Master of Science Applied Physics

Syllabus - First Semester

ELECTRONICS

Course Code: PHY4103 **Credit Units: 04**

Course Objective: This course gives a comprehensive view of the Integrated Circuit Fabrication and Technology, operational amplifiers, modulation and demodulation techniques. Practical Transmitting and Receiving Antennas- the antenna action and their types will also be studied in detail.

Course Contents:

Module I: Integrated Circuit Fabrication

Integrated-Circuit Technology, Advantages and limitations of Integrated Circuits, Basic Monolithic Integrated Circuits, Epitaxial Growth, Masking and Etching, Diffusion of Impurities, Integrated Capacitors and Inductors, Large-Scale and Medium-Scale Integration, Metal-Semiconductor Contact.

Module II: Operational Amplifiers

The ideal Op-Amp-inverting, non-inverting and differential amplifiers-CMRR; Op-Amp IC building blocks-emitter coupled differential amplifier, active load, level shifting and output stage; Op-Amp characteristics-open-loop input output characteristics, frequency response and slew rate; Op-Amp applications-adder, subtractor, integrator, differentiator, comparator, voltage-to-current converter, current-to-voltage converter and logarithmic amplifier.

Module III: Modulation and Demodulation

Definition, Amplitude modulation, Methods of Amplitude Modulation, Frequency Modulation, Phase Modulation, Pulse Modulation Systems- PAM, PWM, PPM, PCM, Delta Modulation, Principle of AM Detection, Frequency Demodulation. Digital modulation schemes: amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK). Multiplexing - time division and frequency division. Applications of Modulation Techniques.

Module IV: Antennas

Antenna Action, Short Electric Doublet, Radiation from a Current Element, Thin Linear Antenna, Effect of Ground: Image Antenna, Short Vertical Grounded Antenna, Total Effective resistance and Efficiency of an Antenna, Yagi Antenna, Loop Antenna, Parabolic Reflectors, Antenna measurements, Broadband antenna principles, Practical Transmitting Antennas, Receiving Antennas, Difference in Receiving and Transmitting Antennas.

Examination Scheme:

Components	CT	HA	S/V/Q	A	EE
Weightage (%)	10	8	7	5	70

CT: Class Test, HA: Home Assignment, S/V/Q: Seminar/Viva/Quiz, EE: End Semester Examination; A: Attendance

Text & References:

- Hand Book of Electronics, Gupta & Kumar, PragatiPrakashan.
- Integrated Electronics: Analog and Digital Circuits and Systems, Jacob Millman and Christos C. Halkias, Tata McGraw-Hill.
- Digital Principles and Applications by A.P. Malvino and D.P. Leach, Tata McGraw-Hill, Publishing Co., New Delhi.

- Text Book of Electronics by S. Chattopadhyay, New Central Book Agency P.Ltd., Kolkata, 2006.
- Electronics Principles by Malvino, 6th Edition, Tata McGraw-Hill Publishing Co., New Delhi, 2001.
- Electronics Principles and Applications by A.B. Bhattacharya, New Central Book Agency P.Ltd., Kolkata, 2007.

COMPUTATIONAL PHYSICS

Course Code: PHY4110 **Credit Units: 04**

Course Objective:
This course aims at exposing the students to basic Computational Physics which will be useful for them to solve the problems of Physics.

Course Contents:

Module I Introduction to MATLAB and Plotting: vector and matrix generation, subscripting and thecolon notation, matrix and array operations and their manipulations, introduction to some inbuilt functions. Two & three-dimensional graphics: basic plots, change in axes and annotation in a gure, multiple plots in a gure, saving and printing gures, mesh plots, surface plots and their variants.

Module II m-files: scripts and user de ned functions, calling functions into a script le, subfunctions,and nested functions, concept of local and global variable, few examples of in-built functions, editing, saving m- les.

Module III Loops and Conditional statements: Flow control using various statements and loops in-cluding For-End and While-End loops with Break commands. Conditional Statements: If-End statement, If-Else-End statement, nested If-Else-End statements.

Module IV Applications of MATLAB: Introduction to builtin functions: related to matrix inversion,eigenvalues, eigenvectors, condition number; for data representation: bar charts, histograms, pie chart, stem plots etc; for solving various type of di erential equations; for specialized plotting e.g., contour plots, sphere, and animations.

