University of Pune

Syllabus of M.Sc. IInd Year (Physics)

(Post graduate centers)

To be implemented from

June 2009

M.Sc. (Physics)

STRUCTURE

Semester-I

1) PHYUTN – 501 Classical Mechanics
2) PHYUTN – 502 Electronics
3) PHYUTN – 503 Mathematical Methods in Physics
4) PHYUTN – 504 Quantum Mechanics I
5) PHYUPN – 505 Basic Physics Lab – I

Semester – II

1) PHYUTN – 601 Electrodynamics
2) PHYUTN – 602 Atoms, molecules and Solids
3) PHYUTN – 603 Statistical Mechanics in Physics
4) PHYUTN – 604 Quantum Mechanics II
5) PHYUPN – 605 Electronic Lab.

Semester – III

1) PHYUTN – 701 Solid State of Physics
2) PHYUPN – 702 Computer Lab.
3) PHYDTN – 703 Departmental Course 1
4) PHYDTN – 704 Departmental Course 2
5) PHYDPN – 705 Special Lab. I

Semester – IV

1) PHYUTN – 801 Nuclear Physics
2) PHYDTN – 802 Departmental Course 3
3) PHYDTN – 803 Departmental Course 4
4) PHYDPN – 804 Special Lab. II
5) PHYUPN – 805 Project

Note : For all Practical and Project Course, there will be one internal and one external examiner.

PHYUT – 701 SOLID STATE PHYSICS

I] Free Electron Theory:

a) Revision : Widemann – Franz law, Lorentz number Sommerfeld model of free electron theory, Energy levels in one dimension, free electron gas in three dimension. (Only problems will be asked in examination)
b) F-D Statistics (Qualitative ideas)
c) DC and AC electrical conductivity of metals
d) Dielectric function of electron gas, plasma optics Dispersion relation for e.m. waves.

Ref. 1. **(4L+2P)**

II] Band Theory of Solids:

a) Nearly free electron model
b) Block theorem (with proof)
c) Kronig-Penney model
d) Motion of electron in 1-D according to band theory.
e) Distinction between metals, insulators and intrinsic semiconductors.
f) Concept of hole
g) Tight binding model for energy bands.
h) reduced, periodic & extended zone schemes
i) Construction Fermi surfaces in 2-D and cyclotron resonance
j) Quantization of electronic orbit in a magnetic field.

Ref. 1: Ch. 7 and 9

(8L+2P)

III] Diamagnetism and Paramagnetism :

a) Classical theory of diamagnetism
b) Langevin theory of Paramagnetism
c) Quantum theory of Paramagnetism
d) Paramagnetic susceptibility of conduction electron
e) Magnetic properties of rare earth ions & iron group ions – graphical representation
f) Crystal field splitting, quenching of orbital angular momentum.

Ref. 1: Ch. 14 **(7L+ 1P)**

III] Ferromagnetism, Antiferromagnetism & Ferrimagnetism :

a) Ferromagnetism : Wiess theory, Curie point, Exchange integral, saturation magnetization and its temperature dependence, Saturation magnetization at absolute zero, ferromagnetic domains, Anisotropy energy, Bloch wall.
b) Antiferromagnetism : Neel temperature
c) Ferrimagnetism : Curie temperature, susceptibility of ferrimagnets, iron garnets.

Ref. 1 :Ch 15 **(7L+2P)**

III) Superconductivity :

a) Occurrence of superconductivity
b) Meissner effect
c) Heat capacity, Energy gap, Microwave and IR properties, Isotope effect.
d) Type I and II superconductors
e) Thermodynamics of superconductivity
f) London equation
g) London penetration depth
h) BCS theory
i) Quantization in a superconductivity ring
j) Qualitative discussion of Josephson superconductor tunneling.

Ref. 1 : Ch.12 **(8L+1P)**

IV) Dielectrics & Ferroelectrics

a) Polarization
b) Depolarization field E_1
c) Local electric field at an atom- Lorentz Field E_2 Field of dipoles inside cavity E_3
d) Dielectric constant and polarizability
e) Ferroelectricity – concept only, Case study of $BaTio_3$.

Ref. 1. Ch.: 13. **(5L+1P)**

Reference Books :

1. Introduction to solid states Physics - Charles, Kittle 7^{th} Edition
2. Introductory Solid States Physics – H. P. Myers
3. Solid States Physics - S.O. Pillai (latest edition)
4. Elementry Solid States Physics : M. Ali Omar
5. Problem in Solid State Physics – S.O. Pillai
6. Solid States Physics – A.J. Dekkar
7. Solid states Physics – Wahab
8. Solid States Physics – Ibach & Luth

PHYUT – 702 COMPUTER LABORATORY

Expected Background: Course contents of PH- 345, C' Programming and Computational Physics. (To be covered by the teacher if required)

Objective : To enable students to use numerical methods in solving problems in Physics and any other areas.

Note : (1) The theoretical background relevant to the experiments listed below should be discussed during practical sessions only.

(2) Wherever possible, the output should be presented in graphical form also.

List of Experiments: Student should perform any four experiments from section-I and any eight experiments from Section-II.

Section-I

(1) Calculate the special functions

(a) Legendre polynomials using the standard recurrence relation. Confirm that the method works well for Legendre functions by comparing with standard tables for special functions. (Use forward recursion.)

(b) Bessel functions of the first kind using the standard recurrence relation.

Use backward recursion with

$J_{50}(x) = 0$, $J_{49}(x) = 0.1 \times 10^{-30}$ and the sum rule

$$J_0(x) + 2\sum_{n=1}^{25} J_{2n}(x) = 1 \quad \text{to get} \quad J_0(x) \text{ to } J_{10}(x) .$$

Analyse your results and causes of errors

(2) To generate random numbers

(3) **Interpolation** : Interpolate the value of a function at a point. Use Legrange interpolation method.

(4) **Rotation of matrix** : Rotate the elements of a n x n matrix in clockwise/ anticlockwise direction and display the matrices ($n \geq 5$).

(5) **Inverse of a matrix** : Find the inverse of a n x n matrix and display both matrices ($n \geq 5$).

(6) **Trapezoidal / Simpson rule** : Evaluate a given function f(x) using Trapezoidal / Simpson rule correct upto given accuracy by successively halving the stepsize.

Section -II

(7) **Graphics** ; Write a program and display the Miller planes in the cubic lattice. Display the FCC, BCC, and simple cubic lattice on the computer screen.

(8) **Differential Equation** : Find out the motion of a charged particle in a uniform magnetic field. The equation of motion of particle with charge 'q' and mass 'm' in a uniform magnetic field B is given by.

$$d^2\mathbf{r} / dt^2 = q / m (\vec{\mathbf{v}} \times \vec{\mathbf{B}}),$$ where $\vec{\mathbf{r}}$ denotes the position vector.

(9) **Gauss – Elimination method** : Circuit analysis using Kirchoff's Laws. Write the relations for currents through various branches of a Wheatstone's bridge. Find the current using Gauss elimination method.

(10) **Different equation** :Write the differential equation for charging / discharging of a capacitor C through a resistance 'R'. Solve this equation using Euler method and display your result in tabular as well as graphical form.

(11) **Differential Equation** : Write the one – dimentional time independent Schrodinger's equation. Solve it using Runge- Kutta method for three different types of potentials. Display your result in tabular as well as graphical form.

(12) **Monte-Carlo method** : Find out the value of 'π' using Monte- Carlo method. Obtain your result correct up to five decimal positions.

(13) **Fourier Analysis** : Perform the Fourier analysis for the superposition of sine waves and display it on the screen. Given;

i) Number of terms in Fourier series to be included.

ii) Fundamental frequency

iii) Maximum time

iv) Step size

(14) Calculate and plot the electric field and potential distribution due a point charge.

(15) Use modified Euler method to solve the differential equation

$$F = m \left(d^2 z / dt^2 \right) = mg$$

For the displacement z of a freely falling body as a function of time t, from a given height $z = z_0$ at $t = 0$. Compare with known analytical results.

i) Add a term due to buoyancy of air on the motion of a spherical body (say a rain drop) of radius r (No damping due to viscosity and drag is considered). Thus,

$$F = m \frac{d^2Z}{dt^2} = \left[M - \frac{4}{3} \pi r^3 \rho \right] g.$$

ρ is the density of air. What happens if the density depends on z ?

ii) Fall of a body in viscous medium : In a liquid medium there is a drag and the force acts in a direction opposite to that of motion and is proportional to the velocity of the particle. Thus,

$$F = m \frac{d^2Z}{dt^2} = m \left[g - \frac{\sigma \eta r \pi}{m} \frac{dz}{dt} \right],$$

η is the coefficient of viscosity of the liquid.

Draw the trajectory to observe position of the falling body at equal time intervals. Are the distance between the body at different times equal ? Change the size, mass, medium etc. and analyse the result.

(16) Consider the motion of a point mass under the influence of a harmonic restoring force $F = -kx$. Solve $m\left(d^2x/dt^2\right) = -kx$ for x as a function of time. The kinetic energy of the mass = $\frac{1}{2} mv^2 = \frac{1}{2} m\left(dx/dt\right)^2 = p^2/2m$ and potential energy is kx. Such that the total energy $E = T+V$ = constant through out the motion. Calculate x,T,V,E for various values of t starting with $t = 0$ and time step $h = dt$, plot x,T,V,E as a function t and find the period of oscillation from the graph. Compare with analytical result

$x = x_0 \cos \omega t$, $T = \frac{1}{2} kx_0^2 \sin^2 wt$, $V = \frac{1}{2} kx_0^2 \cos^2 \omega t$, $E = \frac{1}{2} kx_0^2$

with $\omega^2 = k / m$.

Plot $p = m(dx / dt) = x_0\omega \sin \omega t$ as a function of x. This is the phase space trajectory of the mass. Analyse the curve for various values of Δt. Add damping with damping force proportional to velocity.

$F_{damp} = \alpha\left(dx/dt\right)$ and solve $m\left(d^2x/dt^2\right) = -kx + \alpha\left(dx/dt\right)$

analyse x,T,V,E vs t graphs and the phase space trajectory for the damped harmonic oscillator with α positive and negative.

Reference Books :

1. The C Programming Language : B.W. Kernighan and D.M. Ritchie. Prentice Hall of India Pvt. Ltd., (1985).
2. Schuam's series "Programming in C".
3. Introductory Methods of Numerical Analysis, S.S. Sastry, Prentice Hall of India Pvt. Ltd., (1990).
4. Computational Physics, R.C. Verma, P.K. Ahluwalia and K.C. Sharma, New Age International Publishers (1999).
5. Computational Physics, S.E. Koonin, Benjamin / Cumming Pub. Co., (1986)
6. Computer Methods for Engineering, Y.Jaluria, Allyn and Bacon Inc.,(1988).
7. An Introduction to Computational Physics, T. Pang, Cambridge Uni. Press. (1997)

8. Numerical Analysis : A Practical Approach., M.J. Maron, Macillan Pub. Co. (1997) Inc. (1982).
9. Computer Oriented Numerical Methods, V. Rajaraman.
10. Elementary Numerical Analysis – An algorithmic approach (3^{rd} Ed.): Samuel D. Conte, Carl de Boor. International Student Edition.
11. A first course in Computational Physics, Paul D. Devies, Joh Wiley and Sons.
12. An Introduction to computer simulation methods – applications to physics systems part – I and part – II. Harvey Could Jan Tobochrish, Addison-Wesley Publishing Co.
13. Schaum's outlines – Numerical Analysis (2^{nd} Edition)

PHYUT – 801 NUCLEAR PHYSICS

1. Properties of Nucleus :

Size : Determination by high energy electron scattering method.
Mass : Determination by Bainbridge and Jordan mass spectrograph. Magnetic dipole moment, Electric quadrupole moment and interaction energy, spin & parity, life time of nuclear level

Ref. 1 : Ch.1,9 ; Ref. 4 : Ch.1,7 : Ref. 5 : Ch.1, 6. **(4L + 2P)**

2. Nucleon – Nucleon Scattering :

n-p scattering at low energy, phase shift analysis, scattering length, shape independent effective range theory, Coherent scattering by hydrogen molecule (ortho & parahydrogen).p-p scattering at low energy, n-p and p-p scattering at high energy.

Ref. 1: ch.8 ; Ref.5 : ch.3 **(7L + 1P)**

3. Nuclear Reactors : (Design & applications);

Revision of general concepts of nuclear fusion and fission, Nuclear chain reaction, four factor formula, critical size and mass, various geometries, general aspects of reactor design, classification of nuclear reactors, research & productions reactors – Graphite moderated, swimming pool, light water moderated; Power reactors : heavy water moderated, fast breeder.

Ref. 1 : Ch. 15, Ref. 10: Ch. 16 **(5L + 2 P)**

4. Nuclear decays :

α decay – Gamow theory

β decay – Fermi theory, Curie plots, neutrino, parity conservation violation in β decay, Wu's experiment.

