M.Sc. Syllabus
Department of Physics
(2020)

Semester	Core subject with credit	Elective subject with credit
First Semester	**Theory:** PH 701C Mathematical Physics: Credit = 4 PH 702C Classical Mechanics: Credit = 4 **PH 703C Practical –I Credit = 4** {Basic Electronic Design: Credit = 2 computer programming: Credit = 2} **CSK-II Computer Skill-II : Credit = 4** **(To be done in Computer Science/IT Department**	Elective 1 ST 704 E Basic Statistics Credit 4 (from other Department preferably from Statistics)
Second Semester	**Theory:** PH 801C Basic Quantum Mechanics: Credit = 4 PH802C Statistical Mechanics: Credit = 4 PH 803C Basic Electronics: Credit = 4 **PH 804C** **Advanced Practical-I: Credit = 2** **Advanced Practical-II: Credit = 2**	Elective-1 PH 0805 E Microprocessor Architecture and Programming Credit = 4 **Elective-2** PH 0806E Advanced Computational Physics Credit = 4
Third Semester	**Theory:** PH 901C Electro magnetic theory and Special theory of relativity: Credit = 4 PH 902C Atomic & Molecular Physics : Credit = 4 PH 903C Advanced Quantum Mechanics: Credit = 4 **Practical** **PH 904C AdvancedPractical-III:Credit = 4**	**Elective-1** PH 905E Astrophysics and Astronomy Credit = 4 **Elective-2** PH 0906E Thin-film and Nanoscience Credit = 4
Fourth Semester	**Theory:** PH 1001C Condensed Matter Physics Credit = 4 PH 1002C Advanced Electronics : Credit = 4 PH 1003C Nuclear Physics and Particle Physics: Credit = 4 **PH 1004C** Project Work: Credit = 6	**Elective-4** PH 1005 E Advanced Physics: Credit = 4

Surya Chattopadhyay 18/01/2021

अध्यक्ष / Head
भौतिक शास्त्र विभाग
Department of Physics
त्रिपुरा विश्वविद्यालय
Tripura University

Practical: PH 0703C (Credit=4)

PHS 0703C (Group-A) (Credit-2)
Group B Electronics design (digital & analog)
Marks = 50: Credit = 2
No. of Lectures required (NLP) :
Practical classes:- 75

DIGITAL CIRCUIT DESIGN

Phase 1:
1. Construct a power supply of $\pm$ 12 V / $\pm$ 15 Volts using regulator ICs. Make a facility of using = +5V in the same bread board.
2. Design and implement the following LOGIC GATES using discrete components like resistance, capacitor, diodes and transistors etc.
(a) NAND (b) NOR (c) XOR (d) XNOR

Phase 2: Experiment using IC 74**

1. Implement two input OR gate using AND & NOT gates and verify the truth table.
2. Implement two input AND gate using OR & NOT gates and verify the truth table.
3. With basic gates implement two forms of XOR function and verify the truth table.
4. With basic gates implement two forms of XNOR function and verify the truth table.
5. With NAND gates only, implement two forms of XOR functions and verify the truth table.
6. With NOR gates only, implement two forms of XOR functions and verify the truth table.
7. With NAND gates only, implement two forms of XNOR functions and verify the truth table.
8. With NOR gates only, implement two forms of XNOR functions and verify the truth table.
9. Verify the Boolean expressions with truth table
(a) (A+B).(B+C).(C+A) = AB + CD +CA
(b) $A.\overline{B} + \overline{A}.B = (A+B).\overline{A.B}$
(c) (A+B).(A+ C) = A + BC

Phase 3: Experiments with Linear ICs

1. To construct and study HALF ADDER circuit using AND gate and XOR.
2. To construct and study HALF ADDER circuit using OR, AND and NOT gates.
3. To construct and study a HALF SUBTRACTOR using AND, NOT and XOR gates.
4. To construct and study a HALF SUBTRACTOR using OR, AND and NOT gates.
5. To construct a FULL ADDER using OR, AND and XOR gates.
6. To construct a FULL SUBTRACTOR using OR, AND and XOR gates.
7. To study the 4-bit PARALLEL ADDER using FULL ADDER IC.
8. To study a 4-bit SUBTRACTOR using FULL ADDER IC.
9. To study 4-bit SUBTRACTOR/ADDER using mode control.

ANALOG DESIGN

Phase 1: Using Transistor

1. Design of common emitter amplifier and study of its bandwidth.
2. Design of an emitter follower and study of its bandwidth.