Examination Scheme:

Components	**A**	**CT**	**HA**	**EE**
Weightage (%)	5	15	10	70

CT: Class Test, HA: Home Assignment, EE:End Semester Exam, A: Attendance

Reference Books:

- Applied Numerical Methods with Matlab for Engineers and Scientists by Steven Chapra, McGraw Hill, 2008.
- MATLAB: An introduction with applications: Amos Gilat, 5th Edition, Wiley India, 2014.
- Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers by RudraPratap, Oxford University Press, 2016

Syllabus - Second Semester

INTEGRATED PHYSICS LAB-II

Course Code: PHY4212 **Credit Units: 03**

List of Experiment (Any Eight)

1. Measurement of vacuum using the Pirani/thermocouple gauge.
2. Measurement of lattice parameters and indexing of powder patterns.
3. Determination grain size of the alloy by optical microscope.
4. Calculation of the optical band gap of the semiconductor by absorption spectroscopy.
5. Calculation of the grain size and strain in the samples from the XRD pattern data.
6. Production and measurement of high pressure.
7. To study temperature-dependence of conductivity of a given semiconductor crystal using four probe method.
8. To determine the Hall coefficient for a given semi-conductor.
9. To determine dipole moment of an organic molecule.
10. To study the lattice dynamics using LC analog kit.
11. To study the characteristic of J-H curve using ferromagnetic standards.
12. To determine the velocity of ultrasonic waves using interferometer as a function of temperature.
13. Temperature dependence of a ceramic capacitor - Verification of Curie-Weiss law for the electrical susceptibility of a ferroelectric material.
14. Tracking of the Ferromagnetic-paramagnetic transition in Nickel through electrical resistivity.
15. To study the characteristics of a PN junction with varying temperature & the capacitance of the junction.
16. (i) Study of the characteristics of klystron tube and to determine its electronic tuning range;(ii) To determine the standing wave ratio and reflection coefficient; (iii) To determine the frequency& wavelength in a rectangular waveguide working on TE10 mode; (iv) To study the square law behavior of a microwave crystal detector.
17. To determine the specific charge (e/m) of an electron.
18. To determine the charge of an electron using Millikan oil drop experiment.
19. To determine the emission spectra of hydrogen atom.
20. To study the Kerr effect using Nitrobenzene

Examination Scheme:

Components	TA	V	LR	Attendance	EE
Weightage (%)	7	10	8	5	70

TA: Teacher Assessment V: Viva LR: Lab Record EE: External Examination

Text & References:

- Charles Kittel, Introduction to Solid State Physics, Wiley Eastern, 5th edition.
- A.J. Dekker, Solid State Physics, Prentice Hall of India (1971).
- N.W. Ashcroft and N.D. Mermin, Solid State Physics, Saunders College Publishing (1976).
- Ali Omar, Elementary Solid State Physics, Narosa Publishing House.
- J.S. Blakemore, Solid State Physics, 2nd edition, Cambridge University Press (1974).

Syllabus - Third Semester

EXPERIMENTAL TECHNIQUES-I

Course Code: PHY4314 **Credit Units: 03**

Course Contents:

Module I: Clean Room Technology (CRT)
Clean room technology (CRT) introduction, Requirements, Types of Clean Room (CR) and basic standards, design and filters for clean air, CR disciplines, sources of contamination, quality control, Industrial and Scientific application of CR.

Module II: Ultra High Vacuum Techniques (UHV)
Basics: Introduction to vacuum technique, units, ranges, review of Kinetic theory of gases, Physical parameters at low pressures, Throughput, different vacuum pumps for production of low, medium, high and ultra- high vacuum. Vacuum gauges (Mc Leod, Knudsen, Pirani, Penning and Ionization gauges), Leak detection, Industrial & Scientific applications.

Module III: Diffraction and Microscopic Techniques:
X-Ray diffraction, Electron diffraction, neutron diffraction, Transmission electron microscope (TEM), Scanning electron microscope (SEM), Energy dispersive X-ray analysis techniques (EDX). Atomic Force microscope (AFM), Surface Tunneling microscopy (STM).

Examination Scheme:

Components	CT	HA	S/V/Q	Attendance	EE
Weightage(%)	10	8	7	5	70

CT – Class Test, S/V/Q – Seminar/Viva/Quiz, HA – Home Assignment, EE – End Semester Examination

Text & Reference:

- Clean-room Technology: Fundamentals of Design, Testing and Operation, 2nd Edition, William Whyte, John Wiley & Sons.
- Basic Vacuum Technology, A. Chambers, R.K. Fitch and B.S. Halliday.Taylor& Francis 1998.
- A Users Guide to Vacuum Technology, O'Hanlon. John Wiley & Sons.
- Measurement & Detection of Radiation, Nicholas Tsoulfanids, S Landsberger, CRC Press.
- Radiation Detection and Measurement, G F Knoll, John Wiley & Sons.
- Students solutions manual to Radiation Detection and Measurement, David K Wehe.

