorowa model adatoms on a lattice.

Text books:

1. P. M. Chaikin et al., Principles of Condensed Matter of Physics, Cambridge University Press, 1998

PHY E 408 COMPOSITE MATERIALS

Module I

Classification and definition of composite materials: Fibres and matrices: carbon fibres, glass fibres, organic fibres and comparison of fibres – Thermosetting resins used in composites. Fabrication techniques: The leaky mould technique – High pressure compression moulding – Autoclave moulding – Spray up – Filament winding – Pultrusion – hand lay-up processes – Moulding of reinforced plastics.

Module II

Composites with metallic matrices: Introduction – Metal matrix composite processing – Solid state processing, Liquid State processing, Deposition, In-situ processes.
Ceramic matrix composite materials: Introduction – processing of ceramic matrix composites: Mixing and pressing process using slurry and hot pressing – Liquid State processing – Sol-Gel processing – Vapour deposition techniques – Lanxide process and in-situ techniques.
fibre matrix interface: Interface bond-strength – theories of adhesion – examples of fibre resin interfaces – measurement .

Module III

Geometrical aspects: Unidirectional laminas – Volume fraction and weight fraction – Woven roving, in-plane random fibres, fibre length and fibre orientation distribution – voids – fibre orientation during flow.
laminate theory: Elastic properties of unidirectional laminas – strength of unidirectional laminas: longitudinal tensile strength, transverse tensile strength, longitudinal compressive strength, compressive strength transverse, In plane shear strength, orientation dependence of strength and failure criteria.

Module IV

Short fibre composite materials: Short fibres aligned parallel to each other, in-plane randomly oriented long chopped fibres. Injection moulded products, Short fibre materials.
Fatigue in composite materials: Notch sensitivity and fracture energy – environmental effects. Hybrid composite materials.

Application of composites: Aircraft engineering and space hardware – Wind turbines - Marine craft – Space structure – Applications in surgery, Sports equipments and vehicles.

References:

1. Derek Hull, 'An Introduction to Composite materials', Cambridge University Press, 1988
2. Mathews E. L. and Kaudinge R. D., 'Composite materials: Engineering and Science', Chapman and Hall, 1994
3. Leslie N. Philips, 'Design with Advanced Composite Materials', Ed. Springer – Verlag, 1989
4. Terry Richardson, 'Composites – design Guide', Industrial Press Inc. New York, 1987
5. Schwatz M. M., Composite Materials Hand Book', McGraw Hill Book Co., 1984
6. George Lubin, 'Hand Book of Composite', Van Nostrand Reinhold Co., 1986
7. 'Hand Book of Composite – American Society of Materials', 1990

PHY O 309 ACOUSTICS AND OPTICS

MODULE I

Interference of sound waves (qualitative) – Conditions for interference of sound waves - Silence Zone – Beats – Combination Tones - Musical sound and noise – Speech – Human voice – Human ear – Characteristics of musical sound (1) Loudness or intensity, (2) Pitch, (3) Quality or Timbre – Musical scale – Limits of audibility.

Reflection of sound – Experimental demonstration of reflection of sound – Whispering galleries – Echo – Application of reflection of sound – Acoustics – Reverberation.

MODULE II

Fiber optics–Step index fiber–Graded index fiber-Principle of optical fiber communication – Advantages of optical fiber communication - Lase –Spontaneous emission–Stimulated emission – Population Inversion –Pumping – Ruby laser –Construction and working – Application of laser.

Books for Study

1. A Textbook of Sound - N Subrahmanyam and Brij Lal
2. Optical Fiber communications – J M Senior, Prentice Hall
3. Lasers Theory and application – Ghatak and Thayagarajan, Mc Millan

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Name: …………………

FOURTH SEMESTER M. Sc. DEGREE EXAMINATION, JUNE 2015

PHYSICS (Advanced Materials)

PHY C 401: ATOMIC AND MOLECULAR SPECTROSCOPY

Time: Three Hours **Max. Marks: 60**

SECTION A

Answer any **5** questions. Each question carries **4** marks.