γ decay – Multipole radiation, selection rules.

Ref. 1 : Ch. 5, 6, 7. **(6L + 1P)**

5. Interaction of radiation with matter :

Interaction of electrons and protons : Energy loss , Stopping power, cross section, range and straggling.
Interaction of γ rays – photo electric effect, Compton effect and pair production
Nuclear detectors : proportional counter, surface barrier detector,
Ge(Li) , Si(Li), HPGe. **(5L + 1P)**

6. Accelerators :

Microtron, Synchrotron (electron & Proton), Van- de-Graff, Pelletron

Ref. 1 : Ch. 11 **(5 L + 1 P)**

7. Elementary Particles :

Classification and particle interactions, conservation laws, isospin, strangesness, Gellmann-Nishijima formula, Dicussion of CPT invariance, symmetry properties.

Ref. 1: ch 16, Ref. 3: ch. 7, 8, 9, Ref. 6 : Ch.1 **(6L + 2P)**

Reference Books :

1. Nuclear Physics, D.C. Tayal, Himalaya Publication.(Main Reference Book)
2. Nuclei & Particles-An Introduction to Nuclear & Subnuclear Physics,Emilio Segre(1977),W.A.Benjamn,Inc.
3. Subatomic Physics: Hans Frauenfelder & Ernest M.Henley(1974),Prentice-Hall.
4. Concepts of Nuclear Physics, B.L. Cohen(1971),Tata McGraw-Hill.
5. Introduction to Nuclear Physics, H.A.Enge(1978),Addison-Wesley.
6. Introduction to Nuclear Physics,Samuel S.M.Wong,Prentice-Hall
7. Modern Physics, R.Gautream & W.Savin, Schaum's Outline Series, McGraw-Hill.
8. Nuclear Physics, Burcham.
9. Nuclear Physics an Introduction, S.B. Patel
10. Atomic & Nuclear Physics, Shatendra Sharma, Pearson Education.
11. Nuclear Radiation Detectors, S.S.Kapoor & V.S. Rammurthy.

LIST OF DEPARTMENTAL COURSES
GROUP – A

SEMISTER – III **PHYDT-703 and/ or** **PHYDT-704**	SEMISTER - IV **PHYDT-802 and/ or** **PHYDT-803**
Material Science – I	Material Science – II
Electronics Instrumentation – I	Electronics Instrumentation – II
Biophysics – I	Biophysics – II
Chemical Physics – I	Chemical Physics – II
Acoustics – I	Acoustics – II
Bio-Medical Instrumentation – I	Bio-Medical Instrumentation – II
Medical Physics – I	Medical Physics – II
Energy Physics –I	Energy Physics –II

GROUP – B
PHYDT- 704/ 803

Vacuum Technology and Thin Films
Astrophysics and Astronomy
Lasers and Laser Applications
Atmospheric Physics
Microwave Physics and Applications
Physics of Semiconductor Devices
Communication Electronics
Radiowave Applications
Introduction to Microcontroller and Applications
Physics of Nanomaterials
Remote Sensing.

LABORATORY COURSES

PHYDP – 705 : SPECIAL LAB. I **PHYDP – 804 : SPECIAL LAB. II**

The Special laboratory Courses will consist of experiments corresponding to 2 Departmental Courses offered. Out of these, five experiments will be held on each Departmental Course.

Note:

(i) At least one pair of courses **(I and II)** must be from Group A as Departmental Courses in Semester –III and IV. The other two departmental Courses can be chosen from either Group A or Group B. This choice will be made by the postgraduate Centre.

(ii) Each Course in Group A and Group B will have a corresponding half Laboratory Course equivalent to 5 experiments.

MATERIAL SCIENCE-I

1. Introduction to Materials Science:

Mechanical, electrical, magnetic, structural properties and processing relationships (without derivations) **(L-4)**

2. Defects in Solids:

(a) Point defects – vacancies, interstitials, non-stoichiometry, Schottky & Frenkel defects.
(b) Line defects- edge and screw dislocations: properties of dislocations (with derivation)
- energy of dislocation, movement of dislocation ,dislocation interaction , plastic deformation, force on dislocation , motion of dislocation , creep, Frank Read source,Introduction to elastic and inelastic behaviour

(c) Surface defects – gain boundaries, stacking fault.
(d) Volume defect- twin boundary. **(L-12)**

3. Structure of Solid Solutions :

Solid solubility, types of solid solutions, factors governing solid solubility (Hume- rothery rule), atomic size in solid solutions , size factor , Vegard's law, explanation of strain in dislocations, superlattices (Bragg-William theory). **(L-8)**

4. Metallurgical Thermodynamics:

(a) Revision of laws of thermodynamics, auxiliary Thermodynamic functions, measurement of enthalpy and entropy.
(b) Chemical reaction equilibrium.
(c) Thermodynamic properties of solutions
(d) Thermodynamic Origin of phase diagrams.
(e) Gibb's phase rule. **(L-10)**

5. Phase diagrams:

(a) Lever rule, I, II, III- types of phase diagrams.
(b) Thermodynamic origin of phase diagrams,
(c) Definition of maxima, minima, miscibility gap.
(d) Topology of binary phase diagrams (Explanation in short of eutectic, peritectic, Monotectic, eutectoid, peritectoid, syntactic reaction, extension rule).
(e) Experimental determination of phase diagrams. **(L-8)**

6. Diffusion in Solids:

Mechanism of Diffusion, Fick's first law of diffusion , Fick's second law of diffusion , solution to Fick's second law (error function), Atomic model of diffusion, Applications based on the second law, experimental determination of D , corrosion resistance of duralumin , decarburization of steel. **(L-6)**

Reference books:

1. Elements of materials science and engineering (5^{th} edition)-Lawrence H. Van Vlack, Addison- Wesley Publishing co.
2. Materials science and engineering- V.Raghvan.
3. Physical Metallurgy (PartI) R.W.Cahn and P.Hassen, North Holland Physics Publishing, New York.
4. Introduction to Materials science for engineers (6^{th} edition) -J.F.Shaekelford and M.K.Murlidhara- Pearson Education.
5. Materials science by Kodgire.

PHYDP- 705: SPECIAL LABORATORY-I AND PHYDP- 804: SPECIAL LABORATORY-II (Half Laboratory Course each)

List of Experiments:

1. Phase equilibrium diagram for binary Sn-Pb alloy.
2. Study of Creep behaviour for binary Sn-Pb alloy.
3. Study of the phase transformations in ferroelectric crystals.
4. Thermolumuniscence of alkali halides.
5. Stress measurements of the transparent conduction of oxides (Newton's rings method).
6. Determination of the Diffusion Coefficients of Co atoms in the gel media.(If the experimental set up is not available the analysis of respective data will be treated as equivalent experiment.)
7. To study the absorption spectra of Iodine molecules & to determine the dissociation energy using spectrometer.
8. Magnetic susceptibility by Faraday's method.

Reference books:

1. Experiments in Materials Science – Prof. E.C. Subbarao. et.al.
2. Experiments in Materials Science – V. Raghvan

MATERIAL SCIENCE- II

1. Ceramic Materials:

Ceramics phases ceramic crystals (AX) Ceramic crystals (AmXp), multiple compounds, silicates, mechanical behavior of ceramics, processing of ceramic materials (review and study). (**L-8)**

2. Magnetic Properties of Materials:

Ferromagnetic (briefly) and ferromagnetic materials, magnetic domains, hystersis. Hard magnets and soft magnets. Origin of interaction in Ferromagnetic material, rare earth garnets orthoferrites and Haemitite, Hexagonal ferrites, magnetic bubbles. (**L-10)**

3. Semiconductors:

Intrinsic semiconductors, Band structure impurities, semiconductors III-V and II-VI compounds, p-n Diodes (details), transistor FET, tunnel diode, Gunn effect , Contact diode, microelectronic circuits-elementary level.

(L-12)

4.New Materials:

High Tc materials, Giant magnetoresistance (GMR) materials (with brief discussion on magnetoresistance). Quasi crystals, optical materials, piezoelectric and ferroelectric material, nanoparticles.

(L-8)

5.Characterization Techniques:

Principle, working and applications of (i) X-ray Diffraction (XRD) (ii) IR , (iii)UV-Visible (iv)TGA (v)DTA/DSC (vi)optical and electron microscopy(SEM,TEM,AFM,STM). **(L-10)**

Reference books:

1. Elements of materials science and engineering (5^{th} edition)- Lawrence H. Van Valack, Addison- Wesley Publishing co.
2. Materials science and engineering- V.Raghvan
3. Introduction to materials science for engineers-Pearson
4.Introduction to ceramics-W.D.Kingery et al,2^{nd} edition, Wiley, 1991.

PHYDP- 705: SPECIAL LABORATORY-I AND
PHYDP- 804: SPECIAL LABORATORY-II
(Half Laboratory Course each)

List of Experiments :

1. Preparation of particles of different sizes by chemical method. (e.g.CdS, ZnS, Au,Ag etc.)
2. Study of the particles (e.g. CdS, ZnS, Au,Ag etc.) using UV/VIS spectroscopy for the particle size ,colour, (Luminiscence/Fluroscence)& and gap energy.
3. Preparation of particles of a given material (e.g. CdS, ZnS, Au, Ag , Fe_2O_3 etc.).
4. Separation of different sizes using differential centrifugation and their characterization for the band gap by UV/VIS spectroscopic techniques.
5. Nanoparticles conjugation studies using FTIR.
6. Synthesis of magnetic oxides by using solid state reaction route (weighing, mixing & reaction).
7. Calcination & sintering of magnetic oxides.
8. Determination of crystal structure of given material by X-ray Diffractometer.
9. Determination of size of given samples from broadening of X-ray.
10. Determination of Band gap of given material by UV-Visible-IR spectroscopy.
11. Determination of interatomic bond length in diatomic molecules by studying Rotational vibrational IR spectra.
12. Study of Beer and Lamberts law in absorption spectroscopy by using IR spectroscopy.
13. Study of Hystersis of hard and soft ferrites
14. Determination of resonance frequency of piezoelectric element.
15. Study of Thermogravimatric analysis.
16. Differential Thermo-Analysis.
17. Study of phase transformation in ferroelectric crystal.
18. Measurement of Magnetoresistance.

Reference books:

1. Experiments in Materials Science – Prof. E.C. Subbarao. et.al.
2. Experiments in Materials Science – V. Raghvan

ELECTRONICS INSTRUMENTATION-I

1. General configuration and functional description of measuring instruments, few examples of instruments and their functional description. (Ref.1: #2.1 to 2.4). Input output configuration of measuring instruments, and methods of correction of unwanted inputs. (Ref.1: #2.5) **(L-4)**

2 . Qualities of measurements (Ref.9 Ch# 1) Static characteristics, Errors in measurement, Types of errors, sources of errors (Ref.9 Ch# 1)
Dynamic characteristics: Generalised mathematical model of measurement System, order of instruments: zero, first and second order. Step, ramp and frequency response of first order instruments (Ref.1: #3.3 pp 94 to 115 & 123 to 131) **(L-5)**

3. Transducers :

Electrical transducers, resistive, strain gauge, thermistor, inductive transducers, variable reluctance, LVDT, pressure inductive, capacitive transducers, piezoelectric transducer, photoelectric, magnetoresistive sensors..Transducers for displacement, velocity, acceleration. Fluid flow, fluid rate and velocity. Various temperature transducers : Acoustic temperature sensor, high temperature measurement using a cooled thermocouple(Ref.1),Optical pyrometry. (with at least one application of each transducer). **(L-.12, P-4)**

4. Signal conditioners

Op-amps, instrument amplifier, bridge, chopped DC amplifiers, phase sensitive detector. **(L -6)**

5. Data acquisition and conversion (Ref 9:ch17)

D to A and A to D converters, Data loggers, ADC digital transducer (optical transducer) Data acquisition system. ICs available:ADCs,DACs. **(L- 4)**

6. **Indicators, display system and recorders**: Digital display system with LED and LCD. Printers: principle of Inkjet and Laser printers only **(L- 7)**

7. Introduction to microprocessor based instruments, with suitable examples. Stepper motor controller, and basic idea of process control. **(L- 6)**

Reference Books :

1. Measurement systems- applications and design.4th edn E.O. Doeblin.
2.Measurement system – applications and design by E.O. Doblin ,and Manik .
3.Intrumentation, measurement and systems. Nakra and Chaudhary.
4.Electronic Instrumentation and measurement techniques by A.D.Helfrick and W. D. Cooper. (Pearson.)
5. Instrumentation, devices and systems. Rangan, Mani and Sarma Prentice Hall of India.