INTEGRATED PHYSICS LAB-III

Course Code: PHY4316 **Credit Units: 03**

Course Contents:

1. Fabrication of thermocouple and calibration of the same for the temperature measurement.
2. Production and characterization of plasma.
3. Determination of the transition temperature of the materials undergoing phase transition and calculation of the transition enthalpy.
4. Determination of Young's modulus of steel by flexural vibrations of a bar.
5. To measure numerical aperture and propagation loss and bending losses for optical fibreasfunction of bending angle and at various wavelengths.
6. To determine wavelength of a given laser source.
7. To determine the Diameter, Divergence and Focus Spot Size of a Laser Beam.
8. To measure the degree of polarization using laser.
9. To study Propagation loss & bending loss using Optical Fiber
10. To study the characteristics of LED & Detector using Fiber Optic.
11. To determine the numerical aperture of a given optical fiber.
12. To study the frequency modulation & demodulation by using Fiber Optic Link.
13. To determine the Planck's constant using photocell
14. To determine the mean wavelength of sodium light and to measure the wavelength difference (Äë) using Michelson interferometer
15. To study the spectral characteristics of the incident beam using Fabry Perot Interferometer
16. To find the intensity distribution of single, double and multiple slit by using Fraunhofer diffraction pattern
17. To measure the grating element of grating by Fraunhofer diffraction pattern.
18. To determine the thickness of a thin transparent sheet using Michelson Interferometer.
19. To verify the Fresnel's formula for reflection and refraction by using a plane refracting surface using Spectrometer.
20. To determine the effect of magnetic field on the polarization state in dispersive medium (Faraday Experiment).

Examination Scheme:

Components	TA	V	LR	Attendance	EE
Weightage (%)	7	10	8	5	70

TA : Teacher Assessment,V: Viva, LR: Lab Record EE: External Examination

Text & References:

- J. Milman and C.C. Halkias, Electronic Devices and Circuits, McGraw-Hill (1981).
- A.P. Malvino, Electronics: Principles and Applications, Tata McGraw-Hill (1991).
- G.B. Calyton, Operation Amplifiers, ELBS (1980).
- J. Millman and C.C. Halkias, Integrated Electronics, Tata McGraw Hill (2001).
- R. A. Gayakwad, op-Amps and Linear IC'S, Pearson Education (2003).
- R. P. Singh and S. D. Sapre, Communication Systems: Analog and Digital, Tata McGraw Hill

RESEARCH REVIEW-I

Course Code: PHY4335 **Credit Units: 02**

Methodology:

Practical training is based on the theoretical subjects studied by students. It can be arranged within the college or any in any related industrial unit or in any research lab. The students are to learn various industrial, technical and administrative processes followed in the industry/research. In case of on campus training the students will be given specific tasks of synthesizing /testing/analysis/characterization. On completion of the practical training the students are to present a report covering various aspects learnt by them and give a presentation of the same.

Examination Scheme

Feedback from Industry:	20
Training Report:	40
Viva:	15
Presentation:	25
Total	**100**

DIGITAL ELECTRONICS AND MICROPROCESSORS

Course Code: PHY4306 **Credit Units: 03**

Course Objective:
The main aim of the course is to give concept of Digital Electronics and Microprocessor which is useful for research and industrial application.

Course Contents:
Module I: Boolean Algebra
Truth tables Logic gates: OR, AND, Inverter gates, The Universal NOR and NAND gates, XOR and XNOR gates, De-Morgan's Theorem, Reduction Technique Karnaugh map simplification. Parity check. The half adder, the Full adder, Parallel binary adder, half and full subtractors.
Sequential Logic: Latches, R.S. Flip/Flop, The D.Flip/Flop, T.Flip/Flop, J.K. Flip/flop, Master/ slaveflip/flop, Race Problem, Binary Ripple counter, modified counters using Negative feedback.

Module II: Shift Registers and Counters
Universal Shift Register, shift counter, Ring Counter, D/A converter and A/D converter. Simultaneous and Counter method of A/D converter, Successive Approximation method, Seven segment LED display, BCD to seven segment decoder.
Logic Families: Transistor as a Switch, TTL integrated circuits, CMOS integrated circuit. Logicfamilies and their characteristics, comparing Logic families, Interfacing. Introduction to VHDL and Programming techniques.

Module III: **Introduction to Microprocessor**
Microprocessor 8085: PIN Out and Signals, Internal architecture, Flags, Program counter. Introduction to 8085 Instruction Set: Data Transfer, Arithmetic & Logical Instruction, Branch and machine Code, OP-Code Format, Addressing Mode Timing Diagram. M **(10)**achine Cycle.

