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:
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. Aruldas, 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


Text books:
Fundamentals of molecular spectroscopy, C.N. Banwell, MGH
Molecular structure and spectroscopy, G. Aruldas, 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.

**Reference Books:**
- Introduction to Molecular Spectroscopy, G.M. Barrow, Mc Graw Hill
- Elements of Spectroscopy, Gupta, Kumar & Sharma, Pragathi Prakshan
- 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)
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)

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

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


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


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


Subatomic Physics, Frauenfelder and Henley, Prentice-Hall.


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)

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 & 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, P. Ramesh Babu, Scitech
Digital Signal Processing, Alan V. Oppenheim & R.W. Schafer, PHI

Reference Books:
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
PH3EA2 MICROELECTRONICS AND SEMICONDUCTOR DEVICES

Unit I
Basics of Digital Techniques (18 Hrs)

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
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)

**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)**


**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)**

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

Unit IV

Digital Communication (16 hrs)


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

Reference Books:

Electronic fundamentals and Applications, John D. Ryder, PHI.
Satellite communication, Robert M. Gagliardi, CBS Publishers, Delhi.

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.
PH4OE1: OPTOELECTRONICS

Unit I

Semiconductor Science and Light Emitting Diodes (10 hrs)

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

Text Book


**Fiber Optics (10 Hrs)**

Text Book:

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

**Unit II**

**Laser Principles (10 hrs)**
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)


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

Text Books:

1. Fiber optics and Optoelectronics, R.P. Khare, Oxford University Press, (2004), (Chapter 9)

Non-linear optics (8 Hrs)

Text Book:


Reference Books:

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.
CHAPTER – IV

PARALLEL PGCSS PHYSICS PROGRAMMES

Introduction:
In this chapter, three parallel PGCSS programmes coming under the umbrella subject physics are presented. These three PG Programmes are taught in three colleges affiliated to M.G.University. The colleges and the respective PG Programmes 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 courses 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.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of college</th>
<th>PGCSS Programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C.M.S. College, Kottayam</td>
<td>M.Sc. Applied Physics</td>
</tr>
<tr>
<td>2</td>
<td>S. B. College, Changanassery</td>
<td>M.Sc. Renewable Energy</td>
</tr>
<tr>
<td>3</td>
<td>Catholicate College, Pathanamthitta</td>
<td>M.Sc. Material Science</td>
</tr>
</tbody>
</table>

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 respective Tables.