6.Process controlled instrumentation by C.D.Johnson.
7.Elements of Electronic Instrumentation and measurement. 3rd edn. Joseph Carr. (Pearson).
8.Sensors and transducers. Patranabis.
9.Electronics Instrumentation. Kalsi (Tata McGraw-Hill)

PHYDP- 705: SPECIAL LABORATORY-I AND PHYDP- 804: SPECIAL LABORATORY-II (Half Laboratory Course each)

List of Experiments:

1. Temp. Characteristic of thermister / strain gauge and application. (Ref. # 1)
2. D to A converter circuit (R-2R & binary weighted using IC). For complete negative, negative to positive and positive outputs.
3. V to F, converter as basic concept of ADC.
4. Op-amp as Instrumentation amplifier.
5. Characteristics and applications of photoelectric devices, LED (photodiode, photoelectric relay action).
6. Study of Sample and Hold Circuits
7. Study of data acquisition system
8. Study of thermocouple amplifier.
9. Application of ultrasonic pressure transducer.
10. LVDT displacement Transducer.

ELECTRONICS INSTRUMENTATION -II

1 INTRODUCTION TO PROCESS CONTROL:

Introduction, Control systems, Process control block diagram, Control system Evaluation Control system Objective Stability, Regulation, Transient Regulation, Evaluation Criteria, Damped response, Cyclic response, Sensor time response, Process Control Drawing and symbols with their meaning. **(L- 6)**

2 Discrete Process Control :

Introduction, definitions of discrete state process control characteristics of the systems , relay controllers and ladder diagrams, PLC's
Interfacing with LAN, SCADA systems, intelligent controllers. Ref. 3
(L -12)

3 Controller Principles :

Introduction, Process Characteristics Process Load, Transient, Process Lag, Control System Parameters, Error, Variable Range, Control Parameter Range, Control Lag, Dead Time, Cycling, Controller Modes, Reverse And Direct Action, Discontinuous Controller Modes Two Position Neutral Zone (Examples) Applications, multi position controller floating control mode(eliminate single speed and multiple speed) Continuous controller modes Proportional Control Mode Integral, Control Mode, Derivative Control Mode, Composite Control , PI Control, PD Control Mode, Three Mode Controller (PID) . **(L-12)**

4 **Analog controllers**:

Electronic controller, design considerations. Digital Control: Introduction two position controls and multivariable alarms Ref. 1 **(L -12)**

5.Introduction to modeling and simulation :

Mathematical model, equivalent circuit model, imperical model, block diagram model, modeling methodology, concept and need of simulation and its applications. **(L -3)**

6. **Introduction to Matlab Programming :**

Starting with MATLAB 1.1 to 1.9**,** Creating Arrays 2.1 to 2.11**,** Mathematical Operations with Arrays 3.1 to 3.9**,** Script Files 4.1 to 4.8**,** Two dimensional Plots 5.1 to 5.11**,** Programming in MATLAB 7.1 to 7.8**,** Polynomials, curve fitting and Interpolation **(L- 3)**

Reference Books:

1: Process Control Instrumentation Technology,
Curtis D. Johnson, 7th Edition, Prentice Hall India Pvt. Ltd.
2: MATLAB An Introduction and Applications,
Amos Gilat Wiley Student Edition
3: Computer based industrial controls
K. Kant PHI publications.

.

PHYDP- 705: SPECIAL LABORATORY-I AND
PHYDP- 804: SPECIAL LABORATORY-II
(Half Laboratory Course each)

List of Experiments

Use of MATLAB/SCILAB to solve following topics :

1. Lattice vibration
2. Equipotential countours and surfaces
3. Field and potential distribution across biased and unbiased p-n junction
4. Optical absorption Coefficient.
5. Determination and Visualization of Fermilevel
6. Simple interfacing experiments using PLC
7. Design, Built and test P-I and P-I-D controller. (dc motor, speed controller with tachometer, feedback concept)
8. Design, build and test 4-20 mA current transmitter for an input of 0-10 V, using single ended power supply.

BIOPHYSICS – I

Part (A)

Cellular basis of life : Cell components – structure and function : Plant and animal cells, Bio molecules, General ideas about structure and function – H_2O, proteins, carbohydrates, fats and nucleic acid, introduction to biological energy, energy consumption, respiration, energy production, photosynthesis, ATP synthesis.

Part(B)

Essential physical principles related to life process, chemical bonding, ionization energy, electron affinity, electronegativity, strong bond and weak bond, inter atomic potentials, non central processes, bond energy, spring constituents, free energy, internal energy, thermodynamic principles, water acids basis and aqueous reaction, transport processes, diffusion, viscosity, thermal conduction. **(18L)**

Protein structure: 4 levels, Ramachandran plot, interpretations, classification (by structure, function).
Nucleic acid: Types of DNA, properties, RNA base pairing, transcription and translation.
Conformation analysis: Asymmetric carbon, fisher conventions, L-D type systems, Torsion angle, Newmann projection, Cis-trans peptide. **(10L)**

Neurobiophysics: Structure and function of neuron, types of synapses, testing potential, local depolarization, action potential: Generation and propagation, equivalent circuit of cell, voltage clamp, Na-K pump, equivalent circuit. **(10L)**

Biophysical Techniques:
X-ray crystallography: X-rays, Bragg's law, types of crystals,
Thermoluminescence (TL): TL origin, detection and utility
Electrophoresis : Coulumb;s law, how it separate molecule of different molecular weight and configuration.
UV-visible,IR and Fluorescence spectroscopy.
Circular Dichroism (CD)
NMR – Theory, applications (Briefly) **(10L)**

Reference Books:

1. Biology, a human approach, I.W. Sherman and V.G. Sherman, (Oxford University Press, 1979)
2. Principles of neural science, E.R. Kendel and J.H. Schwaz, (Elsevier, North Holland, 1982)
3. Biophysical Plant Physiology and ecology, P.S. Nobel (University of California, Los Angeles and W.H. Freeman & Co., Sanfranscisco, 1983)
4. Neuron to brain, S.W. Kuffler and J.G. Nichols (Sinacuer Asso. Inc. 1995)
5. The structure and function of proteins, L. Dickerson & J. Geis (Harpes & Row, 1975).

PHYDP- 705: SPECIAL LABORATORY-I AND
PHYDP- 804: SPECIAL LABORATORY-II
(Half Laboratory Course each)

List of Experiments :

1. Electroretinogram of Cockroach
2. Audiometry
3. Absorption spectra of blood/ chlorophyll
4. Radioton dosimetry
5. Verification of Beer's & Lamberts Law.
6. Analysis by Flame photometer and Fluorometer.
7. Computer simulation of Artificial Neural Network (ANN) for Biosignal (e.g. ECG) classification and diagnosis of disease.
8. Electrophoresis.
9. Clinical Laboratory measurement (any 4) pH meter, Blood cell counter, Glucometer, Microscope.
10. Cardiac measurement of B.P. by sphygmomanometer, Heartsound by stethoscope, Blood volume changes by Plethysmograph.

BIOPHYSICS – II

Neuroscience:

A) Higher functions of brain : Origin of EEG, signal characteristics, physiological significance, auditory, visual and somatosensory evoked potentials.
B) Nerve communications : 1) understanding visual system : visual field, receptive field, receptor response, response from ganglion, lateral geniculate simple complex, hypercomplex. Cells and their receptive fields, receptive field formation.
C) Signal processing : Fourier series, transform, correlations (auto and cross, transfer function) (**18L)**

Membrane biophysics and transport:

A) Structure and function of membrane, membrane proteins.
B) Transport across membrane, processes, chemical potential, flux equation, Nernst equation, using Teorell unidirectional flux ratio, osmotic pressure, osmotic phenomena in leaky membrane, The Donnan equilibrium- Goldman equation. **(10L)**

Bioenergetics:

Entropy in biological systems, information, processing, photosynthetic pathways, Redox potentials, glow curves, orders of kinetics, thermodynamics in photosynthesis- Thermoluminescence, mitochondrial bioenergetics.
Enzyme Kinetics: Classification of enzymes, Activation energy barrier, substrate concentration, Vmax, Km, competitive and noncompetitive inhibition, Allostreric enzymes. **(10L)**

Computational Biology:

Introduction, protein sequences and database concept
Sequence alignments: local/ global (details)
Protein structure predictions: Methods, utility
Neural networks: Introduction, theory applications. **(10L)**

Reference Books:

1. Principles of Biochemistry: Lahninger
2. Principles of nueral science, Kundel and Schawatz (Elsevier North Holland,1977)
3. Problems of Biological Physics, L.A. Bleumenfeld (Springer-Verlag, Berlin,1977)
4. Walter Hopper and others(Ed.)
5. Biophysics (Springer Verlag Berlin, 1983).

PHYDP- 705: SPECIAL LABORATORY-I AND PHYDP- 804: SPECIAL LABORATORY-II (Half Laboratory Course each)

List of Experiments (Any Five)

1. Recording and analysis of visual evoked potential
2. Recording and analysis of auditory evoked potentials
3. Recording of electroneutrogram (ENG), motor nerve conduction
4. Recording of ECG (Electrocardiogram)
5. Thermoluminescence in Biomolecules
6. RASMOL
7. Sequence alignment using BLAST
8. Sequence alignment (local, global) using FASTA
9. Use of CLUSTAL to plot phylogenetic tree.

CHEMICAL PHYSICS –I

Abstract group Theory: Definition of Groups, groups of transformations, group multiplication table, the arrangement theorem, generators of finite groups, conjugate elements and classes, subgroups cyclic groups, isomorphism, direct product of groups.

Representation theory of finite groups: representations, invariant subspaces and reducible representations and related theorems, irreducible representations, Schur's Lemmas without proofs, orthogonality theorem, characters of a representation, orthogonality of characters, reduction of a reducible representation, direct product of representations, character tables, representations for cyclic groups. **(10-L)**

Molecular symmetry and the symmetry groups : Symmetry elements and operations, symmetry elements and optical isomerism and its experimental demonstrations, the symmetry point groups,linear molecules, the five platonic solids, a systematic procedure for symmetry classification of molecules, illustrative examples, classes of symmetry operations. Symmetry in long chain molecules, polymeric systems. **(10-L)**

Group theory and quantum mechanics : Wave functions as bases for irreducible representations, the direct product and its importance in Physics, identifying nonzero matrix elements, spectral transition probabilities.

Symmetry adapted linear combinations : Projection operators, illustrative examples of SALC's. **(08-L)**

Introduction to ligand fields : The concept and the scope, the p and d orbitals, qualitative demonstration of the ligand field effect, the physical properties affected by ligand fidls, crystal fields and ligand fields.

Quantitative basis of crystal fields: Crystal field theory : the octahedral and tetrahedral crystal field potential. Its effect on d wave functions, evaluation of 10 Dq (This topic should be covered in seminars)

Atomic Spectroscopy : The free ion, free ion TERMS, term wave functions, spin orbit coupling (to be partly covered in seminars) **(10L)**

Liqand field theory : Splitting of levels and terms in a chemical environment – octahedral, tetrahedral and others, construction of energy level diagrams, the method of descending symmetry, Tanabe-Sugano diagrams.

Free ion in weak crystal fields : effects of cubic crystal field on S,P,D,F,G,H and I terms (to be partly covered in seminars).

Thermodynamical aspects of ligand fields : Crystal field stabilization energy, signatures in other physics properties. **(10L)**

Reference Books :

1. Elements of group theory for physicists, A.W. Joshi (Wiley Eastern Ltd. New Delhi, 1985)
2. Chemical applications of group theory, F.A. Cotton (Wiley Eastern Ltd. New Delhi, 1986)
3. Introduction to Ligand Fields, B.N. Figgis ((Wiley Eastern Ltd. New Delhi, 1976)

PHYDP – 705: SPECIAL LABORATORY – I AND
PHYDP – 804: SPECIAL LABORATORY – II
(Half Laboratory Courses each)

List of Experiments:

1. To determine specific rotation of a given solution at different wavelengths (or different solutions at a given wavelength)
2. To obtain the crystal field stabilization energy and the value of the crystal field parameter 10 Dq for the given transition metal complexes.
3. To obtain the heat of ligation of the given transition metal complex for the given ligands.
4. To obtain the lattice energy of NaCl by X-ray diffraction and by measuring the heat of dissolution (and using the Born-Habber cycle). To obtain the ligand field parameter 10 Dq for Cu_2^+ ions in water and in ammonia.

CHEMICAL PHYSICS - II

Symmetry aspects of molecular orbital (MO) theory – LCAO, the Huckel approximation energy level diagrams, symmetry factoring of secular equations, some simple carbocyclic systems, naphthalene as an illustration.

Hybrid orbitals and molecular orbitals for Abn type molecules : Hybridization schemes for sigma and pi bonding, hybrid orbitals as LCDA, MO theory for AB type molecules, the relationship of the molecular orbital and the hybridization treatments, molecular orbitals for regular octahedral and tetrahedral molecules.

Electronic spectra of complex ions : selection rules and bandwidths, band intensities, spin-orbit coupling departure from cubic symmetry (Jahn-Taller effect), band shapes, spectra in solids, spectra of aqueous solution of metals ions, band assignments, spectra of spin free transition metal ligand octahedral complexes, spectra of distorted octahedral complexes, spectra of tetrahedral complexes, the spectrochemical and nephelauxetic series, charge transfer spectra.