Module IV: Microprocessor: - **Programming and Interfacing**
Subroutine and Sub programming, CALL and RETURN, STACK, PUSH & POP, 8085 Interrupts, RST Code; SID, SOD, RIM and SIM; Delay Program Calculation, Memory Organization. (RAM, EPROM, ROM, PROM, DRAM.) Introduction to 8086 and registers. Addressing and Interfacing, Basic Interfacing Concept, Introduction to I/O and Memory Mapped Techniques, Handshaking, Interfacing I/O devices, Display, Keyboard, Generating Control Signals, De Multiplexing of address Bus, Programming Technique, Interfacing 8155, Programmable I/O Ports and Timer IC, Programmable Peripheral Interface 8255 with 8085. Interfacing of A/D and D/A converters, Study of 8279, 8253.

Examination Scheme:

Components	CT	HA	S/V/Q	Attendance	EE
Weightage (%)	10	8	7	5	70

CT – Class Test, S/V/Q – Seminar/Viva/Quiz, HA – Home Assignment, EE – End Semester Examination

Text & References:

- D. V. Hall, Microprocessors and Interfacing- Programming and Hardware, Tata McGraw Hill (1999)
- Microprocessor Architecture Programming and applicationsa by R.S Gaonkar
- Digital Electronics by Malvino and Leach
  Digital Electronics by V.K.Jain
- B. Brey, The Intel Microprocessors- Architecture, Programming and Interfacing, Pearson Education (2003)

Syllabus - Fourth Semester

EXPERIMENTAL TECHNIQUES-II

Course Code: PHY4402 **Credit Units: 03**

Course Objective:
The objective of the present course is to introduce some advanced measurement, characterization and analytical methods commonly used in experimental physics research to the post graduate students.

Course Contents:

Module I: Cryogenic Techniques
Introduction to Cryogenics and its Scientific & Industrial applications. Properties of Cryogenic Fluids. Properties of Materials at Cryogenic Temperature. Gas-Liquefaction and Refrigeration Systems. Cryogenic Insulations. Vacuum Technology. Instrumentation and Advanced Measurement Techniques at Cryogenic Temperature. Leak detection. Safety in Cryogenics.

Module II: Spectroscopy & Thermal Techniques
UV-VIS spectroscopy, photoluminescence, Infra-red spectroscopy, Raman spectroscopy, Photoelectron spectroscopy (XPS, UPS, AES). Thermal Techniques: TG, DTA, DSC. Scanning Thermal Microscopy (SThM)

Module III: Accelerators & Detectors
Van deGraff Accelerator, Tandem Accelerator, Linear Accelerator (LINAC), Cyclotron, Betatron, Synchrocyclotron, Synchrotron.
Detailed study of Ionization chamber; Proportional counter, GM counter, Scintillation detector, photomultiplier tubes, photodiode, semiconductor diode detector.

Examination Scheme:

Components	CT	HA	S/V/Q	Attendance	EE
Weightage (%)	10	8	7	5	70

CT – Class Test, S/V/Q – Seminar/Viva/Quiz, HA – Home Assignment, EE – End Semester Examination

Text & Reference:

- Thomas M. Flynn, "Cryogenic Engineering", second edition, CRC press, New York (2005).
- Measurement & Detection of Radiation, Nicholas Tsoulfanids, S Landsberger, CRC Press.
- Radiation Detection and Measurement, G F Knoll, John Wiley & Sons.
- Students solutions manual to Radiation Detection and Measurement, David K Wehe.
- Atomic Radiation Detection and Measurement, Harold S Renne, Lloyd J Austin, Literary Licensing.
- Nuclear Radiation Detectors, S. S. Kapoor, V S Ramamurthy, New Age International Publishers.
- Introductory Nuclear Physics, K S Krane, Wiley-Eastern.

RESEARCH REVIEW-II

Course Code: PHY4435 **Credit Units: 02**

Objectives

A workshop is primarily an activity based academic event that is organized to provide the students a one to one and hands on experience on any aspect of their learning. The communication in a workshop has to be necessarily two ways. The trainer has to make sure that the aspect covered is practically practiced by the participants. The student will choose the option of workshop from amongst their concentration electives. The evaluation will be done by Board of examiners comprising of the faculties.

Major Themes for Workshop

The workshop may be conducted on any of the following major themes:

- Nanotechnology
- Renewable Energy
- Data Analytics
- Spintronics
- Matlab
- Superconductivity
- Bio-fuels
- Bio physics
- Quantum Computation
- Plasma Physics
- Cryogenics
- Clean Energy

These themes are merely indicative and other recent and relevant topics of study may be included.

