

BHARATHIAR UNIVERSITY : COIMBATORE- 641 046

M.Phil./Ph.D. in Applied Physics
(w.e.f. 2009-2010 and onwards)

PART-I SYLLABUS

PAPER I : Research Methodology in Applied Physics

PAPER II : Research Trends in Applied Physics

PAPER III : Special Papers

1. Modern Sensors : Physics, Design and Applications
2. Recent Trends in Thin Film Technology

Paper-I : Research Methodology in Applied Physics

UNIT1

- a). Basic electronics (electrical unit e.g. E.M.F, Charge, Current flow, Resistance, Impedance, Frequency, Conductance etc. ECG, EMG, EEG, GSR (Galvanic Skin Response), EP (Evoked Potential) their principles of measurements, BP measurement.
- b) pH measurement, buffers, estimation of macro molecules (protein, carbohydrate and nucleic acids), enzyme kinetics, Colorimetry- ultraviolet-visible spectrophotometry-principles, instrumentation and application, fluorescence spectrophotometry.

UNIT 2

- a. Chromatography techniques and principles and different types (Affinity chromatography, ion exchange chromatography, Gel exclusion chromatography, Gas chromatography, HPLC, TLC, paper chromatography). Isolation of natural products (extraction, purification and separation.
- b. Different types of microscopic techniques (light microscope, compound microscope, dark field microscope, phase contrast microscope, Normaski microscope, confocal microscopy, transmission electron microscopy (TEM) and scanning electron microscopy (SEM), Cell sorting-flow cytometry,

UNIT 3

- a) Ergometry - its principles and different type of ergometers and their applications. Pulmonary function tests, Spirometry. Respiratory gas analysis (expired air), Blood gas analysis. Physical performance assessment.
- b) Routes of immunization, types of adjuvant and their importance, antigen antibody interaction, monoclonal and polyclonal antibodies. ELISA techniques-principle and applications, Immunoradiometric assay- Principles and applications, Hybridoma.

UNIT 4

- a) Environmental/Bio-meteorological analysis: Heat indices using Dry bulb & Wet bulb thermometer, Kata thermometer. Anaemometer, measurement of Basal Metabolic Rate, energy expenditure Direct and indirect calorimetry).
- b) Isolation of genomic DNA and plasmid DNA, DNA sequencing techniques (PCR, RTPCR, restriction analysis, DNA fragmentation analysis, Hybridization techniques) etc. COMET assay, cell viability assay, karyotyping.

UNIT 5

- a) Statistics in biomedical research- Experimental design, Various sampling methods, Probability, frequency distribution average (arithmetic, geometric, means, mode and median) Standard Deviation, Standard Error of Mean, Degree of Freedom, Significance, t-test, Correlation, null hypothesis, distribution.
- b) Bioinformatics: use of computers in data analysis, Biological databases- DNA sequence databases and protein sequence databases. BLAST, FASTA, Multiple sequence alignment.

Paper-II : Research Trends in Applied Physics

UNIT 1

- a) Environment factors effective human health and performance (Heat, Cold, High Altitude, Under water and Space).
- b) Occupational environment and Pollution (type, effect on human health).

UNIT 2

- a. Thermoregulatory mechanisms in human beings and adaptive/acclimatization responses.
- b. Glycolysis, gluconeogenesis, citric acid cycle, pentose phosphate pathway, β -oxidation of fatty acids, ketone bodies; integration of metabolic pathways, electron transport chain, oxidative phosphorylation. k_m , competitive, non-competitive and mixed inhibition, effect of pH; principles of toxicology.

UNIT 3

- a) Physical work capacity (Changes in different environmental conditions, High Altitude, Heat and Cold). Anthropometric and body composition changes in different age and sex.
- a) Oxidative stress and types of free radicals, their role in cell metabolism and diseases; antioxidant defense system, detoxification mechanism; neurotransmitter and neuromodulator

UNIT 4

- a) Biorhythms- Different types mechanisms. Effect of circadian rhythms on human health and efficiency.
- b) Development of immune system, regulation of immune response, humoral and cell mediated immunity

UNIT 5

- a) Different heat stress indices (Effective Temperature, WBGT) its measurement principles and applications. Wind Chill Index, Measurement, Applications. Clo value, its definition and application.
- b) Gene structure and function, DNA replication and repair, cloning and expression of genes. Transcription and translation in prokaryotes and eukaryotes.

Special Paper - 1 : Modern Sensors: Physics, Designs and Applications

Unit I: Sensor Characteristics and Principles

Sensor Classification - sensor characteristics - Physical principles of sensing - electric charges, fields, and potentials - capacitance – magnetism – induction - resistance - piezoelectric effect - pyroelectric Effect - Hall effect - Seebeck and Peltier Effects - SoundWaves - temperature and thermal properties of materials - heat transfer - Light - Dynamic Models of Sensor Elements.