(28L)

Magnetic properties of complex ions: magnetic susceptibility, the magnetic properties of free ions, quenching of orbital angular momentum by legand fields, the magnetic properties of A,E and T terms, the magnetic properties of complexes with A and E ground terms and T ground terms. Experimental methods for magnetic measurement susceptibility, magnetization, ESR, NMR (in brief). **(10L)**

Molecular vibrations: Group theoretical analysis of various modes of vibration of molecules, IR and Raman active modes, F and G matrices (introduction only) IR and Raman spectroscopy (including laser Raman Spectroscopy): Experimental details, analysis of IR and Raman Spectro of simple molecular. **(10L)**

Reference Books :

1. Chemical application of group theory: F.A. Cotton, (Wiley Eastern Ltd., New Delhi, 1986).
2. Introduction to ligand fields, B.N. Figgis (Wiley Eastern Ltd., New Delhi, 1986).
3. Magnetism and transition metal complexes, F.E. Mabbs, D.J. Machin, (Chapman and Hall, London, 1973).
4. Introduction to ligand field theory, C.J. Ballhausen (McGraw Hill, New York, 1962)
5. Symmetry and spectroscopy, D.C. Harris and M.D. Berrtolucci, (Oxford University Press, Oxford, 1978)

PHYDP – 705 : SPECIAL LABORATORY – I AND
PHYDP – 804 : SPECIAL LABORATORY – II
(Half Laboratory Courses each)

List of Experiments:

1. To obtain electronic spectra of transition metal octahedral complexes in water and obtain 10 Dq and B for the metal ions (equivalent to 2 experiments)
2. To obtain electronic spectra of transition metal tetrahedral complexes and obtain 10 Dq and B for metal ions (equivalent to 2 experiments).
3. To obtain vibrational spectra of carbon tetrachloride (vapours) and ammonia (gas) and study the vibrational modes.

ACOUSTICS – I

1 . Basic principles :

Sound wave propagation: plane and spherical wave equations; velocity of sound in fluids; Specific acoustic impedance; Transmission phenomenon: reflection at the surface of a solid: normal and oblique incidence; significance of standing wave ratios; transmission from one fluid medium to another: oblique incidence; Acoustic filters: Helmholtz resonator; acoustic, electrical and mechanical analogous; reflection of waves in a pipe; general theory of side branch

(L-12,P-3)

2. Measurement and perception of sound :

Human voice and hearing mechanism; thresholds of the ear; audiometric testing; acoustic standards and reference conditions; Decibel Scales: Intensity level (IL), Sound Pressure Level (SPL); Sound Power Level (PWL); Loudness Level (LL); Community noise criteria: Equivalent continuous sound level (L_{Aeq}); perceived noise level (L_{EPN}); noise pollution level (L_{NP}); sound level meters and their use; Sonic Boom **(L-8, P-2)**

3. Architectural Acoustics :

Reverberation time; growth and decay of sound in a live room; Sabine's equation; decay of sound in a dead room: Eyring's approach, Millington and Sette's approach; Optimum reverberation time; methods of measuring reverberation time; absorption coefficients and their measurement; Room modes; Synthetic reverberation; acoustical evaluation of auditoria and studios; Audio delay; Anechoic chamber **(L-12,P-3)**

4. Music :

Pitch and timbre; Characteristics of musical notes: Vibrato, Tremolo, Portamento; musical tones; waveforms of musical instruments; basic principles of musical instruments; Electronic musical instruments; Musical Instruments Digital Interface (MIDI) **(L-8)**

Reference Books :

1. Fundamentals of Acoustics, II or III Edn., L.E. Kinsler and A. R. Frey, Wiley Eastern, 1982
2. Acoustics, W.W. Seto, Schaum's Outline, 1978
3. Music, Physics and Engineering, H.F. Olson, Dover Publications, 1967
4. Acoustic Measurements, L.L. Beranek, McGraw Hill, 1970
5. Basic Acoustics, D.E. Hall, Oxford University Press
6. Technical Aspects of Sound, Richardson, Prentice Hall, 1962

7. Noise Reduction, L.L. Baranek, M.LT. Press, 1970
8. Audio Cyclopedia, H. Tremanie, Academic Press, 1968
9. Handbook of Sound Engineers (The New Audio Cyclopedia), G.M. Ballou, Academic Press, 1998
10. Acoustic Techniques for the Home and Studio, F. Alton Everest. Sans Publications, 1970
11. Design for good Acoustics and Noise Control, J.E. Moore, University Press, 1998
12. Acoustics Sourcebook, S. Parker, McGraw Hill, 1996
13. Audio and Video Systems, R.G. Gupta, Tata McGraw Hill, 1995
14. Introduction to Acoustics, Robert D. Finch, Pearson, 2005

PHYDP – 705 : SPECIAL LABORATORY – I AND PHYDP – 804 : SPECIAL LABORATORY – II (Half Laboratory Courses each)

List of Experiments (Any five)

1. Acoustical power of a source and its directivity
2. Study of Mufflers
3. Threshold of audibility
4. Estimation of reverberation time
5. Acoustical evaluation of a class room
6. Measurement of distortion
7. Fourier analysis of noise from a source

ACOUSTICS – II

1. Transducers :

(a) Loudspeakers: Direct-radiator loudspeaker: equivalent circuit and efficiency; effect of voice-coil parameters on acoustic output; materials used for diaphragms; loudspeaker cabinet; Horn loudspeaker: wave equation in horns, infinite exponential horn; measurement of pressure response of loudspeakers; woofers, squawkers, tweeters; Crossover networks; Loudspeaker systems; special purpose loudspeakers; Earphones; Headphones; Hearing aids **(L-12,P-4)**

(b) Microphones: Carbon, Condenser, Moving-coil Electrodynamic and Velocity-ribbon microphones; microphone sensitivity, directional response characteristics; Electroacoustical Reciprocity Theorem; reciprocity calibration of microphones; special purpose microphones **(L-9, P-3)**

2. Sound recording and reproducing systems :

Basic requirements of a system for good quality recording and reproduction; Hi-Fi systems; Graphic Equalizer; Monophonic and Stereophonic sound reproducing systems; Surround sound; Digital audio recording; audio file formats; Noise reduction techniques: Dolbly A, B, C, S, SR; Principles of Compact Disc (CD) audio systems **(L-9,P-3)**

3. Technical Acoustics :

Principles of noise control; active noise control; Ultrasonic transducers: principle and applications: Ultrasonic Medical Tomography, SONAR; Acoustic microscope; Bioacoustics: animal sounds **(L-8)**

Reference Books :

1. Fundamentals of Acoustics, II or III Edn., L.E. Kinsler and A. R. Frey, Wiley Eastern, 1982
2. Acoustics, W.W. Seto, Schaum's Outline, 1978
3. Music, Physics and Engineering, H.F. Olson, Dover Publications, 1967
4. Acoustic Measurements, L.L. Beranek, McGraw Hill, 1970
5. Basic Acoustics, D.E. Hall, Oxford University Press
6. Technical Aspects of Sound, Richardson, Prentice Hall, 1962
7. Noise Reduction, L.L. Baranek, M.LT. Press, 1970
8. Audio Cyclopedia, H. Tremanie, Academic Press, 1968
9. Handbook of Sound Engineers (The New Audio Cyclopedia), G.M. Ballou, Academic Press, 1998

10. Acoustic Techniques for the Home and Studio, F. Alton Everest. Sans Publications, 1970
11. Design for good Acoustics and Noise Control, J.E. Moore, University Press, 1998
12. Acoustics Sourcebook, S. Parker, McGraw Hill, 1996
13. Audio and Video Systems, R.G. Gupta, Tata McGraw Hill, 1995
14. Introduction to Acoustics, Robert D. Finch, Pearson, 2005

PHY DP-705 : SPECIAL LABORATORY-I AND PHYDP-804 : SPECIAL LABORATORY-II (Half Laboratory Course each)

List of Experiments (Any five):

1. Calibration of a microphone
2. Sensitivity of a microphone
3. Study of a loudspeaker system
4. Frequency response of a loudspeaker
5. Directivity of a microphone and loudspeaker
6. Study of a graphic equalizer
7. Signal multiplier wave analyzer

ENERGY STUDIES – I

Indian Energy Scenario

Role of energy in economic development and social transformation, Energy and gross domestic product (GDP), Gross National Product (GNP) and its dynamics.
Various types of energy sources: Energy sources and overall energy demand, Availability of energy sources, Energy consumption in various sectors and its changing pattern, projected energy demands.
Energy sources : Coal, Oil, Natural gas, Nuclear power, Hydro-electricity, Solar and other renewable sources, Depletion of energy sources and impact of exponential rise in energy consumption on economics of India and on international relations.
Energy Security: Energy for security and security of energy, Energy consumption and its impact on environmental climatic change.
Future Energy Option: Sustainable development, Energy crisis, Transition from carbon free technologies, Parameters of transition.

(L-10)

Solar Energy and Its Conversion

Importance of Solar Energy : Nature of solar radiation, Sun as a fusion rector, special distribution of extraterrestrial radiation, Estimation of extraterrestrial solar radiation, Radiation on horizontal and titled surfaces, Beam, diffuse, global radiation and their measurement. Available solar radiation, Measurement of beam, diffuse, global radiation.
Conversion of Solar Energy in different form: Various ways to convert solar energy into different forms, Pyranomater, Pyrhelimeter, Sunshine duration recorder Angstrom relation.

(L-10)

Basics of Heat transfer

Heat and Thermodynamics: Basic units, dimensions, Concept of heat, energy and work, Ideal gas flow, 1^{st} and 2^{nd} law of thermodynamics, Types of heat transfer.
Conductive heat transfer: Fourier's law. Stefans-Boltzman relation and IR heat transfer between gray surfaces.
Radiative heat transfer: sky radiation, radiation heat transfer coefficient
Convective heat transfer: Natural and forced convection, natural convection between parallel plates, Non-dimensional numbers, conductive heat transfer coefficient, Heat transfer due to wind.

(L-10)

Energy Storage :

Types of energy storage systems : sensible and latent heat storage systems, Electric energy storage systems, Chemical energy storage systems, Heat exchanges, Hydrostorage, solar pond as a energy storage.
Hydrogen Energy : Storage, transportation and utilization of Hydrogen, OTEC concept.

(L-10)

Solar Passive Systems and Green House :

Solar active and passive systems, Types of solar passive systems, designs aspects of solar passive systems, f-chart method.
Green House : solar green House, design and control mechanism.

(L-8)

Reference Books :

1. TEDDY Year Book, (Tata Energy Research Institute (TERI) Publication, New Delhi).
2. World Energy Resources, Charles E.Brown (Springer Publication), 2002.
3. Energy Policy for India, B.V. Desai (Welley Eastern Publication)
4. Handbooks of Solar Radiation , A.Mani (Allied Publishers), 1980.
5. Solar Energy Fundamentals and Applications, H.P. Garg and Satya Prakash, (Tata McGraw Hill), 1977.
6. Treatise on Solar energy, H.P. Garg, Volume 1,2 and 3.(John Wiley and Sons) 1982
7. Principles of Solar Engineering, F.Kreith and J.F. Kreider, McGraw Hill , 1978
8. Solar Energy Thermal Processes, J.A. Duffie and W.A. Beckman, (John Wiley and Sons)1980
9. Heat and Thermodynamics, M.W. Zemansky,(McGraw Hill Publication)
10. Principles of Solar Energy Conversion, A.W.Culp (McGraw Hill Publication)
11. Solar Energy Principles of Thermal Collection and Storage, S.P. Sukhatme, 2nd edition (Tata McGraw Hill Publication C.Ltd.(, 1976
12. Solar Energy Utilization, G.D.Rai (Khanna Publishers) 1996
13. Solar Thermal Engineering, J.A. Duffie(Academic Press)
14. Renewable Energy Sources and Conversion Technology, N.K. Basal, M. Kleeman and S.N. Srinivas ,(Tata Energy ReserchInstitute, New Delhi) 1996

PHYDP -705 : SPECIAL LABORATORY – I AND
PHYDP -804 : SPECIAL LABORATORY – II
(Half Laboratory Course each)

List of Experiments :

1. Determination of Calorigic value of Wood/Cow dung.
2. Study of Optical Properties of selective coatings.
3. Study of Photovoltaic a Characteristics of Solar Cell (Variation of Intensity, Distance between Source and Solar Cell, and load)
4. Study of power versus load characteristics of Solar Power Photovoltaic Systems and Study of Series and Parallel Combination of Solar Photovoltaic panels.
5. Study of Solar Collector (Efficiency versus Δ T/I)

ENERGY STUDIES – II

Solar Photovoltaics (SPV) :