Guidelines for Workshop

- The procedure for earning credits from workshop consists of the following steps:
  Relevant study material and references will be provided by the trainer in advance.
- The participants are expected to explore the topic in advance and take active part in the discussions held
- Attending and Participating in all activities of the workshop
  Group Activities have to be undertaken by students as guided by the trainer.
- Evaluation of workshop activities would be done through test and quiz at the end of the workshop.
- Submitting a write up of atleast 500 words about the learning outcome from the workshop

Methodology

The methodology followed at the workshop could be based on any one or more of the following methods:
Course Study
Oral
Presentation/Seminar
Assignment
Group Discussion Write up

Evaluation Scheme:

Attendance	Active Participation	Seminar	Assignment/ Write up	Total
10	30	30	30	100

RESEARCH BASED PROJECT

Course Code: PHY4437 **Credit Units: 13**

GUIDELINES FOR PROJECT FILE AND PROJECT REPORT

Research experience is as close to a professional problem-solving activity as anything in the curriculum. It provides exposure to research methodology and an opportunity to work closely with a faculty guide. It usually requires the use of advanced concepts, a variety of experimental techniques, and state-of-the-art instrumentation.

Research is genuine exploration of the unknown that leads to new knowledge which often warrants publication. But whether or not the results of a research project are publishable, the project should be communicated in the form of a research report written by the student.

Sufficient time should be allowed for satisfactory completion of reports, taking into account that initial drafts should be critically analyzed by the faculty guide and corrected by the student at each stage.

PROJECT FILE

The Project File may be a very useful tool for undertaking an assignment along-with a normal semester, an exploratory study, sponsored projects, a project undertaken during summer period or any other period as per curriculae where the researcher is working with a company/organization. The project/ assignment may also be a part of the bigger research agenda being pursued by a faculty/ institution/ department

The Project File is the principal means by which the work carried out will be assessed and therefore great care should be taken in its preparation. This file may be considered in continuous assessment.

In general, the File should be comprehensive and include:

- A short account of the activities that were undertaken as part of the project;
- A statement about the extent to which the project has achieved its stated objectives;
- A statement about the outcomes of the evaluation and dissemination processes engaged in as part of the project
- Any activities planned but not yet completed as part of the project, or as a future initiative directly resulting from the project
- Any problems that have arisen and may be useful to document for future reference.

PROJECT REPORT

The Project Report is the final research report that the student prepares on the project assigned to him. In case of sponsored project the lay out of the project could be as prescribed by the sponsoring organization. However, in other cases the following components should be included in the project report:

Title or Cover Page

The title page should contain Project Title; Student's Name; Programme; Year and Semester and Name of the Faculty Guide.

Acknowledgement(s)

Acknowledgment to any advisory or financial assistance received in the course of work may be given.

It is incomplete without student's signature.

Abstract

A good "Abstract" should be straight to the point; not too descriptive but fully informative. First paragraph should state what was accomplished with regard to the objectives. The abstract does not

have to be an entire summary of the project, but rather a concise summary of the scope and results of the project. It should not exceed more than 1000 words.

Table of Contents

Titles and subtitles are to correspond exactly with those in the text.

Introduction

Here a brief introduction to the problem that is central to the project and an outline of the structure of the rest of the report should be provided. The introduction should aim to catch the imagination of the reader, so excessive details should be avoided.

Materials and Methods

This section should aim at experimental designs, materials used (wherever applicable). Methodology should be mentioned in details including modifications undertaken, if any. It includes organization site(s), sample, instruments used with its validation, procedures followed and precautions.

Results and Discussion

Present results, discuss and compare these with those from other workers, etc. In writing this section, emphasis should be laid on what has been performed and achieved in the course of the work, rather than discuss in detail what is readily available in text books. Avoid abrupt changes in contents from section to section and maintain a lucid flow throughout the thesis. An opening and closing paragraph in every chapter could be included to aid in smooth flow.

Note that in writing the various secions, all figures and tables should as far as possible be next to the associated text, in the same orientation as the main text, numbered, and given appropriate titles or captions. All major equations should also be numbered and unless it is really necessary, do not write in ¯point‖ form.

While presenting the results, write at length about the the various statistical tools used in the data interpretation. The result interpretation should be simple but full of data and statistical analysis. This data interpretation should be in congruence with the written objectives and the inferences should be drawn on data and not on impression. Avoid writing straight forward conclusion rather, it should lead to generalization of data on the chosen sample.

Results and its discussion should be supporting/contradicting with the previous research work in the given area. Usually one should not use more than two researches in either case of supporing or contradicting the present case of research.

