SEMESTER - IV

PH4C11 ATOMIC AND MOLECULAR PHYSICS

Unit I

Atomic Spectra (18 Hrs)

The hydrogen atom and the three quantum numbers n, l and m_l. - electron spin - spectroscopic terms. Spin-orbit interaction, derivation of spin-orbit interaction energy, fine structure in sodium atom, selection rules. Lande g-factor, normal and anomalous Zeeman effects, Paschen–Back effect and

Stark effect in one electron system. L S and j j coupling schemes (vector diagram) - examples, derivation of interaction energy, Hund's rule, Lande interval rule. Hyperfine structure and width of spectral lines.(qualitative ideas only).

Text Book:

1. Spectroscopy, B.P. Straughan & S. Walker, Vol. 1, John Wiley & Sons

Unit II

Microwave and Infra Red Spectroscopy (18 Hrs)

Microwave Spectroscopy: Rotational spectra of diatomic molecules - intensity of spectral

lines - effect of isotopic substitution. Non–rigid rotor - rotational spectra of polyatomic molecules - linear and symmetric top - Interpretation of rotational spectra.

IR Spectroscopy: Vibrating diatomic molecule as anharmonic oscillator, diatomic vibrating rotor – break down of Born-Oppenheimer approximation - vibrations of polyatomic molecules - overtone and combination frequencies - influence of rotation on the spectra of polyatomic molecules - linear and symmetric top - analysis by IR technique - Fourier transform IR spectroscopy.

Text Books:

Fundamentals of molecular spectroscopy, C.N. Banwell, Tata McGraw Hill

Molecular structure and spectroscopy, G. Aruldhas, PHI Learning Pvt. Ltd.

Unit III

Raman and Electronic Spectroscopy. (18 Hrs)

Raman Spectroscopy: Pure rotational Raman spectra - linear and symmetric top molecules - vibrational Raman spectra – Raman activity of vibrations - mutual exclusion principle - rotational fine structure - structure determination from Raman and IR spectroscopy.

Non- linear Raman effects - hyper Raman effect - classical treatment - stimulated Raman effect - CARS, PARS - inverse Raman effect

Electronic Spectroscopy: Electronic spectra of diatomic molecules - progressions and sequences - intensity of spectral lines. Franck – Condon principle - dissociation energy and dissociation products - Rotational fine structure of electronic-vibrational transition - Fortrat parabola - Pre-dissociation.

Text books:

Fundamentals of molecular spectroscopy, C.N. Banwell, MGH

Molecular structure and spectroscopy, G. Aruldhas, PHI Learning Pvt. Ltd.

Lasers and Non-Linear Optics, B.B Laud, Wiley Eastern

Unit IV

Spin Resonance Spectroscopy (18 Hrs)

NMR: Quantum mechanical and classical descriptions - Bloch equations - relaxation processes - chemical shift - spin–spin coupling - CW spectrometer - applications of NMR.

ESR: Theory of ESR - thermal equilibrium and relaxation - g- factor - hyperfine structure -applications.

Mossbauer spectroscopy: Mossbauer effect - recoilless emission and absorption - hyperfine interactions – chemical isomer shift - magnetic hyperfine and electronic quadrupole interactions - applications.

Text Book:

Molecular structure and spectroscopy, G. Aruldhas, PHI Learning Pvt. Ltd.

Spectroscopy, B.P. Straughan & S. Walker, Vol. 1, John Wiley & Sons

Reference Books:

Introduction of Atomic Spectra, H.E. White, Mc Graw Hill

Spectroscopy (Vol. 2 & 3), B.P. Straughan & S. Walker, Science paperbacks 1976

Raman Spectroscopy, D.A. Long, Mc Graw Hill international, 1977

Introduction to Molecular Spectroscopy, G.M. Barrow, Mc Graw Hill

MolecularSpectraandMolecularStructure,Vol.1,2&3.G. Herzberg, Van Nostard, London.

Elements of Spectroscopy, Gupta, Kumar & Sharma, Pragathi Prakshan

The Infra Red Spectra of Complex Molecules, L.J. Bellamy, Chapman & Hall. Vol. 1 & 2.