Solar Photovoltaics (SPV) Conversion : Basic principles of solar photovoltaic conversion. Types of solar cell materials, Fabrication of solar photovoltaic cells, solar cell parameters and characteristics, Modules.
Solar Photovoltaic (SPV) Conversion Systems : Block diagram of general SPV conversion system and their characteristics , Different configurations, Solar photovoltaic conversion system components and their characteristics, Application (such as street light, water pumps, Radio/TV, Small capacity power generation)
Solar Photovoltaic (SPV) Systems Designing : Load estimation, selection of inverters, battery sizing, array sizind. Hybrid Solar Photovoltaic (SPV) systems. **(L-10)**

Photothermal applications of Solar Energy :

Selective coatings : Ideal characteristics of selective coating for various applications, Types of selective coatings, materials and techniques for selective coatings, Effect of selective coating on the efficiency of solar collectors.
Solar Thermal Devices and Systems : Different types of collectors , Flat plate collector(Basic principle, construction, Energy balance equation of steady state, Testing, Methods to reduce losses), Solar cookers, Domestic hot water system, Solar dryers, solar pond, Solar still, Solar furnace, Solar refrigeration, Solar concentraters, systems based on use of solar concentraters.
(L-10)

Hydrogen Energy :

Hydrogen Fuel : Imortance of Hydrogen as a future fuel, Sources of Hydrogen, Fuel of vehicles.
Hydrogen production : Production of Hydrogen by various methods, Direct electrolysis of water, Direct thermal decomposition of water, Biological and biochemical methods of hydrogen production.
Hydrogen storage : Gaseous, Cryogenic and Metal hydride.
Utilization of hydrogen : Fuel cell – Principle, construction and applications. **(L-10)**

Wind Energy :

Wind Energy : Introduction, Basic principle of wind energy conversion, Extraction of maximum power from wind and its dependence on various parameters.
Wind Mills : Types of wind mills, Vertical axis and Horizontal axis wind mills their performance, Merits and Demerits, Limitations of wind energy conversions.
(L-10)

Bio Energy :

Biomass : Generation and utilization, Property of biomass, Agriculture crop and Forestry residues used as fields. Physical, Chemical and biological conversion of biomass into useful form of energy. Gasification, Biomass gasifiers and types.
Biogas : Introduction , Generation of biogas, Aerobic and anaerobic bioconversion process. Substances used to produce biogas (Cow dung, Human and other agricultural waste, Municipal waste etc.), Digesters and their designs, Pyrolysis and gasification, Fermentation process.

Biofuels : Types of biofuels,, Production processes, Biofuel applications, Ethanol as a biofuel.

(L-08)

Reference Books :

1. Climatological and Solar data for India, Seshadri. (Sarita Prakashan), 1969.
2. Solar Energy Utilization, G.D.Rai, 9Khanna Publishers), 1995.
3. Energy technology, S.Rao and B.B. Parulekar (Khanna Publishers), 1995
4. Terrestrial Solar Photovoltaics, Tapan Bhattacharya, (Namsa : Publication House, New Delhi)
5. Solar Cells-operating Principles, technology and System Applications, Martin A. Green (Prentice Inc. USA).
6. Solar Thermal Engineering, J.A. Duffie (Academic Press)
7. Renewable Energy Sources and Conversion Technology, N.K. Bansal, M. Kleeman and S.N. Sreinivas 9 Tata Energy Research Institute, New Delhi), 1996.
8. Fundamentals of Solar Cells, F.A. Faherenbruch and R.H. Bube 9Academic Press).
9. Biomass Energy Systems, Venkata Ramala and S.N. Srinivas (Tata Energy Research Institute, New Delhi, New Delhi),1996.
10. Thin Film Solar Cells, K.L. Chopra and S.R.Das (Plenum Press),1983
11. Solar Hydrogen Energy Systems, T. Ohta (Pergamon Press)1979
12. Hydrogen Technology for Energy D.A. Maths (Noyes Data Corp.)1976
13. Handbook Batteries and Fuel Cell, Linden (McGraw Hill)1984
14. Wind energy Conversion Systems, L.L. Freris (Prentice Hall)1990

PHYDP-705 : SPECIAL LABORATORY – I AND
PHYDP-804 : SPECIAL LABORATORY – II
(Half Laboratory Courses each)

List of Experiments :

1. Study of Hot Water system.
2. Determination of heat Loss Coefficeient in Flat Plate Collector.
3. Study of Solar Dryer (Hot Air Collector)
4. Study of Solar Still.
5. Performance Evaluation of Box Type and Concentrating Type Solar Cooker.

BIOMEDICAL INSTRUMENTATION – I

1.Introduction to Biomedical Instrumentation :

1.1 Essentials of biomedical instrumentation.
1.2 Need of biomedical instrumentation
1.3 Type and history on problems encountered in design, fabrication and utilization

(L-4)

2.Bioelectric Signals:

2.1 Origin of bioelectric signals, testing and action potential. Nearest equation
2.2 Propagation of action potential
2.3 The bioelectric potentials ECG, EEG, EMG. (L-6)

3. Electrodes:

3.1 Electrode Theory
3.2 Biopotential Electrodes
3.3 Electrodes for ECG,EEG,EMG. (L-4)

4. Physiological Transducers:

4.1 Introduction
4.2 Classification of Transducer
4.3 Performance characteristic of transducer.
4.4 Displacement, position and motion transducer.
4.5 Pressure transducer
4.6 Transducer for Body temperature measurement
4.7 Biosensors (L-8)

5. Recording Systems and Signal Analysis:

5.1 Basic recording system.
5.2 General consideration for signal conditioners
5.3 Preamplifiers, Differential, Instrumentation, Isolation amplifier.
5.4 Source of noise in low level measurement.
5.5 Biomedical signal analysis techniques
5.6 Fourier Transform, FFT and Wavelet Transform
5.7 Signal processing techniques. (L-8)

6. Cardiovascular System and Measurements:

6.1 The Heart.
6.2 The Heart and Cardiovascular system
6.3 Blood Pressure
6.4 Characteristic of blood flow
6.5 Heart Sounds. (L-6)

7. Electrocardiograph (ECG)

7.1 Block diagram
7.2 The ECG leads
7.3 Effect of Artifacts on ECG recording (L-4)

8. **Pacemakers:**

8.1 Introduction
8.2 Types of pacemakers
8.3 Need for pacemakers
8.4 Pacemaker system and its functioning
8.5 Pacing modes and Pulse generator **(L-6)**

9. Patient safety:

9.1 Electric shock hazards-Gross shock-Micro current shock
9.2 Precautions to minimize electric shock hazards (L-2)

Reference Books:

1 .Biomedical Instrumentation and Measurements (Second edition)
By Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer
Pearson education.
2. Handbook of Biomedical Instrumentation (Second Edition)
by R. S. Khandpur (Tata McGraw Hill).
3. Biomedical Instrumentation and Measurement by Carr and Brown-Pearson.

PHYDP-705:SPECIAL LAVORATORY-I AND PHYDP-804:SPECIAL LAVORATORY-II

(**Half laboratory course each**)

List of Experiments (Any Five):

1 .Active filters for Bio-signals _ Design and Filtering
(Low pass and High pass filter)
2. Design and build a Notch filter (To reduce noise of 50 Hz).
3. ECG preamplifier-Instrumentation amplifier and testing.
4. Use of sphygmomanometers for measurement of blood pressure.
5. Concept of ECG, system and placement of electrodes
ECG signal recording with surface electrodes.
6. Analysis of ECG signal using FFT.
7. Measurement of biopotential.(EOG/ EMG/ERG/EEG)
8. Design and build a Wide/ Narrow band pass filters.
Measurement for Bio-signals
9 To study LVDT Characteristic.
10 To study Thermistor Characteristic.
11 Study of strain measurements using Strain gauges and Canniever assembly .
12 Determination of linear range of operation of strain measurements.
13 To measure Systolic and Diastolic Blood Pressure values of human heart.

BIOMEDICAL INSTRUMENTATION –II

1. The computer in Biomedical Instrumentation:

1.1 The digital computer-computer hardware-Computer Software.
1.2 Microprocessors –Types of Microprocessors
1.3 Microprocessors in Biomedical instrumentation
1.4 Microcontrollers in Biomedical instrumentation
1.5 Examples of Microcontroller Based system (data acquisition)
1.6 Interfacing the computer with medical instrumentation and other equipment.
1.7 Biomedical computer applications. (L-8)

2. Biomedical Recorders:

2.1 Introduction to nervous system, Neuromuscular transmission, muscle potentials, receptors, neurotransmitters, Electroencephalograph (EEG),Block diagram, Computerized Analysis of EEG.
2.2 Electromyography (EMG) (L-6)

3. Ultrasonic Imaging Systems:

3.1 Diagnostic ultrasound,
3.2 Physics of ultrasonic waves,
3,3 Characteristics impedance, wavelength and frequency, velocity of propagation,
3.4 Absorption of ultrasonic energy beam width, resolution,
3.5 Generation and detection of ultrasound.
3.6 Basic pulse echo apparatus
3.7 Diagnostic scanning mode A-mode, B-mode. (L-10)

4.Modern Imaging Systems:

4.1 X-ray machines and digital radiography.
4.2 Basic of diagnostic radiology,
4.3 Nature of x-rays, properties of x-rays, unit of x-ray,
4.4 Production of x-ray machine, digital radiography.
4.5 X-ray computed Tomography : basic principle, system component, viewing system, storing and documentation.
4.6 Nuclear Medical Imaging systems : Radio isotopes in medical diagnosis, physics of Radioactivity
4.7 Positron emission tomography(PET) (L-12)

5. Respiratory system and measurements:

5.1 The Physiology of the respiratory system.
5.2 Tests and instrumentation fo the mechanics of breathing
5.3 Gas exchange and distribution
5.4 Respiratory Therapy Equipment
5.5 Heart lung machine (L-4)

6. Radiology:

6.1 Basic definition ,
Generations of ionizing radiation
Detections of radiation
6.2 Instrumentation for diagnostic x-rays.
6.3 Instrumentation for the medical use of radio isotopes (L-6)

7.Oximetry:

7.1 Introduction
7.2 Pulse oximetry (L-2)

Reference Books:

1 .Biomedical Instrumentation and Measurements (Second edition)
By Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer
Pearson education.

2. Handbook of Biomedical Instrumentation (Second Edition)
by R. S. Khandpur (Tata McGraw Hill).

3. Biomedical Instrumentation and Measurement by Carr and Brown-Pearson.

PHYDP-705: SPECIAL LAVORATORY-I AND
PHYDP-804: SPECIAL LAVORATORY-II

(Half laboratory course each)

List of Experiments (Any five)

1. Recording of pulse signal using pulse oximetry/Pulse recording system.
2. Glucometer as a sensors/strain gauge
3. Design and built data acquisition system using microprocessor/Microcontroller
4. Skin temperature using thermo sensor
5. Operation and function of all the controls of hospital X-ray machine (Visit at Hospital)
6. Operation and function of all the controls of hospital Ultrasound machine (Visit at Hospital)
7. Operation and function of all the controls of hospital CT scan machine (Visit at Hospital)
8. Heart Rate cum ECG monitor with real time
9. To study Lead I , II and III of standard bipolar Lead configuration
10 To study AVR, AVF and AVL lead of standard unipolar leads configuration
11. To study the abnormalities present in Human Cardiovascular System
12. To study of operating principles and characteristics of the A/D.
13. To study of operating principles and characteristics of the D/A
14.To study Respiration rate monitor.
15. Using EMG to observe the electrical potential generated by the muscles and nervous and observe the EMG signals by affixing biomedical electrodes to the surface of human body.
16. Using EEG to study and observations of electrical potentials generated by the brain & also observe EEG signals by affixing biomedical electrodes to the scalp of human body.
17. Measurements of the pulse or heart rate of the human body in resting or moving state.

MEDICAL PHYSICS – I

1. Introduction to Medical Physics :

Introduction,
Terminology,
Modelling,
Measurements. **(L-4)**

2. Forces acting on body :

Statics,
Frictional forces,
Dynamics,
Conservation of Energy in the body,
Heat losses from body,
Pressure in the body. **(L- 8)**

3. Physics of the skeleton :

Composition of bone,
Physical properties of bone,
Mechanics of joints,
Measurement of bone minerals. **(L- 5)**

4. Electricity within the body :

Nervous system and neuron,
Electrical potential of nerve,
Biopotentials EMG, ECG, EEG, EOG, ERG,
Magnetic signals from heart and brain. **(L – 10)**

5. Physics of hearing :

Physics of ear,
Sensitivity of ear,
Testing of hearing.
Deafness and hearing aids,
Sound in medicine,
Sound pollution,
Effects of sound pollution on living body,
Methods to minimize sound pollution **(L – 6)**

6. **Physics of vision** :

Optics of eye,
Diffraction effects of eye,
Refractive effect in eye and its correction,
Color vision and chromatic aberration,
Instruments used in Opthalmology. **(L –7)**

7. **New trends in Medical Physics** :

Introduction to embeded system,
Embeded system in Hospitals,
Applications,
New trends in Medical Physics . **(L-8)**

PHYDP-705 : SPECIAL LABORATORY –I AND PHYDP-804 : SPECIAL LABORATORY-II (Half laboratory Course each)

Reference books :

1. Medical Physics by John R. Cameron, J. G. Skofronick, John Wiley and Sons, International Publication.
2. Essential of Biophysics by Narayanan, New age Publication.
3. Radiation Biophysics by Edward Alphan, prentice Hall Advance Referes.
4. T.B. of Biophysics by R.N. Roy , Central Publication.
5. Biophysics by Mohan Arora , Himalaya Publication House , Mumbai(2004).
6. Opthalmology by A.K. Khurana, New age Publication.
7. Introduction to Biomedical Engineering by Enderle, Elsevier Publication.