Phase 2: Using Linear IC 741/536 (OPAMP):

1. Design non-inverting amplifier with gain at any desired value in between 10 to 20 and

(i) Study the frequency response curve with input voltages fixed at 200 mV, 500 mV and 1V.

(ii) Keep the frequency fixed at 100 Hz, 1 KHz and 10 KHz and study the variation of output voltage with input.

(iii) Study the gain-bandwidth product considering gains equal to 1, 10 and 20.

2. Design inverting amplifier with gain at any desired value in between 10 to 20 and

(i) Study the frequency response curve with input voltages fixed at 200mV, 500 mV and 1V.

(ii) Keep the frequency fixed at 100 Hz, 1 KHz and 10 KHz and study the variation of output voltage with input.

(iii) Study the gain-bandwidth product considering gains equal to 1, 10 and 20.

Phase 3: Using Linear IC 741/536 (OPAMP):

1. With designing details, construct and study the following first order active filters
   (i) Low-Pass.(ii) High-Pass (iii) Band-Pass (iv) Band-Reject
2. With designing details, construct and study the following first order active filters
   (i) Low-Pass.(ii) High-Pass (iii) Band-Pass (iv) Band-Reject
3. Design and construction positive and negative half wave rectifiers and study their distortion with respect to variation of input voltage and frequency.
4. Design and construction positive and negative full wave rectifiers and study their distortion with respect to variation of input voltage and frequency.

PHS 0703C Group: B (Credit=2)

Computer Programming and Numerical Analysis: (Practical)

Elements of FORTRAN language: Integer and Real arithmatics. Numerical INPUR and OUTPUT. Formatted INPUT OUTPUT and field specifications. Transfer of controls. If - GOTO statements. DO loops. Nested DO loops. Arrays, subscripted variables. DIMENSION statement. FUNCTIONS and SUBROUTINES. DATA statement. INPUT from and OUTPUT in data files. Structured FORTRAN.

With problems from set.-I to set-IX.

Total number of lectures required: 10 (theory*)*

Numerical Analysis: Theory: Solution of nonlinear equations; functional iteration; bisection method; secant method; Newton - Raphson method. Interpolation: Linear interpolation; Newton'e method; Lagrange's interpolation; numerical differentiation, Numerical integration, Riemann, trapezoidal and Simpson's rules; Romberg integration; Gaussian quadrature formula. Solution of linear simultaneous equations - Gauss elimination; Gauss - Jordan elimination. Matrix algebra; eigen values and eigenfunctions of matrices.

Elementary statistical estimations; frequency distribution; simple regression; linear least square fitting; correlation coefficient. Solutions of ordinary differential equations (ODE); solution of ODE as an initial value problem; Euler's method; RungaKutta method; predictor corrector method.

Total number of lectures required: 10 (theory)

Paper: PH- 0805E (option 1)
Microprocessor Architecture and Programming
Credit = 4 Full Marks = 100 Credit = 4
(Distribution of marks: 70 (for final examination) + 30 (Internal Evaluation)
No. of Lectures required (NLP) = 50

Theory:
Internal microprocessor architecture, Memory mapping, Data addressing modes, Program addressing modes,Stack memory addressing modes, Data movement instructions, Arithmetic and logic instructions, Program control instructions, Assembler details, Modular programming, using the keyboard, Data conversion, Disc files, Example programs, Pin-out and the pin functions of 8085 and 8085A, clock generators(8284A), Bus buffering and latching, Bus timing, Ready and Wait states, Memory devices, Address decoding in 8085A, memory interface, Dynamic RAM, Introduction to I/O interface, I/O port address decoding, Direct Memory Access.

Practical:

Programming in 8085 assembler kit

Paper: PH- 0806E (Credit=4)
Advanced Computational Physics
Credit = 4 Full Marks = 100
(Distribution of marks: 70 (for final examination) + 30 (Internal Evaluation)
No. of Lectures required (NLP) = 50

Introduction to various open source and proprietary computational software, software licensing, installation in different operating system environment, familiarization of the different sections of a software package, navigation, help and resources, console commands, basic variables, constants and operators, running codes from console and editors, control statements, matrix operations, functions, handling format and runtime errors, basic 2D and polar plots, polynomial operations, data read and write operations, package installations, image processing, low and high pass filtering of image, addition of noise in an image, image noise reduction, edge detection, face recognition, statistical operations, basic regression analysis, definite integral, solving linear and non-linear equations, advanced plotting, Graphical User Interface (GUI), circuit simulation, symbolic mathematics, application of numerical analysis to problem solving in physics, basic modeling, basic concept of Artificial Intelligence (AI)

