SYLLABUS FOR M.Sc. IN PHYSICS

UNDER

CHOICE BASED CREDIT SYSTEM (CBCS)

(To be effective from 2018 -19)

(5 Credits).

Course

MPHYCC-9 Lab-Il

Objectives:

1. To encourage students to "discover" physics in a way how physicists learn by doing research.
2. To address analytically intractable problems in physics using computational tools.
3. To enhance the various computational technique with programming basic in C to face the world of problems using high performance iteration techniques.
4. To show how physics can be applied in a much broader context than discussed in traditional curriculum.

PROGRAMMING NUMERICAL METHODS USING C LANGUAGE (any 8):

1. To find mean, standard deviation and frequency distribution of an actual data set from any physics experiment.
2. Successive approximation (Method of Iteration), Newton Raphson method
3. The Bisection method
4. Gauss Elimination method
5. Matrix Inversion, Lagrange •s Interpolation ibrnu.lla
6. Trapezoidal Rule, Simpsolfs l;3-rule
7. Euler's nwthod, Runge-Kutta method(Fourth Order)
8. Predictor corrector methods
9. To find mean, standard deviation and frequency distribution of an actual data set from any physics experiment.
10. To find the area of a unit circle by Monte Carlo integration. 1 l . To simulate the random walk.

Course Outcome:

At the end of this course, students will be able to

1. Understand the basic idea about finding solutions using computational methods basics.
2. Learn how to interpret and analyze data visually, both during and after computation.
3. Gain an ability to apply physical principles to real-world problems.
4. Acquire a working knowledge of basic research methodologies, data analysis and interpretation.
5. Realize the impact of physics in the global/societal context.

SEMESTER 111

MPHYCC-IO Atomic and Molecular Physics, Lasers (5 Credits)

Course Objectives:

1. Objective of this course is to learn atomic, molecular and spin resonance spectroscopy.
2. To understand mechanism and working of lasers.
3. To be able to understand atomic and molecular transitions and selection rules.
4. To understand the Raman effect and its applications

Course

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with 2 from each unit (10 X 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 X 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 X 10 = 30).

Unit 1: Atomic Physics: Vector Atom Model (LS, JJ Coupling), Fine Structure and Hyperfine Structure, Zeeman Effect, Paschen- Back and Stark Effect.

Intensity, Shape and width of spectral lines, Independent particle model, He atom as an approximation for many electron atomic systems, Slater determinants to write possible multiplets.

Unit 2: Electronic and Molecular Spectra: Molecule as non-rigid rotator, Anharmonic Oscillator (vibration-rotation system), Frank Condon Principle, NMR and ESR. Spectra/Vibration of Polyatomic molecule, Electronic spectra of polyatomic molecules, Chemical analysis by electronic spectroscopy, Spectra of Hydrogen Molecule

Unit 3: Molecular Potential: Concept of Molecular Potential, Separation of electronic and nuclear wave function, Born-Oppenheimer approximation and its breakdown, Analysis by infrared techniques, Molecular orbital theory, LCAO approximation theories.

Unit 4: Raman and Spin Resonance Spectroscopy: Vibrational and pure rotational Raman spectra, Structure determination, Raman and Infrared spectroscopic Technique and instrumentation

Unit 5: Laser: Significance of Einstein's A and B coefficients, pumping schemes, Characteristics of Laser beams, Principles of Fiber Communication, Numerical Aperture.

Laser Operation: Oscillator versus Amplifier, Laser Resonators, Laser rate equations for three and four level Laser systems, Liquid (Dye) Lasers, Gas (C02, Nitrogen and Eximer) lasers, Laser applications in industry, Nuclear science, Spectroscopy. Light detection and Ranging (LIDAR), scanning laser beam devices, Laser communication, (injection photodiode and Avalanche Photodiode), optical computing, and medical applications.

Outcomes:

Students will have understanding of:

1. Atomic spectroscopy of one and two valance electron atoms.
2. The change in behavior of atoms in external applied electric and magnetic field.
3. Rotational, vibrational, electronic and Raman spectra of molecules.
4. Electron spin and nuclear magnetic resonance spectroscopy.
5. Principle, working and applications of laser

References:

1. H. E. White, Introduction to Atomic Spectra, McGraw Hill, (1934).
2. C. N. Banwell, andE. M. McCash, Fundamentals of molecular spectroscopy, Tata McGraw Hill, (2007).
3. G. Aruldhas, Molecular structure and Spectroscopy, Prentice Hall of India, New Delhi, 2001

MPHYCC-II Conde nsed Matter Ph sics | 5 Credits

Course Objectives:

1. To study some of the basic properties of the condensed phase of materials especially solids.
2. To study electrical and magnetic properties of solids
3. To understand superconductivity and various properties of semiconductors

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with 2 from each unit (10 X 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 X 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 X 10 = 30).