(5×4 = 20 marks)

1. What is Born- Oppenheimer approximation? Discuss the breakdown of Born-Oppenheimer approximation.
2. Briefly explain how the Raman and IR spectra help to identify the structure of the molecules?
3. State and explain Franck-Condon principle.
4. Explain Fortrat diagram and its importance.
5. What is Larmour precession? Relate the Larmour precession frequency with the resonance frequency.
6. Discuss chemical shift and its effect in Mossbauer spectrum.

SECTION B

Answer any **2** questions. Each question carries **11** marks

(2×11 = 22 marks)

7. Discuss space quantization and explain how this leads to different quantum numbers. Also explain how it is explained by Stern and Gerlach?
8. With the help of a neat diagram explain the different components of NMR spectrometer and explain the functioning of each component. Also discuss the basic difference in NMR and ESR spectrometers.
9. Explain resonance absorption and emission of gamma rays. Discuss the effect of magnetic field and crystal field in Mossbauer spectra.

SECTION C

Answer any **3** questions. Each question carries **6** marks.

(3×6 = 18 marks)

10. Sketch the anomalous Zeeman pattern of Sodium atom.
11. The fundamental and first overtone transactions of $^{14}N^{16}O$ are centered at 1876.06 cm^{-1} and 3724.0 cm^{-1} respectively. Evaluate the equilibrium vibration frequency and the anharmonicity constant. Also calculate the zero point energy and force constant of the molecule.
12. The value of $\bar{\nu}_e$ and x_e for the lower and upper states of C_2 are 1641.4 cm^{-1}, 0.00711 and 1788.2 cm^{-1}, 0.00919 respectively. Find the number of vibrational levels below the dissociation limit and hence the dissociation energy for the upper and lower states of C_2.
13. Calculate the recoil velocity and energy of the free Mossbauer nucleus ^{119}Sn when emitting a gamma ray of frequency 5.76×10^{18}Hz. What is the Doppler shift of the gamma ray frequency to an outside observer? What is the natural width? ($T_{1/2}=1.9\times10^{-8}$ seconds).

Reg. No. ………………. **(Pages: 2)**

Name: …………………

FOURTH SEMESTER M. Sc. DEGREE EXAMINATION, JUNE 2015

PHYSICS (Advanced Materials)

PHY C 402: PARTICLE AND ASTROPHYSICS

Time: Three Hours **Max. Marks: 60**

SECTION A

Answer any **5** questions. Each question carries **4** marks.

(5×4 = 20 marks)

1. Write a note on resonance particles.
2. Explain why kaons and hyperons are called strange particles?
3. Write a note on quarks.
4. What are pulsars?
5. What is Chandrasekhar limit? Explain.
6. Give an account of origin of life on earth.

SECTION B

Answer any **2** questions. Each question carries **11** marks

(2×11 = 22 marks)

7. Discuss on the basis of SU(3), the classification of hadrons. Show how did the SU(3) classification lead to the prediction of Ω^- particle.
8. Give an account of the conservation laws, one should look at in the study of elementary particles.
9. Explain how spectroscopic parallax method and apparent methods are used to determine stellar distances.

SECTION C

Answer any **3** questions. Each question carries **6** marks.

(3×6 = 18 marks)

10. The resonance in π^+-p scattering appear at 195MeV with a maximum cross- section of 195mb. Calculate the de Broglie wavelength of the wave involved at the resonance.

11. Which of the following processes are possible? Among the processes which are possible verify whether the interaction is strong, electromagnetic or weak.

    i. $p \rightarrow e^{+} + \gamma$

    ii. $K^{+} \rightarrow \mu^{+} + \gamma_{\mu}$

    iii. $\pi^{0} \rightarrow \gamma + \gamma$

    iv. $\Sigma^{0} \rightarrow \Lambda^{0} + \gamma$

    v. $\Omega^{-} \rightarrow K^{-} + \bar{K}^{0}$

12. A visual binary star has a parallax of 0.25" and the angular distance between the component stars is 2.5". Calculate the linear separation between the two members of the binary.

13. If a star has apparent and absolute magnitudes of +1.5 and -1.5 respectively, calculate its distance in parsecs and in light years.