Nano Science and Thin Film
PH-906E (Elective)
Credit = 4 Full Marks = 100
(Distribution of marks: 70 (Final examination) + 30 (Internal Evaluation)
No. of Lectures required (NLP) = 50

Group-A
Marks = 50: No. of Lectures Required (NLP) = 25

Definition of nano, Scientific Revolution, Emergence and Challenges of nanoscience and nanotechnology, Influence of nano over micro/macro dimension. Size effect. Large surface to volume ratio, Delocalization of freee electrons, Optical effect. Surface effect on the properties.

NLP=10

One dimensional, Two dimensional and Three dimensional nanostructured materials, Quantum Dots. Metal oxide nano particles, semiconductor nano particles, composites nano particles, mechanical-physical-chemical properties.

NLP=8

Application of nano particles: In electronics and opto electronics devices, in coating and paint technology, biological and environmental technology and drug delivery system, polymer based application.

NLP=7

Group-B
Marks = 50: No. of Lectures Required (NLP) = 25

What is Thin Film and why it is important, Two dimension nano structure. Different Thin Film preparation techniques, Brief discussion on Langmuir Blodgett technique, layer-by-layer self assembled technique, Spin coating technique, vacuum deposition technique. Different characterization techniques

NLP=15

Brief discussions on the application of Thin Film in different technological fields- in preparation of Light emitting diodes, in MOSFET, in Transistor and diodes, in various sensors, in gas sensor, in biological sensors and others.

NLP=10

Advanced Physics

PH-1005E (Credit=4)

Group: A

(Atmospheric Science and Solar Environment Physics)

Total marks: 25, Total lecture periods: 12

Atmospheric science **total marks= 12.5, total lecture periods: 06**

Origin and composition of the Earth's atmosphere, distribution of pressure and density, ionosphere, atmospheric electric field, magnetosphere, distribution of temperature and winds, atmosphere as a fluid and physical laws, overview of meteorological observations, surface, radar, upper-air and satellite observational techniques, introduction to Chaos dynamics

Solar environment **total marks= 12.5, total lecture periods: 06**

Structure and composition, solar rotation, the quiet Sun, sunspots, radiation characteristics, 11 year periodicity, solar flares, coronal mass ejection, prominences, calcium plages, monitoring the sun with radio emission and X-rays, solar wind, solar proton event, solar magnetic field and its variation and solar noise storms.

Group-B

(Thin Film and nano Science Group)

Total marks: 25, Total lecture periods: 13

UV-Vis absorption spectroscopy, Fluorescence spectroscopy, in-situ Brewster angle microscopy (BAM), Atomic force microscopy (AFM), Scanning electron microscopy (SEM), Fluorescence resonance energy transfer (FRET), Bio-mimetic surface.

Group-C

(Nanophysics and Nanotechnology)

Total marks: 25, Total lecture periods: 12

Different nanomaterials and their special properties. Quantum well, Quantum wire and Quantum Dots. Definition of Nanophysics, Nanotechnology: Fabrication of Nanoparticles: Bottom up and Top down approaches: Stabilization of nanoparticles.

Braggs Law, Construction of Reciprocal Lattice, X-Ray Diffractometer and its principle: Structural Characterization, Morphological analysis by electron microscopy (Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM)) and usefulness of High resolution TEM. Effect of doping on the nanomaterials and ion irradiation effect, Different Application of nanomaterials including photonics and plasmonics.

Group-D

(Introductory Theoretical Chemical Physics & Density Functional Theory)

Total marks: 25, Total lecture periods: 13

Elementary idea about the approximation methods in molecular quantum mechanics: Thomas Fermi model, Hartree theory, Hartree-Fock (HF) Approximation, Roothaan equations, Configuration Interaction, Coupled-Cluster Theory.

Density functional theory : Introduction to density functional theory, early density functional theories, the H-K theorems, the Kohn-Sham approach, K-S equation, exchange-correlation functionals, Generalized Gradiant approximation (GGA), Local density Approximation (LDA), Local Spin Density Approximation (LSDA), concept of LCAO and basis set, applications and limitations of DFT. Computational algorithms and Packages related to DFT.

Sunyee Chattopadhyaya 18/01/2021

अध्यक्ष / Head
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