Unit 1: Crystal structure: Reciprocal lattice and applications, Brillouin Zones, Laue equations and Bragg's law. Laue and powder diffraction; Structure factor, atomic form factor, Intensity of diffraction maxima, extinctions due to Lattice centering.

Unit 2: Electronic Properties: Motion of electron in periodic lattice, Bloch theorem, nearly free electron model, tight binding and cellular methods, effective mass, intrinsic and extrinsic semiconductors, Fermi Surface, Cyclotron resonance and de Haas--van Alphen effect

Unit 3: Magnetic Properties: Heisenberg model, molecular field theory, Spin waves and magnons, Curie-Weiss law for susceptibility, Theories of ferromagnetism, anti-ferromagnetism and ferrimagnetism.

Unit 4: Superconductivity: Meissner effect, London equation, Flux quantisation, Josephson effect, Crystal Defects: Point defects, line defects, planar faults, role of dislocations in Plastic deformation and crystal growth, colourcentres

Unit 5: Dielectric Properties: Microscopic concept of Dielectric polarisation, Langevin theory of polarisation, Claussius-Mossotti equation, Dielectrics in Alternating Field, Complex Dielectric constant and Dielectric loss, ferroelectricity, optical properties of crystals.

Course Outcomes:

Students will have understanding of:

1. Structures in solids and their determination using XRD.
2. Behavior of electrons in solids including the concept of energy bands and effect of the same on material properties.
3. Electrical, thermal, magnetic and dielectric properties of solids.

References:

1. Introduction to Solid State Physics, 3rd& 6th Editions. C. Kittel , Wiley Publishing
2. Condensed Matter in a Nutshell, Wil G. D. Mahan, Princeton Univ. Press 2011.
3. Solid State Physics, W. Ashcroft, N.D. Mermin Holt-Rinehart-Winston 1976.

Course

4. Elementary Solid State Physics, Principles and Applications, Ali Omar. M Addison Wesley Publishing , 2011

MPHY CC-12 Electronics Il (Analog and Digital Electronics) (5 Credits)

1. To understand the working of advanced semiconductor devices and digital circuits and the utility of OP-AMP
2. To learn the basics of integrated circuit fabrication, applications of timer IC-555 and building block of digital systems.

The End Semester Examination will be of 3 hour duration and will carry 70 marks (Pass Marks28). The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus (10 X 2 = 20). Part B will have five short answer questions, with at least one question from each unit. The student is required to answer any four out of them (4 X 5 = 20). Part C will have five long answer questions with at least one question from each unit. The student is required to answer any three out of them (3 x 10=30).

Unit-I: Operational Amplifiers construction and other linear devices: Building blocks of an OPAMP : Differential amplifier — dual input, balanced and unbalanced output amplifiers, current sources, current mirror, level translator, complementary symmetry output. 555 IC timer and its applications, Schmitt trigger. VCO and phase locked loops and their important applications.

Unit 2: OP-AMP applications: Instrumentation amplifier, logarithmic and exponential amplifiers, analog multiplication, comparators, astable and monostable multivibrators, half wave and full wave precision rectifiers, Active Filters — Second order Butterworth filters — LPF, HPF, narrow band and wide band, band-pass and band-reject filters.

Unit 3: Digital Circuits and Combinatorial logic I: Logic Families — TTL and CMOS, Construction of basic gates, characteristics. Combinatorial Circuits - Ys complement adder and subtractor.

Unit 4: Combinatorial logic Il: Decoder, encoder, multiplexer, demultiplexer, D/A and A/D convertors.

Unit 4: Sequential Circuits: Master-slave JK flip-flop, D and T flip-flops, edge triggered flip-flops; Registers and Counters — Shift registers, Bidirectional registers, ripple counter, synchronous counter, up-down counter, decade counter, Johnson and Ring counter.

Course Outcomes:

Students will have understanding of:

1. Fundamental designing concepts of different types of Logic Gates, Minimization techniques etc.
2. Designing of different types of the Digital circuits, and to give the computational details for Digital Circuits.
3. Characteristics of devices like PNP, and NPN junction diode and truth tables of different logic gates.
4. Basic elements and to measure their values with multimeter and their characteristic study.
5. Working of Flip-flops, registers and counters.