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FOURTH SEMESTER M. Sc. DEGREE EXAMINATION, JUNE 2015

PHYSICS (Advanced Materials)

PHY E 403: THIN FILM TECHNOLOGY

Time: Three Hours **Max. Marks: 60**

SECTION A

Answer any **5** questions. Each question carries **4** marks.

(5×4 = 20 marks)

1. Write a note on size effect.
2. Explain the advantages and disadvantages of electron beam evaporation.
3. Explain the principle of operation of quartz crystal thickness monitor.
4. What are interference filters?
5. Write a note on atomic force microscopy.
6. What do you mean by trimming of thin film resistors?

SECTION B

Answer any **2** questions. Each question carries **11** marks

(2×11 = 22 marks)

7. Write an essay on the mechanism of formation of thin films.
8. What is sputtering? List different sputtering techniques for thin film preparation. Give details of one such technique giving necessary diagrams.
9. With necessary theory explain the principle of operation of X- ray Diffractometer. What are its applications?

SECTION C

Answer any **3** questions. Each question carries **6** marks.

(3×6 = 18 marks)

10. A dielectric film formed between two parallel plates gives a capacitance of 0.03μF per square centimeter. If the permittivity of the film is 8, determine the thickness of the film.

11. A diamond tipped four point probe of in-line-type with probe spacing0.5mm is placed over a thin film sample deposited over an insulating substrate. A potential of 1V is applied and the current was 0.5mA. If the film thickness is 1μm, calculate the sheet resistance of the sample.
12. The area of a crystal in a quartz crystal thickness monitor is $1cm^2$ and is kept at a distance of 15cm from the boat. The observed change in frequency is 20Hz. Calculate the characteristic constant of the crystal, if the fundamental frequency of the crystal is 6MHz.
13. Briefly explain scanning electron microscopy.

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FOURTH SEMESTER M. Sc. DEGREE EXAMINATION, JUNE 2015

PHYSICS (Advanced Materials)

PHY E 404 PHOTOVOLTAIC ENERGY CONVERSION

Time: Three Hours **Max. Marks: 60**

SECTION A

Answer any **5** questions. Each question carries **4** marks.

(5×4 = 20 marks)

1. Write a note on the formation of photo voltage in solar cells.
2. Explain short circuit current and open circuit voltage.
3. Differentiate direct radiation and diffuse radiation.
4. What are amorphous solar cells? Discuss its advantages and disadvantages over crystalline solar cells.
5. Write a note on the effect of solar irradiation and temperature on PV modules.
6. What are the different types of optical losses? How they can be minimized?

SECTION B

Answer any **2** questions. Each question carries **11** marks

(2×11 = 22 marks)

7. (a) What are the materials used for preparing thin film solar cells?
   (b) Describe the procedure for preparing cadmium telluride solar cells.
8. Write an essay on solar cell design for high short circuit current.
9. Explain the design and structure of photo voltaic modules.

SECTION C

Answer any **3** questions. Each question carries **6** marks.

(3×6 = 18 marks)

10. A silicon solar cell of area $1cm^2$ has the following parameters: Acceptor doping $N_a=5\times10^{17}/cm^3$, Donor doping $N_d=10^{16}/cm^3$, Hole diffusion coefficient $D_p=10cm^2/s$ Electron diffusion coefficient $D_n=20cm^2/s$, Hole recombination time $\tau_p=10^{-7}s$, Electron

recombination time τ_n=3×10^{-7}s and Photo current I_L=25mA. Calculate the open circuit voltage at 300K.

11. Calculate the hour angle at sunrise and sunset on June 21 and December 21 for a surface inclined at an angle of 10^0 and facing due south ($\gamma=0^0$). The surface is located at Bombay ($19^0$07'N, $72^0$51'E).
12. The minority carrier concentration in an n-type material is about 10^3cm^{-3}. It is changed to 10^{16}cm^{-3} due to incident light. The excess minority carriers travel a distance of 2μm in 2μs before recombine. Calculate its recombination rate.
13. A solar cell has the following parameters, V_{OC}=0.6V, I_{SC}=30mA, FF=76% and P_{rad}=1000W/m^2.