List of Experiments (Any five)

1. ECG Recording and analysis.
2. Measurement of sound intensity using SPL.
3. Audiometry and analysis.
4. Comparison of resolving limit of eye and telescope.
5. Study of opthalmoscope.
6. Analysis of EEG using FT.
7. Visit to Hospital (for study of Instruments used in Opthalmology).
8. Study of Snellen chart / Tonometer.

MEDICAL PHYSICS-II

1. Nuclear Medicine :

Radioactivity,
Sources of Radioactivity,
Nuclear medicine imaging device rectilinear scanner,
Positron emission tomography,
Magnetic resonance imaging,
Laser in medicine. **(L -8)**

2. Radiation physics :

Ionizing Radiation,
Interaction of radiation with matter,
Dosimetry,
Radiation isotopes,
Biological effects of radiation,
Radiation protection in theraphy. **(L -8)**

3. X-ray in medicine :

Discovery,
Production of X-ray,
Making of X-ray image,
Fluoroscopy,
Computer tomography,
X-ray in diagnosis,
X-ray in theraphy,
Hazards of X-ray. **(L-9)**

4. Cardiovascular Instrumentation :

Biopotential of Heart,
Electrodes,
Amplifiers,
Patient monitoring,
Defibrillators,
Pace makers. **(L-7)**

5. **Biomaterials and their applications** :

Bio-ceramics,
Bio-polymer,
Bio-steel,
Bio-chip . **(L-4)**

6. **Rheology** :

Physical properties of plasma,
Viscosity of blood,
Non Newtonian fluids – blood, plasma and whole blood,
Comparison between Newtonian and Non Newtonian fluid. **(L-5)**

7. **Medical Informatics** :

Computer in medicine,
Medical informatics terminology,
New trends in Medical informatics,
Applications. **(L-7)**

Reference Books :

1. Medical Physics by John R. Cameron, J. G. Skofronick, John Wiley and Sons,International Publication.
2 .Essential of Biophysics by Narayanan, New age Publication.
3. Radiation Biophysics by Edward Alphan, prentice Hall Advance Referes.
4. T.B. of Biophysics by R.N. Roy , Central Publication.
5. Medical Informatics by Smita Mishra and K. C. Mishra, ICFAI university.
6. Fundamental of Bioinformatics by Harisha. S.
7. Biomedical Engineering by S.N. Sarbadhikari, University press.
8. Principles of medical electronics & Biomedical instrumentation by c. Raja Rao, S. K. Guha , University press.
9. Electronics in medicine & Biomedical instrumentation by Nandini Jog , PHI.
10. Medical Informatics – A Primer by Mohan Bansal ,Tata Publication.

PHYDP-705 : SPECIAL LABORATORY –I AND PHYDP-804 : SPECIAL LABORATORY-II (Half laboratory Course each)

List of Experiments (Any five)

1. Study of X-ray machine and making an image.
2. Measurement of transmittance of film by varing exposure time and voltage.
3. Blood analysis, Absorption spectra of Blood.
4. Medical Informatics using Internet.
5. Designing and study of instrumentation amplifier./Right leg driven system.
6. Designing and building pace makers circuit.
7. Visit to Hospital for study of nuclear medicine.
8. Measurement of Viscosity if blood.
9. Mechanical properties of bone.
10. Study of clinical laboratory.
11. Study of biomaterial (processed rod).
12. Measurement of Biopotential EMG/EEG.

13 ECG simulator

VACUUM TECHNOLOGY & THIN FILM PHYSICS

1. Vacuum Science:

Introduction to vacuum, vacuum units and ranges, theory of gas at low pressures (kinetic theory of gases, velocity distribution, mean free path), Surface interactions (Viscosity, Thermal conductivity, Pressure), flow, conductance, impedance, pumping speed, pump down time, applications and importance of vacuum technology. **(L -5)**

2. Theories of Thin film growth:

Nucleation, condensation, Capillarity model, Atomistic model, comparison of models, various stages of film growth. **(L-8)**

3. Thin film deposition techniques:

Physical Vapour Deposition, Chemical Vapour Deposition, Molecular Beam Epitaxy, Sputtering, Electron –beam, Pulsed Laser Ablation. **(L-5)**

4. A. Production of vacuum:

Production: Mechanical Pumps (Roughing and backing), Medium & High Vacuum Pumps (Roots Pump, Molecular Drag Pump, Turbo molecular Pump, Diffusion Pump), Capture Pumps (Cryopumps & Sorption Pumps, Getter Pumps, Ion Pumps), Vacuum systems (High Vacuum and Ultra High Vacuum system). **(L-8)**

B. Measurement of vacuum:

Measurement: Direct Pressure/ Force Methods, McLeod gauge, Thermal conductivity gauges (Pirani, Thermocouple gauge), Ionization gauges (Penning, Triod ionization, BA gauge). **(L-4)**

5. Thickness measurement & monitoring:

Tolansky technique, Talystep (styles) method, Quartz crystal microbalance, optical methods. **(L-3)**

6. Properties of thin films:

Electrical Properties: Source of Resistivity in Metallic conductors, commonly measured quantities for thin films. Influence of thickness on the resistivity of thin films, Hall Effect & Magnetoresistance in thin films, Fuch-Sondhemir theory, TCR and its effects. **(L-4)**

Mechanical properties: Adhesion & its measurement with mechanical and nucleation methods, stress measurement with various methods. **(L-5)**

Optical properties **(L-2)**

7. Applications of thin films

Resistors, capacitors, Junction devices (Metal semiconductor junction) Solar cells, ICs, optical coating. **(L-4)**

Reference books:

1. Hand book of Thin Film Technology: Maissel and Glang, (Mc Graw Hill)
2. Thin Film Phenomena: K. L. Chopra, (Mc Graw Hill)
3. Material Science of Thin Films: M. Ohring, (Academic Press)
4. Thin Film Process: J. L. Vossen and Kern, (Academic Press)
5. Vacuum Technology (2^{nd} revised edition), A. Roth, (North Hollad)

PHYDP-705 : SPECIAL LABORATORY –I AND PHYDP-804 : SPECIAL LABORATORY-II (Half laboratory Course each)

List of Experiments (Any five)

1. Study of Rotary- Diffusion vacuum system in detail
2. Study of different parts of Rotary pump and determination of its speed
3. Determination of conductance of various pipes.
4. Determination of pumping speed by steady state method.
5. Study of Mc.leod, thermocouple, pinari and penning gauges (any three)
6. Deposition of metallic thin films by vacuum evapouration method and measurement of resistance by two probe method.
7. Deposition of thin films by sprey pyrolysis method and thickness measurement by gravimetric method

ASTRONOMY AND ASTROPHYSICS

Introduction :

Sun, Solar system and its origin, Components of the Solar System (Planets, Satellites, Comets, Meteors, Asteroids). Solar and Lunar Eclipses.Black Body Radiation, Planks Radiation Curve Wein's Law, Electromagnetic Spectrum , Kirchhoff's law of radiation, Types of spectra , Doppler effect in light.General Optics: Focal length, Magnification, Resolution, Dispersion, Diffraction, Reflection, Refraction. (L-2)

1. Solar Physics:

Solar Mass, Radius Density, surface temperature, Solar constant.
Solar Atmosphere – Photosphere, Chromosphere, Corona. Structure and composition of the Sun. Sun as a source of radiation. Solar energy sources- Nuclear reactions in stars. Proton-proton Cycle, Carbon cycle, Formation of Helium and heavier elements. Photospheric effects- sun spots, solar cycle, granulation, solar faculae. Chromospheric effects- solar flares, prominences, Limb darkening. Solar Magnetic field, solar particles and solar wind and their effects on earth. **(L-6)**

2.Hertzsprung- Russel Diagram and Stellar evolution:

H-R diagrams, stellar evolution-gravitational condensation, protostars, position of stars on the HR diagram, main sequence stars, red giants, blue giants, white dwarfs, brown dwarfs, Nova, supernova, neutron stars, pulsars and black holes. Variable stars, binaries, Chandrasekhar limits. **(L-4)**

3.Stellar Spectrum:

Classification of stellar spectra, line profiles, broadening effects, information obtained from stellar spectra- abundance of elements, temperature, speed of rotation, magnetic field. **(L-4)**

4.Galaxies:

Types of Galaxies- Radio, Seyfert, Quasars (Quasar red shift), Milky way galaxy. **(L-3)**

5.Astronomical Concepts:

Brightness and luminosity, magnitude scale. systems of co-ordinates- horizon , equatorial, ecliptic and galactic. Celestial sphere, inter conversion between co-ordinates- horizon and equatorial. Concept of time, sidereal time, UT, LST. Distance measurements- Astronomical unit par sec., light year. Stellar parallaxes, eclipses, occultations, transits, Meteor showers . **(L-8)**

6.Astronomical Instruments:

1. Telescopes-Optical-Types, Refracting, reflecting, Newtonian, Cassegrain. Telescope mounts- German equatorial, fork, horse-shoe, alt-azimuth. Telescope tracking requirements.
   Non-optical Astronomy- IR,UV.X-ray, Gamma ray and Radio astronomy – Origin of radio emissions from pulsars and radio galaxies. Non-optical telescopes. Radio interferometry .
2. Spectroscopy-prism and grating spectroscopy, Fourier transform spectroscopes.
3. Photometry-Types-visual photographic and photoelectric, spectrophotometry
   Image intensifiers, filters, CCD camera, image processing.

(L-9)

7 Atmospheric effects:

Absorption, scintillation, scattering, atmospheric extinction, turbulence, "seeing", night sky brightness and pollution. **(L-4)**

8. Relativity and Cosmology:

Einstein's theory of relativity- Special and General. Space time curvature, Geodesics, principle of equivalence.
Hubble's law, Hubble's constant Big Bang theory, Steady State Theory, Oscillating universe, Experimental Evidences of the theories. **(L-8)**

List of Reference Books:

1. Astronomy- Fundamentals and Frontiers- Robert Jastrow, Malcolm H. Thompson. (Pub. John Wiley and Sons)
2. An Introduction to Astrophysics- Baidyanath Basu (Pub. Prentice Hall of India Pvt.Ltd.)
3. Introduction to Cosmology- J. V. Naralikar (Pub. Cambridge University Press)
4. An Introduction to the study of Stellar Structures- S. Chandrashekhar (Pub. Dover)

5. Source Book of Space Sciences- Samuel Galsston, D. Van Nostrand Company Inc.
6. Astronomy Structure of the Universe- A. E. Roy and D. Clarke(Pub. Adam Hilger)
7. Text book of Astronomy and Astrophysics with elements of cosmology-V. B. Bhatia.
8. Structure of the Universe- J. V. Narlikar.
9. Telescopes and Techniques- C. R. Kitchin(Springer 1995)
10. Astronomical Photometry- A. A. Henden, R. H. Kaitchuk (Willmann-Bell 1990)
11. Astronomical Spectroscopy- C. R. Kitchin, IOP 1995.
12. Observational Astrophysics-D. S. Birney, CUP 1995.

PHYDP- 705: SPECIAL LABORATORY-I AND
PHYDP- 804: SPECIAL LABORATORY-II
(Half Laboratory Course each)

List of Experiments (Any five)

1. Study of Binocular, refracting and reflecting telescopes and their mount and then alignment
2. Measurement of The Solar Constant
3. Observation of the Emission, continuous and absorption spectra.
4. To observe the Fraunhofer lines in sunlight and determine the elements present
5. To determine the limb darkeing effect in the Sun
6. To determine : the latitude and longitude of of a place and the speed of rotation of the earth

LASERS AND LASER APPLICATIONS

Chapter 1

Interaction of radiation with matter: Absorption, spontaneous and stimulated emission, population inversion, properties of laser, metastable state, gain, absorption coefficient, Einstein's coefficient, stimulated emission cross section, threshold condition.

(L-8)

Chapter 2

Two level laser (ammonia laser, physical separation of excited species from those in ground state), three and four level system and rate equations, threshold pump power, relative merits and demerits of three and four level system.