Conclusion(s) & Recommendations

A conclusion should be the final section in which the outcome of the work is mentioned briefly. Check that your work answers the following questions:

- Did the research project meet its aims (check back to introduction for stated aims)? What are the main findings of the research?
- Are there any recommendations?
- Do you have any conclusion on the research process itself?

Implications for Future Research

This should bring out further prospects for the study either thrown open by the present work or with the purpose of making it more comprehensive.

Appendices

The Appendices contain material which is of interest to the reader but not an integral part of the thesis and any problem that have arisen that may be useful to document for future reference.

References

References should include papers, books etc. referred to in the body of the report. These should be written in the alphabetical order of the author's surname. The titles of journals preferably should not be abbreviated; if they are, abbreviations must comply with an internationally recognised system.

Examples:

For research article:

Voravuthikunchai SP, Lortheeranuwat A, Ninrprom T, Popaya W, Pongpaichit S, Supawita T. (2002) Antibacterial activity of Thai medicinal plants against enterohaemorrhagic*Escherichia coli* O157: H7. *ClinMicrobiolInfect* ,**8** (suppl 1): 116–117.

For book:

Kowalski,M.(1976) Transduction of effectiveness in *Rhizobium meliloti*. SYMBIOTIC NITROGEN FIXATION PLANTS (editor P.S. Nutman IBP), **7**: 63-67

The Layout Guidelines for the Project File & Project Report:

- A4 size Paper
- Font: Arial (10 points) or Times New Roman (12 points)
- Line spacing: 1.5
- Top and bottom margins: 1 inch/ 2.5 cm; left and right margins: 1.25 inches/ 3 cm

ASSESSMENT OF THE PROJECT FILE AND THE PROJECT REPORT

Essentially, the assessment will be based on the quality of the report, the technical merit of the project and the project execution. Technical merit attempts to assess the quality and depth of the intellectual efforts put into the project. Project execution is concerned with assessing how much work has been put in.

The Project should fulfill the following ***assessment objectives:***

- Range of Research Methods used to obtain information
- Execution of Research
- Data Analysis (Analyze Quantitative/ Qualitative information)
- Quality Control
- Conclusions

Assessment Scheme:

Continuous Evaluation: 40% (Based on punctuality, regularity of work, adherence to plan andmethodology, refinements/ mid-course corrections etc. as reflected in the Project File.)

Final Evaluation: 60% (Based on the Documentation in the file, Final report layout, analysis andresults, achievement of objectives, presentation/ viva)

It is recommended that the Final evaluation should be carried out by a panel of evaluators.

NANO-SCIENCE AND TECHNOLOGY

Course Code: PHY4404 **Credit Units: 03**

Course Objective:
The objective of the present course is to introduce Nanoscience and nanotechnology. The course also provides the fundamentals of Nanoscience & nanotechnology and some of its applications. The course further provides the introduction of some of the Synthesis and characterization techniques.

Course Contents:

Module-I: Physics of Low-dimensional Materials -
Nano-materials and their types, Top down and bottom up approach. 1D, 2D and 0D confinement and Concept of quantum dots, quantum wires and quantum wells; Density of states for bulk materials, quantum wells, wires and dots; Importance of size distribution control, size measurement and size selection .

Module-II: Synthesis of Nanomaterials
Chemical methods: Sol-gel/Combustion method, Solvothermal, Chemical bath deposition Chemical vapour deposition, Homo- and hetero-nucleation growth methods, Co-precipitation method, Citrate precursor method. Sputtering and types:RFsputtering,DC sputtering and Magnetron sputtering. Thermal Evaporation, e-beam evaporation, Pulse Laser Ablation (PLD)

Module-III: Properties and Applications of Nanomaterials Physical and Mechanical properties ofnanomaterials,Optical Properties, Electronic properties, Magnetic Properties, Electro-magnetic properties

Module-IV: Applications of Nanomaterials
Applications of carbon based nanostructured materials: CNT, Graphene and Fullerenes, Defense application,Medical Application, Mechanical Applications. Applications in communication, Water purification and Agriculture applications.

Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	15	5	5	70

A-Attendance; **CT**-Class Test; **S/V/Q**-Seminar/Quiz/Viva; **HA**-Home Assignment; **EE**-End Semester Examination

Suggested Books:

- Edelstein A. A. and Cammarata R.C., ¯Nanomaterials-Synthesis Properties and Applications‖, Institute of Physics Publishing, London, 1998.
- Poole, Jr. CP and Owens, FJ, ¯Introduction to Nanotechnology‖, Wiley India, 2006.
- Shik, A, ¯Quantum Wells: Physics and Electronics of two-dimensional systems‖, World Scientific, 1999.
- Benedek et al G., ¯Nanostructured Carbon for advanced Applications‖, Kluwer Academic Publishers, 2001.
- Harrison, P, ¯Quantum Wells, Wires, and Dots: Theoretical and Computational Physics‖, John Wiley, 2000.