Unit II: Sensor Components and Circuits

Optical Components of Sensors : radiometry - photometry – windows - mirrors - lenses - Fresnel lenses - fiber optics and waveguides – concentrators - coatings for thermal absorption - electro-optic and acousto-optic modulators - Interferometric Fiber-optic Modulation, Interface Electronic Circuits: input characteristics of interface circuits - amplifiers - excitation circuits - analog-to - digital converters direct digitization and processing - ratiometric circuits - bridge circuits - data transmission- Noise in Sensors and Circuits - batteries for low power sensors

Unit III: Types of Sensor I

Occupancy and Motion Detectors : ultrasonic sensors - microwave motion detectors - capacitive occupancy detectors - triboelectric detectors - optoelectronic motion detectors, Position, Displacement, and Level : potentiometric sensors - gravitational sensors - capacitive sensors - inductive and magnetic sensors - optical sensors - ultrasonic sensors - radar sensors - thickness and level sensors, Velocity and Acceleration: accelerometer characteristics - capacitive accelerometers - piezoresistive Accelerometers - piezoelectric accelerometers - thermal accelerometers - gyroscopes - Piezoelectric Cables, Force, Strain, and Tactile Sensors: strain gauges - tactile sensors - piezoelectric force sensors, Pressure Sensors : concepts of pressure - units of pressure - mercury pressure sensor - bellows, membranes, and thin plates-piezoresistive sensors- capacitive sensors- VRP Sensors- optoelectronic sensors - vacuum sensors.

Unit IV: Types of Sensor II

Flow Sensors : basics of flow dynamics - pressure gradient technique - thermal transport sensors - ultrasonic sensors - electromagnetic sensors - microflow sensors - breeze sensor - coriolis mass flow sensors - drag force flow sensors, Acoustic Sensors : resistive microphones - condenser microphones - fiber-optic microphone - piezoelectric microphones - electret microphones - solid-state acoustic detectors, Humidity and Moisture Sensors : concept of humidity - capacitive sensors - electrical conductivity sensors - thermal conductivity sensor - optical hygrometer - oscillating hygrometer. Light Detectors : introduction - photodiodes - phototransistor - photoresistors - cooled detectors - thermal detectors - gas flame detectors, Radiation Detectors : scintillating detectors - ionization detectors, Temperature Sensors: thermoresistive sensors- thermoelectric contact sensors- semiconductor P-N junction sensors-optical temperature sensors- acoustic temperature sensor- piezoelectric temperature sensors.

Unit V: Nanosensors

Chemical Sensors : chemical sensor characteristics - specific difficulties - classification of chemical-sensing mechanisms - direct sensors - complex sensors - chemical sensors versus instruments, Sensor Materials and Technologies : materials - surface processing - nano-technology - photolithography, Chemical and Molecular Sensors – Displacement and Motion Sensors – Force Nanosensors – Pressure Sensing – Thermal Nanosensors – Electric and Magnetic Sensing – Cellular Bioscanning – Non-invasive Neuroelectric Monitoring– Macrosensing– Acoustic Macrosensing – Electric and Magnetic Macrosensing – Neural Macrosensing

References

1. Jacob Fraden, Handbook of Modern Sensors (2003) Springer, 3rd Edition ISBN 0-387-00750-4.
2. Nano Medicines Edited by Dr.Parag Diwan and Ashish Bharadwaj (2006) Pentagon Press ISBN 81-8274-139-4.

Special Paper - 2 : Recent Trends In Thin Film Technology

Unit I: Vacuum Science and Technology

Kinetic theory of gases – molecular velocities – pressure – gas impingement on surfaces – Gas transport and pumping - gas flow regimes – conductance – pumping speed – vacuum pumps and systems – pumps – rotary mechanical pump – diffusion pump - turbo molecular pump – cryopumps – sputter ion pumps – systems – system pumping consideration – vacuum gauges – thermal conductivity vacuum gauges – ionization vacuum gauges.

Unit II: Preparation of thin films

Film deposition methods - introduction – fundamentals of film deposition – thermal evaporation – Spray Pyrolysis - Flame Pyrolysis - molecular beam epitaxy – pulsed laser deposition – dc/rf magnetron sputter deposition – chemical vapour deposition – layer by layer growth and ultra thin films – chemical solution deposition – Langmuir Blodgett films

Unit III: Electrical and Optical Properties of Thin films

Introduction of electrical properties of thin films - measurement of resistivity - conduction in metal films – electrical transport in insulating films – semiconductor contacts and MOS structures - Hall Effect and Magneto Resistance, – photoconduction –field effect thin film transistors- Insulation films – Dielectric properties – dielectric losses – Ohmic contacts – metal-insulator and metal contacts – DC and AC conduction mechanism.

Unit IV: Magnetic properties of Thin films

Electron transport in magnetic multi-layers – GMR - spintronics - spin polarized electron tunneling – interlayer exchange coupling – spin relaxation in magnetic metallic layers and multi-layers - non-equilibrium spin dynamics in laterally defined magnetic structures.

Unit V: Optical properties of thin films and thin film solar cells

Thin Film optics – theory – optical constants of thin films – experimental technique-multilayer optical systems – Interferences – filters – Antireflection coatings. Thin film solar cells: Role and progress and production of thin film solar cells-photovoltaic parameters. Thin film silicon (Polycrystalline) solar cells. Current status of bulk silicon solar cells – fabrication technology photovoltaic performance – Emerging solar cells : GaAs and CuInSe.

Books for Study:

1. The Materials Science of Thin Films, Milton Ohring (1992) Academic Press.
2. Fundamentals of Vacuum technology, Walter Umrath (1998)
3. Hand book of thin film Technology, L. Meissel and Glang
4. Thin Film Phenomena, K. L. Chopra
5. Ultra thin Magnetic Structures III – Fundamentals of Nanomagnetism, J.A. C. Bland and B. Heinrich, Springer (2004) ISBN 3540219536
6. Thin Film Solar Cells, K. L. Chopra and S. R. Das

Books for reference:

1. Vacuum Deposition of thin films, L. Holland
2. The Use of Thin Films in Physical Investigation, J. C. Anderson
3. Thin Film Technology, Berry, Koil and Horris
