SEMESTER III

MPHYCC-10 ATOMIC AND MOLECULAR PHYSICS LASERS (5 CREDITS)

COURSE OBJECTS :

1. Objectives 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 transmissions and selection rules.
4. To understand the Raman Effect and its applications.

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 two 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 question 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 Atomic Model (LS, JJ and 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 : Electronics and Molecular Spectra:

Molecule as non-rigid rotator, Anharmonic Oscillator (vibrstion-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, Ruby Laser. He-Ne Laser, Semi conductor Lasers, Liquid (Dye) Lasers, Gas (CO_2) Lasers, Laser applications in industry, Spectroscopy, Light detection and Ranging (LIDAR), scanning laser beam devices. Laser communication, (injection photodiode and Avalanche Photodiode), and medical applications.

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MPHYCC-11 Condensed Matter Physics (5 CREDITS)

COURSE OBJECTS :

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 two 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 question 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, light binding and cellular methods, effective mass, intrinsic and extrinsic semi- conductors, 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 quantization, 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 polarization, Langevin theory of polarization, Claussius-Mossotti equation, Dielectric in Alternating Field, Complex Dielectric constant and Dielectric loss, ferroelectric, optical properties of crystals.

Course Outcomes:

Students will have understanding of:

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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-Rinehar-Winston 1976.
4. Elementary Solid State Physics, Principles and Applications, Ali Omar. M Addison Wesley Publishing, 2011.

Course 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, vibration, electronic and Raman spectra of molecules.
4. Electron spin and nuclear magnetic resonance spectroscopy.
5. Principle working and application of laser.

References:

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

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MPHYCC-12 Electronics II (Analog and Digital Electronics) (5 CREDITS)

COURSE OBJECTIVES:

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. 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 two 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 question with one question from each unit. The student is required to answer any three out of them (3 x 10 = 30).

Unit 1 : Operational Amplifiers construction and other linear devices:

Building blocks of an OP-AMP: Differential amplifier- dual input, balanced and unbalanced output amplifiers, current sources, 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-2"s complement adder and subtractor.

Unit 4: Combinatorial Logic II:

Decoder, encoder, multiplexer, demultiplexer, D/A and A/D convertors.

Unit 5: Dielectric Properties:

Master-slave JK flip-flop, D and T filp-flops, edge triggered flip-flops, Resistors and Counters-Shift resistors, Bidirectional registers, ripple counter, synchronous counter, up-down counter, decade counter, Johnson and Ring counter.

Course Outcomes:

Students will have understanding of:

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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 characteristics study.
5. Working of Flip-flops registers and counters.

References:

1. T.F. Schubert and E.M. Kim, Active and Nonlinear Electronics, John Wiley Sons, New York (1996).
2. I Floyd, Electronic Devices, Pearson Education New York (2004).
3. Dennis Le Crissitte, Transistors, 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 Hill (1965).
9. Ben G. Streetman, Solid state electronic devices, Printice Hall, Englewood cliffs, NJ (1999).
10. R.A. Gayakwad, Op-Amps and Linear integrated circuits, Printice Hall India Pvt. Ltd. (1999).
11. Digital Electronics by R.P. Jain.

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MPHYCC-13 Nuclear and Particle Physics (5 CREDITS)

COURSE OBJECTIVES:

1. 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 with two 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 question 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 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-Winger 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, β and γ bands.

Unit 4: Nuclear decay:

(a) Fermi theory of β decay, allowed and forbidden transitions Parity violation in β decay and Helicity of neutrino (b) Radiative transitions in nuclei (γ -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 Qark model, Elementary idea of chromo dynamics.

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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).
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, 4th edition Himalaya House, Bombay (1980).

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MPHYCC-14 Lab III (5 CREDITS)

COURSE OBJECTIVES:

1. 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)

1. Study of Transistor Bias Stability.
2. Study of single stage RC coupled amplifier using transistor and its frequency response.
3. Study of two stage RC coupled amplifier using transistor and its,freqnency response.
4. Study of Silicon Controlled Rectifier.
5. Study the characteristics of UJT.
6. Experiment of FET and MOSFET characterization and application as an amplifier.
7. Study of an Astable multivibrator circuit using OP-AMP.
8. Study of adder, subtracter, differentiator and integrator circuits using the given OP-AMP.
9. Study of an A/C converter circuit and its performance.
10. Study of an D/A converter circuit and its performance.
11. Construction of half -adder and full- adder circuit using NAND gates and study their performance.
12. FLIP flops-RS, JK and D flip flops.
13. Shift register and Photo diode characteristics.
14. Photo-diode characteristics.
15. Photo-transistor characteristics.
16. Multiplexer and Demultiplexer.

Course Outcomes:

At the end of the course,

1. The student will have knowledge on the different experimental techniques involved in electronics.
2. The student should be able to independently construct the circuit.
3. The student should be able to apply the concepts of electronics and do the interpretation and acquire the result.

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