(L-8)

Chapter 3

g-parameters of laser cavity, stability curve, Gaussian beam and their properties, resonant frequencies, mode structures of laser cavity, mode separation, introduction to Q-parameters and Q-switching, measurement of laser power, energy, wavelength, frequency, line width.

(L-10)

Chapter 4

Gas Lasers and Dye Lasers: excitation in gas discharge, collisions of first and second kind, electron impact excitation and its cross section, different types of gas lasers: He-Ne laser, nitrogen laser, CO_2 laser, excimer lasers and Dye laser
Solid State Lasers: Nd:YAG laser, semiconductor lasers (principle and homojunction lasers)

(L-12)

Chapter 5

Holography (Recording and Construction), laser spectroscopy (multiphoton and Raman spectroscopy), medical applications, laser fusion, military applications, laser range finding, laser in non-linear optics(Harmonic generation, second harmonic generation, self focusing of light), introduction to optical fiber communication, optical fiber detector.

(L-10)

Reference books:

1. Principles of lasers – O.Svelto – Plenum, 1982.
2. Solid state engineering Vol-I – W.Koechner Springer Verlag (1976).
3. Lasers fundamentals – W.T. Silfvast.
4. Laser and non-linear optics – B.B.Laud (2^{nd} Edition).
5. Lasers – A.G. Sigman, Oxford University Press 1986.
6. Introduction to fiber optics – A.Ghatak, K.Thyagarajan- Cambridge University Press.
7. Laser Guidebook – J.Hecht
8. Principles of laser and their applications – Callen O'Shea, Rhodes

9. An introduction to Laser theory and application – M.N.Avdhanulu – S.Chand Publications
10. Optics – E.Hecht, A.RGanesan – Pearson Education 4th edition

PHYDP – 705 : SPECIAL LABORATORY – I / PHYDP – 804 : SPECIAL LABORATORY – II (Half Laboratory each)

List of Experiments:

1. Determine the spot size and divergence of the He-Ne Laser.
2. Diameter of a given wire by diffraction.
3. Determination of Brewter's angle.
4. Determination of band width of a given optical Fiber.
5. To study magneto optic rotation and magneto-optic modulation.

Reference books:

1. Experiments with He-Ne laser –R.S. Sirohi, IIT Madras

ATMOSPHERIC PHYSICS

Chapter 1 Atmospheric Thermodynamics

Atmospheric compositions, equation of states for dry and moist air, Adiabatic process, virtual temperature, Humidity parameters, Thermodynamic laws, entropy, potential temperature, Pseudo adiabatic process, Clausius–Capeyron equation , Thermodynamic Diagrams-general considerations, Emagram, Tephigram, uses of thermodynamic diagrams, Hydrostatic equation, Height computation for upper –air sounding, hydrostatic of special atmospheres.

(L-20)

Chapter 2 Radiation

Solar and terrestrial radiation, scattering (Rayleigh and Mie Scattering), Radiation balance of earth, Green house effect.

(L-5)

Chapter 3 Upper Atmosphere

Thermal structure of Troposphere, Stratosphere, Mesosphere, Ionosphere, D and E Region, Radio wave propagation effect of the earth‘s curvature, Stratosphere circulation and Stratosphere warming, Quasi-Biennial oscillation, Ozone, temporal and spatial variation of ozone, Umkehr effect, Ozone depletion.

(L-11)

Chapter 4 Cloud Physics

Atmospheric aerosol and condensed nuclei, curvature and solute effect, condensation, growth of cloud droplets by diffusion and by collision and coalescence, collection efficiency, freezing nuclei, mechanism of growth of ice particles in cloud, formation of ice, rain making experiments, thunderstorm and hail. Observational studies on cloud structure, effect of wind shearing on cloud growth

(L-12)

Reference Books:

1. Introduction to theoretical meteorology-S.Hess
2. An introduction to climate-G.T. Trewartha
3. Tropical meteorology Vol I and II-G.C.Asnani
4. Weather forecasting –A.A.Ramshastry
5. Cloud Physics -Rogers
6. Cloud Physics – Wallace &Bob
7. Atmosphere, Weather and Climate – K. Siddhartha (Kisalaya Publication Pvt. ltd)

PHYDP- 705: SPECIAL LABORATORY-I AND
PHYDP- 804: SPECIAL LABORATORY-II
(Half Laboratory Course each)

List of Experiments :

1.Study of Tephigram

2. Thickness of layer using Tephigram

MICROWAVE PHYSICS AND APPLICATIONS

Pre requisite : Electron Motion in electric field, Magnetic field and electromagnetic field, Electric and Magnetic wave equation, Poynting theorem.

Passive Elements :

1. Introduction to microwaves, it's application, transmission line theory, their equations and solutions reflection coefficient, standing wave ratio (SWR), line impedance, admittance resonant lines. (**L–8)**

2. Impedance matching, single stub and double stub, rectangular wave guides, circular wave guides, TE & TM modes of propagation Q – of cavity resonator, use of Smith chart. **(L-8)**

3. Wave guide components :
   Attenuators, filters, junctions, Tee's – magic Tee, (hybrid T), directional couplers , hybrid rings (Rat – Race), wave guide corners, bends, loads scattering parameters. **(L-5)**

Active Elements :

4. Microwave generation problems and principles, Reflex Klystron, two cavity Klystron, operation as amplifiers and oscillators, bunching process, Applegate diagram, Magnetron traveling wave tube amplifier, BWA (**L-8)**

5. Semiconductor devices : Microwave transistor : Cutoff frequency, power gain, maximum available gain, frequency limitation. Johnson four equations, Gun diode, Tunnel diode, MOSFET,PIN diode, read diode, parametric amplifiers. (**L-10)**

6. Other devices : Ferrite isolators, Bolometers, TR and ATR switches (**L-3)**

7. Microwave measurements : Impedance, power, frequency attenuation, dielectric constant Q measurements. (**L-6)**

Reference Books :

1. Introduction to microwave theory and measurements : Lance PUB McGraw Hill.
2. Foundations of microwave engineering : Collins PUB McGraw Hill.
3. Microwave semiconductor devices and their circuit applications : Watson PUB McGraw Hill.
4. Microwave devices and circuits : Liao, PHL
5. Physics of semiconductor devices : Size, Willey Eastern.

6. Microwave Electronics : V.Kulkarni 1up Publication.
7. Microwave application : Sisodia, Raghuvanshi.
8. Microwave principles : Richi, Addion Wesley.

PHYDP – 705 : SPECIAL LABORATORY – I / PHYDP – 804 : SPECIAL LABORATORY – II (Half Laboratory each)

List of Experiments (Any five)

1. Measurement of frequency, wavelength and VSWR in waveguide.
2. Measurement of load impedance using Smith chart.
3. Measurement of dielectric constant.
4. Impedance matching using slide screw tanner.
5. To measure the gain of an aerial horn.
6. To measure the performance of directional coupler.

PHYSICS OF SEMICONDUCTOR DEVICES

Properties of Semiconductor

Band structure of semiconductors, carrier concentration at thermal equilibrium for intrinsic and doped semiconductors, carrier energy distribution, application of Fermifactor to semiconductors, Density of available states Excess carriers, carrier transport phenomena. Mobility Resistivity, hall effect, recombination process. Basic equation for semiconductor device operation. **(L-8)**

P.N. Junction

Basic device technology, Depletion region and depletion capacitance, current Voltage characteristics : Ideal case, Shockley Equation, Generation recombination process, High injection condition, Diffusion capacitance, Narrow base diode, Junction breakdown. **(L-8)**

Junction Transister

Formation of transistor, Basic current Voltage relationship, current gain in transistor Injection efficiency, base transport factor, Depletion layer and surface recombination. Static characteristics common base and common emitter configurations. Power transistor, General consideration, second breakdown switching transistor, uninjuction transistor. **(L-6)**

Field-Effect-Devices

Schottky diode, semiconductor controlled rectifier, Junction field effect transistor. Basic characteristics static characteristics, Dynamic characteristics, current limiter. **(L-2)**

Metal Semiconductor Devices

Schottky effect, Energy Band relation at metal semiconductor contact, Ideal condition and surface states depletion Layer, General expression for barrier height Current Transport Theory in Schottky barrier, Thermionic Emission Theory, Diffusion theory, Thermionic Emission - Diffusion theory. Measurement of Schottky barrier height current voltage measurement, Forward characteristics. Reverse characteristics, capacitance – voltage measurement, photoelectric measurement, clamped transistor, Schottky barrier Gate field effect transistor, metal semiconductor IMPATT Diode. **(L-8)**

Metal Insulator Semiconductor devices

Ideal MIS diode, surface states, surface charges and space charges, Effects of metal work function, Crystal orientation temperature, Illumination and radiation on MIS characteristics. **(L-6)**

Optoelectronic Devices

Radioactive transitions, Intrinsic transition, Extric transitions, Luminescent efficiency, methods of Exitation.

Solar Cell : Basic characteristics, spectral response, Recombination current and series resistsnce.

Photoelectrors : Photoconductor, Depletion Layer Photodiode, general consideration, P –I –n Photodiode, P – n junction Photodiodes. **(L-6)**

Semiconductor Lasers

Transition processes, Direct and indirectly band gap semiconductors, Population inversion, Gain, Junction Lasers, device fabrication, Threshold current density.

Tunnel diode : Effects of high doping. Tunneling process qualitative consideration, Tunneling probability and tunneling current. Excess current. **(L-4)**

Referance Books

1. Physics of Semiconductor Devices – S.M. Sze
2. Physics Solid State Devices – Streetman B.B.
3. Semiconductor Physics – Smith
4. Fundamentals of Semiconductor Devices – J. Lindmayer and C.Y. Wrigley
5. Physics of Semiconductor Devices – Michael shur
6. Introduction to Semiconductor devices – K.J.M. Rao

PHYDP-705: SPECIAL LABORATORY-I/
PHYDP-804: SPECIAL LABORATORY-II
(Half Laboratory each)

List of Experiments

1. Determination Resistivity by four Probe Method
2. Determination of hall coefficient
3. Characteristics of Solar Cell
4. Measurement of band gap semiconductor diode
5. Study of optocoupler
6. Ionic conductivity
7. Determination of Wavelength and Divergence of beam using diode laser.

COMMUNICATION ELECTRONICS

1. **Digital Communication** :

   Fundamentals of digital communication systems.
   Characteristics of data transmission system such as Band-Width requirement, speeds SNR, cross talk, echo suppressors, distortion equalizer, Digital codes, Baudot code, binary code, ASCII code (EBCDIC), hollerith code, error detection, constant ratio codes, Redundant codes, parity check codes, Communication system using modern interfacing, interconnection of Data circuit to telephone loops, Network organization. **(L-12)**

2. **Broadband Communication systems :**

   Multiplexing – FDM, TDM, Higher order digital multiplexing, Fiber Optic Communications – Principles of light transmission in a fiber, effect of Index profile on propagation , Modes of propagation, Number of modes a fiber will support, Single-mode propagation, losses in fibers. Dispersion – effect of dispersion on pulse transmission , types of dispersion, intermodal, material and waveguide, total dispersion and maximum transmission rates, Light sources for fiber optics, An Optical Receiver Circuit, Connectors and Splices – loss mechanism, types of connectors and fiber Splices, Fiber communication systems. **(L-12)**

3. **Telephone System :**

   Wire telephone, telephone subscriber's loop circuit, transmission bridges, four wire terminating set, Two –wire repeaters, Four wire transmission , Public telephone network, Trunk circuits and Private telephone networks, Cellular and mobile phone systems.
   (L-10)

4. **Facsimile :**

   Facsimile transmission, reception, Transmission of facsimile telegraph, line transmission and radio transmission, radar systems, Fundamental radar range equation, basic pulsed radar. **(L-8)**

5. **Satellite Communication :**

   Satellite frequencies, orbits (geostatics, equatorial/polar, synchronous) station keeping, satellite attitude, transmission path, path loss, noise considerations, satellite system and scanning methods. **(L-6)**

Reference Books :

1. Electronic communications – Rooddy – Coolen (PHI) electronic
2. Communication Systems – George Keneddy (TMH)
3. Telecommunication switching systems & Network – T.Vishwanathan.(PHI)
4. Mobile Cellular Tele communication System – C.Y.Lee
5. Communication Electronics – Fresnel
6. Communication Electronics – Katre

PHYDP – 705 : SPECIAL LABORATORY – I / PHYDP – 804 : SPECIAL LABORATORY – II (Half Laboratory each)

List of experiments (Any Five)

1. Delta pulse Modulation
2. Optical communication with LED and Photo-transistor.
3. Directional characteristics of Dish antenna.
4. Digital Multiplexing
5. Study of cordless telephone
6. Study of PAM/PPM,PWM
7. Study of 3 way intercom system.