ATMOSPHERIC PHYSICS

Course Code: PHY4405 **Credit Units: 03**

Course Objectives:
Several fundamental aspects related to Physics, Thermodynamics and Chemistry of the Atmosphere and Oceans will be introduced to the students in order to make them understand, and apply the knowledge to the physico-chemical processes that influence the weather and climate.

Course Contents:

Module-I: Thermodynamics
Thermodynamics of dry and moist air, atmospheric stability and dry adiabatic lapse rate, moist processes in the atmosphere, saturated and unsaturated ascent, moist adiabatic and saturated adiabatic processes in the atmosphere, saturated adiabatic lapse rate, pseudo adiabatic processes and equivalent potential temperature, conditional instability second kind, moist convection, aerosols, condensation processes, formation of cloud droplets, precipitation.

Module-II: Ocean Morphology
Ocean physics, thermodynamics of sea water, observed temperature, salinity, and density in the ocean, density stratification, water mass distribution, coastal currents and upwelling, thermohaline circulation. Oceans currents, coupling of surface and deep ocean waters, basic foundation of turbulence, turbulent flows, turbulent vorticity, turbulence pressure, eddy diffusivity, coherent structures, surface fluxes, air-sea interaction, mixing processes in the ocean.

Module-III: Earth-Atmosphere Radiation Balance
Radiative transfer in atmosphere and ocean: Sun and climate, Planck function, black-body radiation, local thermodynamic equilibrium, radiometric quantities, absorption and emission, Schwarzchild's equation, radiative equilibrium in a grey atmosphere, balance between incoming solar and outgoing thermal radiation, role of aerosols, absorption by atmospheric gases, heating rates, net radiative heating, Radiative transfer in atmosphere-ocean system.

Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	15	5	5	70

A-Attendance; **CT**-Class Test; **S/V/Q**-Seminar/Quiz/Viva; **HA**-Home Assignment; **EE**-End Semester Examination

References

- The Solid Earth: An Introduction to Global Geophysics [Paperback] C. M. R. Fowler, Cambridge University Press, 1990.
- Climate and the Oceans, Ed. Geoffray K. Vallies, Princeton University Press, 2012.
- Ocean Circulation: Wind-Driven and Thermohaline Processes, Ed. RuiZin Huang, Cambridge University Press, 2009.

OPTICAL FIBERS AND COMMUNICATION

Course Code: PHY4407 **Credit Units: 03**

Course Objective:
The objective of the present course is to introduce fundamentals of optical fibers, detectors and amplifiers and their applications in Physics.

Course Contents:

Module-I: Optical Fiber Fundamentals
Light propagation in optical fiber, Acceptance angle and numerical aperture, Losses in optical fiber: absorption loss scattering loss, bending loss, and splice loss. Pulse propagation in dispersive medium, pulse broadening, Intermodal and intramodal dispersion, group velocity dispersion (material and waveguide).

Module-II: Modal Analysis of step index multimode and graded index fiber
Characteristics equation of step index multimode fiber, Transverse Electric (TE), Transverse magnetic (TH) and Hybrid modes, linearly polarized modes, V parameter, mode cutoff, Mode field diameter, Modal analysis of graded index fiber.

Module-III: Optical Sources, Detectors and Amplifiers
Types of Optical Sources, Light emitting diodes (LED), Edge emitting LEDs, Coupling of LEDs with fibers, Semiconductor Lasers; Detectors: Photoconductors, Photodiodes, Avalanche Photodiodes and Phototransistors, Amplifiers: Semiconductor Laser Amplifiers, characteristics, advantages and drawback, Erbium Doped Fiber Amplifier (EDFA), gain and noise in EDFA and noise figure.

Module-IV: Fiber Optical Communication Components and System
Coupling Components- couplers, connectors and splices, Modulators and Modulation methods, Transmitters, Receivers, Repeaters and switches; Transmitter, Receiver and link design, Line codes for optical fiber links, wavelength division multiplexing (WDM) and Optical Division Multiplexing.