Laser Spectroscopy techniques and applications, E.R. Menzel, CRC Press, India

PH4C12 NUCLEAR AND PARTICLE PHYSICS Unit I

Nuclear Properties and Force between Nucleons (18 Hrs)

Nuclear radius, mass and abundance of nuclides, nuclear binding energy, nuclear angular momentum and parity, nuclear electromagnetic moments, nuclear excited states

Duetron, nucleon-nucleon scattering, proton-proton and neutron-neutron interactions, properties of nuclear forces, exchange force model

Text Book:

1. Introductory Nuclear Physics, K. S. Krane Wiley, (Chapter 3&4)

Unit II

Nuclear Decay and Nuclear Reactions (18 Hrs)

Beta decay, energy release, Fermi theory, experimental tests, angular momentum and parity selection rules, Comparative half lives and forbidden decays, neutrino physics, non conservation of parity

Types of reactions and conservation laws, energetics of nuclear reactions, isospin, Reaction cross sections, Coulomb scattering, nuclear scattering, scattering and reaction cross sections, compound-nucleus reactions, direct reactions, heavy ion reactions.

Text Book:

1. Introductory Nuclear Physics, K. S. Krane Wiley, (Chapter 9&11)

Unit III

Nuclear Models, Fission and Fusion (18 Hrs)

Shell model potential, Spin-orbit potential, Magnetic dipole moments, Electric quadrupole moments, Valence Nucleons, Collective structure,

Nuclear vibrations, Nuclear rotations, Liquid drop Model, Semi-empirical Mass formula

Characteristics of fission - energy in fission - fission and nuclear structure, Controlled fission reactions - Fission reactors.

Fusion processes, Characteristics of fusion, Controlled fusion reactors Text Book:

1. Introductory Nuclear Physics, K. S. Krane Wiley, (Chapter 5, 13 &14)

Unit IV

Particle Physics (18 Hrs)

Types of interactions between elementary particles, Hadrons and leptons-masses, spin, parity and decay structure. Quark model, confined quarks, coloured quarks, experimental evidences for quark model, quark-gluon interaction. Gell-Mann-Nishijima formula, symmetries and conservation laws, C, P and T invariance, applications of symmetry arguments to particle reactions, parity non-conservation in weak interactions. Grand unified theories.

Text Book:

1.Introductory Nuclear Physics, K. S. Krane Wiley, (Chapter 18)

2. Nuclear Physics, D. C. Tayal, Himalaya Publishing House (Chapter 16)

Reference Books:

Introduction to Elementary Particle, D.J. Griffiths, Harper and Row, NY,(1987)

Nuclear Physics, R.R. Roy and B.P. Nigam, New Age International, NewDelhi, (1983).

The particle Hunters - Yuval Ne'eman & Yoram kirsh CUP, (1996)

Concepts of Nuclear Physics, B.L. Cohen, TMH, New Delhi, (1971).

Theory of Nuclear Structure, M.K. Pal, East-West, Chennai, (1982).

Atomic Nucleus, R.D. Evans, McGraw-Hill, New York.

Nuclear Physics, I. Kaplan, 2nd Edn, Narosa, New Delhi, (1989).

Introduction to Nuclear Physics, H.A. Enge, Addison Wesley, London, (1975).

Introductory Nuclear Physics, Y.R. Waghmare,Oxford-IBH, New Delhi, (1981).

Atomic and Nuclear Physics, Ghoshal,Vol. 2, S. Chand & Company

Fundamentals of Elementary Particle Physics, J.M. Longo, MGH, New York, (1971).

Nuclear and Particle Physics, W.E. Burcham and M. Jobes, Addison-Wesley, Tokyo, (1995).

Subatomic Physics, Frauenfelder and Henley, Prentice-Hall.

Particles and Nuclei: An Introduction to Physical Concepts, B. Povh, K. Rith, C. Scholz and Zetche, Springer (2002)

Elementary Particles and Symmetries, L.H. Ryder, Gordon and Breach, Science Publishers, NY, 1986

3.3 ELECTIVES

3.3.1 BUNCH – A: ELECTRONICS

PH3EA1: INTEGRATED ELECTRONICS AND DIGITAL SIGNAL PROCESSING

Unit I

Integrated Circuit Fabrication and Characteristics (16 Hrs)

Integrated circuit technology – basic monolithic IC – epitaxial growth – marking and etching – diffusion of impurities – transistor for monolithic circuit – monolithic diodes – integrated resisters, capacitors and inductors – monolithic circuit layout - additional isolation methods – MSI, LSI, VLSI (basic ideas) – the metal semiconductor contact.