References:

Course Objectives:

1. T.F. Schubert and E.M.Kim, "Active and Nonlinear Electronics John Wiley Sons. New York (1996).
2. I -.1[L]'loyd. Electronic I)evices. • •Pearson Education" New York 2004
3. Dennis Le Crissitte, Transitors, Prentice Hall India Pvt. Ltd (1963)
4. J.Milman and C.C. Halkias, Integrated Electronics, McGraw Hill (1972)
5. A. Mottershed, Semiconductor Devices and Applications, New Age Int Pub
6. M. Goodge, Semiconductor Device Technology Mc Millan (1983)
7. S.M.Sze, Physics of Semiconductor Devices , Wiley-Eastern Ltd.,
8. Milman and Taub, Pulse, digital and switching Waveforms, McGrew Hiil (1965)
9. Ben.G.Streetman, Solid state electronic devices, Printice Hall, Englewood cliffs, NJ (1999)
10. R.A.Gayakwad, Op-Amps & Linear integrated circuits, Printice Hall India Pvt. Ltd.(1999)

MPHYCC-13 Nuclear and Particle Physics (5 Credits)

l. To study the general properties of nucleus
2. To study the nuclear forces and nuclear reactions.
3. To introduce the concept of elementary particles
4. To impart knowledge about basic nuclear physics properties and nuclear models for understanding of related reaction dynamics.

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus (10 X 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 X 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 X 10 = 30).

Unit 1: Nuclear forces: Exchange forces and tensor forces. Low energy nucleon- nucleon scattering, Effective range theory; Deuteron problem, high energy nucleon-nucleon scattering (Qualitative Discussion), Charge independence, spin dependence and charge symmetry of nuclear forces, Isospin formalism; Yukawa interactions

Unit 2: Nuclear reactions: Kinematics and conservation laws, Nuclear Reactions and Cross sections, Theory of Compound nucleus, Breit-Wigner single level formula, Mechanism of nuclear fission and fusion, Nuclear reactors

Unit 3: Nuclear models: (a) Single particle Shell model: Magic numbers, spin, parity, magnetic dipole moment, electric dipole moment, (b) The Nilsson unified model, (c) Collective model: vibrational and rotational states, [3 and y hands

Unit 4: Nuclear decay: Fermi theory of decay and forbidden transitions. Parity violationin decay and I of rieutrino. (b) Radiative ions In nuclei (Y-decay), Spontaneous decay, internal conversion, Mossbauer Effect

Unit 5: Elementary Particle Physics: Conservation Laws and Symmetry, Strangeness, hypercharge, CPT invariance, Classification of elementary particles, SU(2) symmetry and its application to decay and scattering processes, SU(3) symmetry and the Quark model, Elementary idea of chromodynamics.

Course Outcomes:

At the end of the course, the students can able to

1. Acquire basic knowledge about nuclear and particle physics
2. Develop the nuclear reactions and neutron physics.
3. Understand the nuclear fission and fusion reactions.
4. Impart the knowledge about the nuclear forces and elementary particles

References:

1. Kenneth S. Krane, Introductory nuclear physics, Wiley India, New Delhi (2008).

Course Objectives:

2. J. Basdevant, J. Rich, M. Spiro, Fundamentals in nuclear physics, Springer, New York (2005).
3. D. Griffiths, Introduction to elementary particles, Wiley VCH, Weinheim (2008).
4. D.C. Tayal, Nuclear Physics, 4^{th} edition, Himalaya House, Bombay (1980).

MPHYCC-14 Lab-Ill 5 Credits

l . To make the student familiarize with the basics of electronics.
2. To enable the student to explore the concepts involved in the oscillators
3. To make the student understand the basic concepts in IC and digital devices
4. To allow the student to understand the fundamentals of multivibrators

LIST OF EXPERIMENTS (minimum 12)

l . Study of Transistor Bias Stability
2. Construction a single stage RC coupled amplifier using transistor and study its frequency response.
3. Construction of a two stage RC coupled amplifier using transistor and study its frequency response.
4. Study of Silicon Controlled Rectifier
5. Study the characteristics of UJT
6. Experiment on FET and MOSFET characterization and application as an amplifier
7. Construction of an Astable tnultivibrator circuit using AIVIP & 555 IC's
8. Characteristics of Tunnel diode and Gunn diode
9. Construction of a bistable multivibrator circuit using IC555 and study its performance.
10. Construction of adder, subtracter, differentiator and integrator circuits using the given OP — Amp
I I . Construction of an A/D converter circuit and study its performance
12. Construction of an D/A converter circuit and study its performance
13. Construction of half— adder and full — adder circuit using NAND gates and study their performance.
14. Construction of half— subtracter and full — subtracter circuit using NAND gates.
1 5. l)esizn of sehimitt•s -crigget- using ICs 74 1 and 555 tituer — study of frequency divides.
16. Flip flops — RS, JK and D flip flops
17. Shift register and Photo diode characteristics
18. Study of counters: Ripple, Mode 3, Mod 5 counters
19. Photo — diode characteristics
20. Photo — transistor characteristics
21 . Analog computer circuit design — solving the simultaneous equations.
22. Multiplexer and Demultiplexer
23. Decoders and Encoders

Course Outcome:
At the end of the course,
1. The student will have a knowledge on the different experimental techniques involved in electronics.
2. The student should be able to independently construct the circuits.
3. The student should be able to apply the concepts of electronics and do the interpretation and acquire the result.

SEMESTER IV

MPHYEC-I Elective Pa er l 5 Credits