Examination Scheme:

Components	CT	HA	S/V/Q	Attendance	EE
Weightage (%)	10	8	7	5	70

CT – Class Test, S/V/Q – Seminar/Viva/Quiz, HA – Home Assignment, EE – End Semester Examination

Text & References:

- John. M. Senior, Optical fiber communications: principles and practice, Prentice Hall of India.
- Gerd Keiser, Optical fiber communications, McGraw Hill, 3rd edition.
- D. K. Mynbaev, L. L. Scheiner, Fiber optic communication technology, Pearson Technology.
- Introduction to fiber optics, AjoyGhatak and K. Tyagrajan.
- R. P. Khare, Fiber optic and optoelectronics, Oxford University press.
- Light wave Communication Systems: A practical prospective: R Papannareddy, Penrum International Publishing
- Fundamental of photonics, Saleh and Teich, Wiley Interscience, 2nd Edition, 2007.

PHYSICS OF SOLAR PHOTOVOLTAICS

Course Code: PHY4408 **Credit Units: 03**

Course Objective:
In this course, one would learn about the fundamentals of photoelectric conversion: charge excitation, conduction, separation, and collection. You will become familiar with commercial and emerging photovoltaic (PV) technologies and various cross-cutting themes in PV: conversion efficiencies, loss mechanisms, characterization, manufacturing, systems, reliability, life-cycle analysis, and risk analysis

Course Contents:

Module I: Solar Cells and Sunlight
Outline of solar cell development, physical source of sunlight, review of solar intensity at the Earth's surface, solar insolation data

Module II: Review of Semiconductor Properties
Crystal structures and orientations, forbidden energy gaps, dynamics of electrons and holes, carrier density, carrier transport, generation and recombination of carriers due to light, direct and in-direct band gap semiconductors, basic device physics, p-n junction diode,

Module III: Standard Silicon Solar Cell Technology (1 st generation solar cells)
Photovoltaic effect , solar cell output parameters, characteristic lifetime, diffusion length, diffusion coefficient, absorption coefficient, efficiency limits, losses, and measurements. Review of fabrication technology, polysilicone and single crystal silicon cell technologies. Design of Solar Cells , Solar cells to solar module

Module IV: Thin Film Solar cells (2^{nd} – Generation)
Polysilicone silicon, amorphous silicone, gallium arsenide solar cells, copper sulfide and cadmium sulfide solar cells, potential & drawbacks of currently manufactured technologies (single- and multicrystallinesilicon, CdTe, CIGS, CPV)

Module V: Emerging Solar Cells technologies and concepts (3^{rd} –Generation)
Organic solar cells, Dye-sensitized solar cells, Perovskite solar cells, GaAs solar cells, Thermo-photovoltaic approaches to overcome single junction efficiency limits, spectrum modification approaches, hot carrier solar cells, Quantum Dot solar cells

Examination Scheme:

Components	CT	Assignment		Attendance	EE(1)
Weightage (%)	15	10		05	70

Text & References:
- Solar Photovoltaics (Fundamentals, Technologies and Application) by Chetan Singh Solanki
- Martin A. Green, Solar Cells-Operating Principles, Technology, and System Applications
- M. S. Tyagi, Introduction to Semiconductor Materials and Devices
- Third Generation Photovoltaics (Advanced Solar Energy Conversion) By Martin A. Green; Lecture Notes

BIOPHYSICS

Course Code: PHY4409 **Credit Units: 03**

Course Objective:
This course aims at exposing the students to basic Biophysics concepts which will be useful for them to solve the integrated problems of Biology and Physics.

Course Contents:

Module I: General Biophysics and Techniques in Biophysics
Fundamentals of Biophysics, Surface tension, Adsorption, Osmosis, Osmotic pressure, Dialysis, Colloids, Colloidal systems of life, Buffer, Buffer capacity, Buffers in life system, pH, its importance, Basics of spectroscopy, X-ray crystallography, NMR, UV etc

Module II: Molecular Biophysics
Different levels of protein structure, Primary, secondary, tertiary and quaternary structure. Main chain and side chain torsion angles, Alpha helix, beta sheet, turns. Ramachandran plot , Allowed conformations for a pair of linked peptide units, Motifs and domains.

Module III: Thermodynamics
Laws of thermodynamics, concept of free energy, unavailable energy and entropy, heat content of food, bomb calorimetry, chemical kinetics – rate, order, molecularity of reactions and energy of activation

Module IV: Simulations, Data Analysis and Visualization
Advantages and challenges in simulations of Biophysics, Basics of simulation software such as NAMD and/or GROMACS, Data Analysis of simulation generated data, Visualization software such as PyMol and VMD

Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	10	8	7	70

CT: Class Test, HA: Home Assignment, S/V/Q: Seminar/Viva/Quiz, EE: End Semester Examination; A: Attendance

Text & References:

- Biophysics by W HoopeEdtr., Springer – Verlag New York .
- Molecular Biophysics by R B Setlaw& EC Pollard, Addison Wesley Reading MA
- Essentials of Biophysics by P Narayanan, New Age International Publishers.