Unit II

Basics of Digital Signal Processing (18 Hours)

Signals and representation – classification - continuous time (CT) and discrete time (DT) signals - standard CT and DT signals - Fourier Analysis of periodic and aperiodic continuous time signals - convolution and correlation of DT and CT Signals – classification of systems CT – DT - causal, noncausal, static and dynamic systems - stable systems - FIR and IIR systems -frequency domain representation of systems

Unit III

DSP Techniques (18 Hrs)

Frequency analysis of DT signals - discrete Fourier Transform - Fast Fourier Transform (FFT) - Decimation in time and decimation in frequency algorithm - Z-Transform regional convergence and properties - relation to

Fourier Transform - Poles and Zeros of system function - Gibb's phenomenon

Unit IV

Digital Filters (20 Hrs)

FIR and IIR Filters - IIR Filter design techniques - Approximation of derivatives -Impulse invariant method - Bilinear transformation - FIR filter design techniques - Fourier Series method - Window techniques - FIR filter using rectangular window - Realisation of IIR systems - Direct form I & form II realization - Direct form and cascade form realization of FIR systems - Finite word length affecting digital signal processing.

Text Books

Integrated Electronics – Analog and Digital Circuits and Systems, J. Millmann & C.C. Halkias, TMGH

Digital Signal Processing: Theor, Analysis and Digital-Filter Design, B. Somanathan Nair, PHI (2004)

Digital Signal Processing, P. Ramesh Babu, Scitech

Digital Signal Processing, Alan V. Oppenheim & R.W.Schafer, PHI

Reference Books:

Computer applications in physics, Suresh Chandra, Alpha Science International (2006)

Digital Signal Processing, S. Salivahanan, A. Vallavaraj, C. Gnanapriya, TMH

Signals and Systems, Allan V. Oppenheim, Alan S. Willsky, S.H. Nawab, PHI

Digital Signal Processing, John G. Proakis, Dimitris G. Manolakis, PHI

Digital signal processing, Sanjay Sharma, S.K. Kataria & Sons, 2010

Mathematical Methods for Physicists, G.B. Arfken & H.J. Weber.Elsavier, Academic Press

PH3EA2 MICROELECTRONICS AND SEMICONDUCTOR DEVICES

Unit I

Basics of Digital Techniques (18 Hrs)

Review of 8085 microprocessor - General organization of a microprocessor based microcomputer system – memory organization – main memory array – memory management – cache memory – virtual memory - input/output - standard I/O – memory mapped I/O – microcomputer I/O circuits – interrupt driven I/O –DMA – RAM - hard disk - CD – Flash memory.

Unit II

8086 Microprocessor (19 Hrs)

The Intel 8086 - architecture - MN/MX modes - 8086 addressing modes - instruction set- instruction format - assembler directives and operators - Programming with 8086 - interfacing memory and I/O ports - Comparison of 8086 and 8088 - Coprocessors - Intel 8087 - Familiarisation with Debug utility.

Unit III

Microcontrollers (19 Hrs)

Introduction to microcontrollers and Embedded systems - comparison of microprocessors and microcontrollers - The 8051 architecture - Register set

of 8051 - important operational features - I/O pins, ports and circuits - external memory - counters and timers – interrupts - Instruction set of 8051 - Basic programming concepts - Applications of microcontrollers - (basic ideas) – Embedded systems(basic ideas)

Unit IV

Semiconductor Devices (16 hrs)

Schottky barrier diode - qualitative characteristics – ideal junction properties – nonlinear effects on barrier height – current voltage relationship – comparison with junction diode – metal semiconductor ohmic contact – ideal non rectifying barriers – tunnelling barrier – specific contact resistances – hetro-junctions – hetro junction materials – energy band diagram – two dimensional electron gas – equilibrium electrostatics – current voltage characteristics

Text Books

Microprocessors and Microcomputer based system design, H. Rafiquizzaman, Universal Book stall, New Delhi

Microprocessor and Peripherals, S.P. Chowdhury & S. Chowdhury- SCITECH Publications

Microprocessor Architecture Programming and Applications with 8085, R.S. Gaonkar – Penram int. Pub. Mumbai

The 8051 microcontroller, Architecture Programming and Applications, Kenneth J Ayala- Penram Int. Pub. Mumbai.