RADIOWAVE APPLICATIONS

1. ANTENNAS:

Definition, Introduction, Properties and parameters, Elementary electrical doublet, Characteristics of antenna systems, Broadside and Endfire arrays, Yagi antenna, Loop antenna, Parabolic reflectors, Folded dipole, Log periodic and Helical antenna, All important terms and numericals **(L-10, P-2)**

2. MODULATION:

Types of modulations: AM, FM, PM, SSB, VSB (Theory, Frequency Spectrum, Power Relation, Generation), Forms of AM, Applications in communication systems, Block diagram and demodulator of AM and FM **(L-10,P-2)**

3. RECEIVER AND COMMUNICATION SYSTEM:

Characteristic and types of receiver, Block Diagram of TV Receiver, tuner and mixer stage, IF amplifier, Video amplifier, Sync separator **(L-10)**

4. TELEVISION COMMUNICATION SYSTEM:

Block diagram of TV transmitter, Scanning synchronization, Composite video signal, TV camera tubes, Frequency multiplexers and demultiplexers, Negative polarity in TV transmission, Information theory, Information content channel capacity, Signal to noise ratio **(L-8)**

5. RADIO WAVE PROPAGATION:

Types of Propagation: Ground or surface wave, Space wave, Sky wave propagation, Duct propagation, Radio horizon, Troposcatter, Ionospheric propagation, Fading **(L-6)**

REFERENCE BOOKS:

1. Electronic Communication – Roddy and Coolen
2. Antennas and Wave Propagation – G. S. N. Raju
3. Electronic Communication Systems – Kennedy
4. Electronics and Radio Engineering- Terman
5. Electronic Communication Systems-Wayne Tomasi

PHYDP- 705: SPECIAL LABORATORY-I AND
PHYDP- 804: SPECIAL LABORATORY-II
(Half Laboratory Course each)

List of Experiments (Any five)

1. Study of amplitude modulation and detection
2. Characteristics of Yagi antenna (gain, directivity, impedance and polarization.)
3. Study of TV receiver characteristics.
4. Study of balanced modulator and DSB / SSB
5. Loop AE with a Vertical antenna for DF
6. F.M. Detector
7. Mixer with filter for (wc-wm) and (wc-2wm)
8. Study of (VSNL) parabolic AE (TV)

INTRODUCTION TO MICROCONTROLLERS AND APPLICATIONS

Chapter 1 : Introduction to Computing :

Numbering and coding systems-m Decimal , binary , hex number systes and convertions. Addition , subtraction of binary and hexadecimal numbers , ASCII code. Digital primer – Logic gates , flip-flops (L-5)

Chapter 2 : 8051 Microcontroller :

Microprocessor versus microcontroller, microcontroller for embedded systems, criteria for choosing a microcontroller, history of 8051. (L- 5)

Chapter 3 : The 8051 Architecture :

8051 microcontroller, Hardware – oscillator, clock, program counter, data pointer, A and B CPU registers, Flags and the program status word (PSW) , Internal memory, Internal RAM , the stack and stack pointer, special function register (SFR), internal ROM.
I/O pins, ports and circuits External memory, counters and Timers serial data input/output, Interrupts. (L-15)

Chapter 4 : 8051 Assembly Language Programming

Introduction , structure of assembly language, assembling and running on 8051 program, Data transfer types , addressing modes, PUSH and POP operations, Arithmatic, Logic , JUMP, LOOP, CALL instructions, time delay, I/O programming, serial port programming. (L- 15)

Chapter 5 : Applications :

Interfacing of LCD, Keyboard, ADC, DAC and Sensor interfacing. (L-6)

Chapter 6 : Microcontroller Application Development Tools :

Use of Kell software 8051 development tool. (L- 2)

Reference Books :

1 The 8051 Microcontroller and embedded system
using assembly and C - Mazidi, Mazidi Mckinlay
2 The 8051 Microcontroller – Ayala - third edition.
3 Microcontroller – Architecture, Programing, Interfacing and system design – Rajkamal
4 8051 Microcontroller – Mckenzie.

PHYDP- 705: SPECIAL LABORATORY-I AND PHYDP- 804: SPECIAL LABORATORY-II (Half Laboratory Course each)

List of Experiments : (Any Five)

1. Addition of the first 10 natural numbers (Ex. 3.2 Mazidi)
2. Program for toggling bits of port 1 with a delay whichdepends on the value of a number in Ro (Ex. 3.11 Mazidi)
3. Program to get the x value p1 and send it's square to p2 continuously. (Ex. 5.8 Mazidi)
4. Addition of two 16 – bit Hex numbers (Ex. 6.3 Mazidi)
5. Hexadecimal to Decimal convertion(Ex. 6.9 Mazidi)
6. Program to find largest number in the set (Ex. 6.24 Mazidi)
7. Program for checksum byte (Ex. 6.36 Mazidi)
8. Program to transfer a letter "Y" serially at 9600 baud continuously and also to send "N" through port 0 which is connected to a display device (Ex. 10.2 Mazidi)
9. Program for 1's complement.
10. Program for LCD interfacing.
11. Program for Keyboard interfacing.
12. Program for ADC interfacing
13. Program for DAC interfacing
14. Use of Keil software.

PHYSICS OF NANOMATERIALS

1. Introduction to Nanomaterials :

Introduction to nano-sized materials & structures effect of reduction of dimensions, quantum size effect.
Particle in a box , density of states for a zero, one, two,& three dimensional box.
Surface & interface effect, modeling & manifestation of quantum size effect.
Ref 1 : chapt. 1, Ref 2 : chapt. 2. **(L-6)**

2. Physical methods for the synthesis of Nanomaterials :

High energy Ball Milling, Melt mixing, Physical vapour deposition, Ionised cluster beam deposition, Laser ablation, Laser pyrolysis, Sputter deposition, Chemical vapour deposition, Electric arc deposition, Photolithography.
Ref 1: chapt. 3, 8 . Ref 2 : chapt. 5 . **(L-8)**

3. Chemical methods for the synthesis of Nanomaterials

Surface energy, surface curvature, Ostwald's ripening, electrostatic stabilization DLVO theory, steric stabilization.
Homogeneous nucleation, growth of nuclei controlled by diffusion & surface process.
Heterogeneous nucleation.
Synthesis of metal & semiconductor nanoparticles by colloidal route, Langmuir-Blodgett method, microemulsions, Sol-gel method.
Ref 1 : chapt. 4, Ref 2 : chapt. 2 , 3 . **(L-12)**

4. Characterization techniques :

X-ray diffraction, UV-vis-NIR spectroscopy, Photo luminescence spectroscopy, Transmission electron microscopy, Scanning electron microscopy.
Ref 1: chapt. 6 , Ref 2: chapt. 8 , Ref 5 : chapt. 2 . **(L-8)**

5. Properties of Nanomaterials:

Mechanical, Thermal, Electrical, Optical & Magnetic Properties.
Ref 1: chapt. 7, Ref 2: chapt. 8. **(L-6)**

6. Special Nanomaterials:

Carbon nanotubes, Porous silicon, Aerogels core shell structures.
Ref 1:chapt.9, Ref 2 :chapt.6, Ref 5: chapt. 9 **(L-5)**

7. Applications:

Nanoelectronics, Medical, Biological, Quantum Dots & Quantum well devices, Plasmon wave guides(Optical Devices), Automobiles, Space, Defence, Sports & Cosmetics.
Ref 1: chapt.10, Ref 2: chapt. 9 . **(L-3)**

References:-

1. **Nanotechnology: Principles & Practicals**. Sulbha K. Kulkarni ,Capital Publishing Co.New Delhi.
2. **Nanostructures & Nanomaterials Synthesis, Properties & Applications.** Guozhong Cao, Imperials college Press London.
3. **Nanomaterials: Synthesis, Properties & Applications.** Edited by A.S. Edelstein & R.C. Commorata. Institute of Physics Publishing, Bristol & Philadelphia.
4. **Introduction to Nanotechnology.** C.P. Poole Jr.& F. J.Owens, Wiley Student Edition.
5. **Nano: The Essentials.** T.Pradeep , McGraw Hill Education.

PHYDP- 705: SPECIAL LABORATORY-I AND
PHYDP- 804: SPECIAL LABORATORY-II
(Half Laboratory Course each)

List of Experiments: Physics of Nanomaterials

1. Synthesis of metal oxide nanoparticles by wet chemical method.
2. Synthesis of metal oxide nanoparticles by electrochemical method.
3. Deposition of thin films by spray pyrolysis technique.
4. Preparation of porous silicon using electrochemical etching method
5. Study of optical absorption of nanoparticles.
6. Determination of structure & particle size of nanoparticles from X-ray diffraction.
7. Use of photolithography technique to develop pattern on substrate.
8. Study of photoluminescence of nanoparticles.
9. Deposition of thin film in vacuum.
10. Thin film formation by chemical vapour deposition technique.
11. Deposition of thin films by spin coating method.
12. Synthesis of metal oxide nanoparticles by Hydro-thermal method.

REMOTE SENSING

1. Introduction: Sun and atmosphere, remote sensing system, Indian remote sensing programme, electromagnetic (EM) radiation: characteristics, interaction of electromagnetic radiation with earth surface features and atmosphere attenuation, absorption, reflection, scattering, emissivity, black body, Planck's law, Stefan-Boltzmann law, Eien's displacement law, source of EM radiation for remote sensing **(L-6)**

2. Fundamental of Radiometry: Radiative transfer, rotational, vibrational and mixed spectra, emissivity and polarization, Beer's law, thermal radiation, Physical basis of signatures: Signature in the reflective optical infrared region, thermal infrared, microwave region, spectral windows. **(L-6)**

3. Remote sensors, classification, sensor characteristics, resolution; special, spectral, radiometric, temporal; visible, water vapour, infrared sensors, microwave sensors, active sensing using LASER and microwave radar; sensor materials, comparison of passive and active sensing; advantages and disadvantages. **(L-8)**

4. Platforms: Satellite orbits and altitude, principles of satellite motion, Kepler's laws, orbital elements, satellite latitude and its control, types of orbits: polar and geostationary, earth and sun synchronous, orbit optimization, orbital perturbations viewing geometry, launch vehicles and spacecrafts, global positioning system. **(L-6)**

5. Satellite data processing: satellite data acquisition, satellite communications, data collection, data products, data analysis: image processing, visual image analysis, image enhancement techniques, noise removal methods, image interpretation, pattern recognition, image classification, computer based classification, use of transforms for conversion of data to frequency domain, use of artificial neural networks for remote sensing data analysis. **(L-10)**

6. Application of remote sensing for Earth resource management: In agriculture, forestry, land cover/land use mapping, water resources, geographical information system, details of application ina any one field e.g. Applications in atmospheric sciences, atmospheric sounding principle, absorption techniques, sensors, importance of clouds, International cloud classification, identifying cloud types and patterns in VIS-IR, microwave images from satellites. **(L-12)**

Reference Books

1. Fundamnentals of remote sensing by George Joseph, Universities press (India), 2003.
2. Remote sensing, Agarwal C.S. and Garg P.K., A.H.Wheeler & Co. New Delhi, 2000.
3. Remote sensing and image interpretation Lillisand T.M. and Keifer R.W., John wiley & sons, New York, 1990.
4. Remote sensing digital image analysis: An introduction, Richards J.A. and Jia Xiuping Springer.
5. Remote sensing models and method for image processing: Schowenderdt R.A.Academic Press.
6. Introduction to environmental remote sensing: E.C.Barett and L.F.Curtiss, Hohn wiley & sons.
7. Remote sensing: The quantitative approach: Swain and Davis ed.1978, McGraw-Hill publications.
8. Remote sensing: principles and interpretation, Sabnis F.F., 2nd Ed. 1978, freeman and Company.
9. Microwave remote sensing: Active and Passive, Ulaby et. Al. 1981, vol.1 ch.6, vol.2 ch.2, ch.8,9
10. Lecture notes on satellite meterology, vol.1 and 2, SAC, Ahmedabad.
11. Images in weather forecasting, M.J.Badar, G.S.Forbes, J.R.Grant, R.B.E.Lilly and A.J.waters, Cambridge press, 1955.
12. Satellite meterology, S.Q.Kidder and T.H. Van der Haar, academic press, 1955.
    Quantitative meterological data from satellites, WMO Technical note No.166.

PHYDP-705: SPECIAL LABORATORY-I/
PHYDP-804: SPECIAL LABORATORY-II
(Half Laboratory each)

List of Experiments (any Five)

1. Downloading of data from visible, IR, microwave satellites using internet.
2. Visual interpretation of images from visible, IR, microwave satellites.
3. Determination of cloud features and their classification from cloud photos.
4. Digital image classification techniques.
5. Computer simulation of artificial neural networks (ANN) for classification of satellite images.
6. Visits to institutes such as:
   - i) Indian Meterological department (IMD), Shivajinagar, Pune.
   - ii) Indian Institute of tropical meterology (IITM), Pashan, Pune.
   - iii) National remote sensing agency, Hyderabad, Chandigarh.
   - iv) Department of satellite Meterology, IMD, New Delhi.