Semiconductor Physics and Devices, Donald A. Neamen, McGraw Hill

Reference Books:

0000 to 8085 Introduction to Microprocessors for Engineers and Scientists.- P.K. Gosh & P.R. Sridhar, PHI

Advanced microprocessors and peripherals, A.K. Ray & K.M. Burchandi – TMH.

Microprocessor and microcontroller, R. Theagarajan- SCITECH Publications India Pvt. Ltd.

Operating system Principles, Abraham Silberschatz & Peter Baer Galvin & Greg Gagne, John Wiley

PH4EA3 INSTRUMENTATION AND COMMUNICATION ELECTRONICS

Unit I

Transducers and Digital Instrumentation (20 Hrs)

Transducers: Classification of transducers - electrical transducer - resistive transducer - strain gauges- piezo-electric and magnetostrictive transducers - Hall effect transducers -thermistor inductive transducer - differential output transducers - pressure transducers - pressure cell - photoelectric transducers - photo voltaic cell – semi conductor photo diode – thermo electric transducers – mechanical transducers – ionization transducers – digital transducers - electro chemical transducers.

Digital Instrumentation: Digital counters and timers - digital voltmeter – RAMP - voltage to time conversion - voltage to frequency conversion - frequency to voltage conversion - digital multimeter - digital phase meter - digital frequency meter - time and frequency measurement – tachometer - pH meter.

Unit II

Measurement of Basic Parameters and Recorders (18 Hrs)

Transistor Voltmeter - amplified DC meter – A.C voltmeters using rectifiers – precision rectifier – true RMS responding voltmeter – chopper type DC amplifier voltmeter - milli voltmeter using operational amplifier – differential voltmeter – Ohm meter – electronic multimeter – commercial multimeter – output power meters - stroboscope – phase meter – vector impedance meter – Q meter – RF measurement – transistor testers – CRO (Basic ideas)

Recorders: Strip chart recorders - XY recorders - digital XY plotters - magnetic recorders -digital data recording - Storage oscilloscope – Digital storage oscilloscope

Unit III

Introduction to Communication (18 Hrs)

Bandwidth requirements − SSB technique – radio wave propagation − Ionosphere − Ionosphere variations − Space waves − Extraterrestrial communication - Transmission lines − Basic principles − Characteristic impedance − Losses − Standing waves − Quarter and half wavelength lines.

Television fundamentals − Monochrome transmission − Scanning − Composite TV video wave form − Monochrome reception − Deflection

circuits – Colour Television. Basic ideas of high definition TV – LCD & LED TV

Unit IV

Digital Communication (16 hrs)

Pulse Communication – Information theory – Coding – Noise – Pulse modulation – PAM – PTM – PCM – PPM. Digital communication – Data Communication – Digital codes – Data Sets and interconnection requirements.

Multiplexing techniques – Frequency division and time division multiplexing. Microwave generators – Klystron and Magnetron – Satellite communication. Digital cellular systems GSM, TDMA and CDMA – basic ideas of GPS

Text Books:

Electronic Instrumentation, H.S. Kalsi,TMH (1995)

Transducers and instrumentation, D.V.S. Murty, PHI (1995)

Monochrome and Colour Television R.R. Gulati, New Age India

Electronic communication systems, George Kennedy, TMH

MobileCellularTelecommunicationSystems,WilliamC.Y.Lee, MGH

Reference Books:

Modern electronic Instrumentation and Measurement Techniques, A.D. Helfric & W.D. Cooper,PHI, (1997)

Instrumentation-Devices and Systems 2nd Edn. C.S. Rangan, G.R. Sarma, V.S.V. Mani, TMH, (1998)

Electronic Measurements and Instrumentation, M.B. Olive & J.M. Cage, MGH, (1975)

Digital Instrumentation, A.J. Bouwens,TMH, (1998)

Elements of Electronic Instrumentation, J. Jha, M. Puri, K.R. Sukesh, & M.Kovar., Narosa, (1996)

Instrumentation Measurement and Analysis, B.C. Nakra & K.K. Chaudhry, TMH, (1998)

Op-amps and Linear Integrated Circuits, R.A. Gaykward, PHI, (1989)

Electronic fundamentals and Applications, John D. Ryder, PHI.

Satellite communication, Robert M.Gagliardi, CBS Publishers, Delhi.

Electric and electronic measurements and instrumentation 10^{th} Edn. A.K. Sawhney, Dhanpath Rai & Company.

PH4PA4 ADVANCED ELECTRONICS PRACTICALS

(Minimum of 12 Experiments should be done choosing at least 2 experiments from each group)

[A] Microprocessors and Micro Controllers (use a PC or 8086-µp kit)

Sorting of numbers in ascending/descending order.

Find the largest and smallest of numbers in array of memory.

Conversion of Hexadecimal number to ASCII and ASCII to Hexadecimal number.

Multi channel analog voltage measurements using AC card.

Generation of square wave of different periods using a microcontroller.

Measurement of frequency, current and voltage using microprocessors.

Communication Electronics

Generation PAM and PWM

Frequency modulation and demodulation using IC –CD4046.

Multiplexer and demultiplexer using digital IC 7432.

Radiation characteristics of a horn antenna.

Measurement of characteristic impedance and transmission line parameters of a coaxial cable.

Electronic Instrumentation

DC and AC milli-voltmeter construction and calibration.

Amplified DC voltmeter using FET.

Instrumentation amplifier using a transducer.

Generation of BH curve and diode characteristics on CRO.

Voltage to frequency and frequency to voltage conversion.

Construction of digital frequency meter.

Characterization of PLL and frequency multiplier and FM detector.

Optoelectronics

Characteristic of a photo diode - Determination of the relevant parameters.

Beam Profile of laser, spot size and divergence.

Temperature co-efficient of resistance of copper.

Data transmission and reception through optical fiber link.

OPTIONAL ELECTIVE BUNCH

PH4OE1: OPTOELECTRONICS

Unit I

Semiconductor Science and Light Emitting Diodes (10 hrs)

Semiconductor energy bands - semiconductor statistics – extrinsic semiconductors – compensation doping – degenerate and non degenerate semiconductors – energy band diagrams in applied field - direct and indirect bandgap semiconductors, - p-n junction principles - open circuit- forward and reverse bias – depletion layer capacitance – recombination life time – p-n junction band diagram - open circuit - forward and reverse bias – light emitting diodes – principles - device structures - LED materials, heterojunction high intensity LEDs – double heterostructure - LED

characteristics and LEDs for optical fiber communications - surface and edge emitting LEDs.

Text Book

Optoelectronics and Photonics: Principles and Practices, S.O. Kasap, Pearson 2009, (Chapter 3)

Fiber Optics (10 Hrs)

Symmetric planar dielectric slab waveguide – waveguide condition – single and multimode waveguides – TE and TM modes – modal and waveguide dispersion in the planar waveguide – dispersion diagram – intermodal dispersion – intramodal dispersion – dispersion in single mode fibers – material dispersion – waveguide dispersion – chromatic dispersion – profile and polarization dispersion – dispersion flattened fibers - bit rate and dispersion – optical and electrical bandwidth – graded index optical fiber - light absorption and scattering – attenuation in optical fibers.

Text Book:

Optoelectronics and Photonics: Principles and Practices, S.O. Kasap, Pearson (2009), (Chapter 2)

Unit II

Laser Principles (10 hrs)

Laser oscillation conditions - diode laser principles - heterostructure laser diode – double heterostructure – stripe geometry – buried heterostructure – gain and index guiding - laser diode characteristics – laser diode equation - single frequency solid state lasers – distributed feedback –quantum well lasers - vertical cavity surface emitting laser - optical laser amplifiers.

Text Book:

Optoelectronics and Photonics: Principles and Practices, S.O. Kasap, Pearson (2009), (Chapter 4)

Laser Output Control (6 hrs)

Generation of high power pulses, Q-factor, Q-switching for giant pulses, methods of Q-switching, mode locking and techniques for mode locking.

Text Book:

1. Laser fundamentals, William T. Silfvast, CUP 2nd Edn. (2009), (Chapter 13)

Unit III

Photodetectors and Photovoltaics (18 hrs)

Principle of p-n junction photodiode - Ramo's theorem and external photocurrent - absorption coefficient and photodiode materials - quantum efficiency and responsivity - PIN-photodiode – avalanche photodiode – phototransistor - photoconductive detectors and photoconductive gain - noise in photo-detectors – noise in avalanche photodiode - solar energy spectrum - photovoltaic device principles – I-V characteristics - series resistance and equivalent circuit - temperature effects - solar cell materials, device and efficiencies

Text Book

Optoelectronics and Photonics: Principles and Practices, S.O. Kasap, Pearson (2009), (Chapter 5 & 6)

Unit IV

Optoelectronic Modulators (10 Hrs)

Optical polarization, birefringence, retardation plates, electro-optic

modulators – Pockels effect - longitudinal and transverse electro-optic modulators, Kerr effect, Magneto-optic effect, acousto-optic effect – Raman Nath and Bragg-types.

Text Books:

1. Fiber optics and Optoelectronics, R.P. Khare, Oxford University Press, (2004), (Chapter 9)
2. Optoelectronics:an Introduction,J.WilsonandJ.F.B.Hawkes, PHI, (2000), (Chapter 3)

Non-linear optics(8 Hrs)

Wave propagation in an anisotropic crystal - polarization response of materials to light - second order non-linear optical processes - second harmonic generation - sum and frequency generation, optical parametric oscillation - third order non-linear optical processes - third harmonic generation - intensity dependent refractive index - self-focusing - non-linear optical materials, phase matching - angle tuning - saturable absorption - optical bistability - two photon absorption.

Text Book:

1. Laser fundamentals, William T. Silfvast, CUP 2nd Edn. 2009, (Chapter 16)

Reference Books:

Semiconductor optoelectronic devices: Pallab Bhattacharya, Pearson(2008)

Optoelectronics: An introduction to materials and devices, Jasprit Singh, Mc Graw Hill International Edn., (1996).

Optical waves in crystals: Propagation and Control of Laser Radiation, A. Yariv and P. Yeh, John Wiley and Sons Pub. (2003)

Formation of large scale structure - Jeans mass in the expanding universe, Growth in the postrecombination era, Observational constraints, Elementary ideas on structure formation

Observations of the cosmological significance - Measurement of Hubble's constant, Anisotropy of large-scale velocity fields, Age of the universe, Abundance of light nuclei, Dark matter, Microwave background, Gravitational wave stochastic background.

Text Books:

First course in general relativity, B. F. Schutz Cambridge: Cambridge University Press.

General Relativity and Cosmology, J. V. Narlikar Delhi: Macmillan Company of India Ltd.

General Relativity, I. R. Kenyon, Oxford University Press.

Classical Theory of Fields, Vol. 2, L. D. Landau and E. M. Lifshitz, Oxford : Pergamon Press.

Introduction to Cosmology, 3rd Edition, J. V. Narlikar, Cambridge University Press.

CHAPTER – IV

PARALLEL PGCSS PHYSICS PROGRAMMES

Introduction:

In this chapter, three parallel PGCSS programmes coming under the umbrala subject physics are presented. These three PG Programmes are taught in three colleges affiliated to M.G.University. The colleges and the respective PG Prograames are given in Table 4.1. The number of hours per week, number of credit per course and the total hours per semester allocated to a course in these parallel PGCSS programmes will remain same as those for M.Sc. Physics programme as described in Chapter – I. These programmes have 12 Core corses and 4 Elective courses each. There will not be any open elective bunch for these programs. The four Elective courses are accommodated two each in Semester III and Semester IV.

Sl. No.	Name of college	PGCSS Programme
1	C.M.S. College, Kottayam	M.Sc. Applied Physics
2	S. B. College, Changanassery	M.Sc. Renewable Energy
3	Catholicate College, Pathanamthitta	M.Sc. Material Science

Table 4.1 Colleges and parallel PGCSS Programmes

The examination pattern and question paper modal remain the same as that described in Chapter –II. The mode of conduct of these programmes are required to follow the rules depicted in Chapter – II. The changes are only in the Course Codes and Course Titles. These are given in the repective Tables.