# SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited with "A" grade by NAAC
Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai – 600 119
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**School of Science and Humanities**
**Department of Physics (DST-FIST Sponsored)**
**BOARD OF STUDIES**
**Minutes of Meeting**

Date: 15/4/2019 **(10.00 AM – 1.30 PM)** Venue: Board Room, VC Office

Board of studies meeting of Department of Physics was held on 15th April 2019 between 10 am to 1.30 pm at Board Room of VC's Office. Dean/S & H addressed the gathering about the programmes and courses offered by the Department of Physics. She projected the syllabus of M.Sc., B.Sc. and B.E./B.Tech. The external members had gone through the syllabus and their suggestions are listed below:

**Agenda of Meeting:**

- Reframing the theory and lab syllabus for M. Sc, B. Sc and B.E/B.Tech.

**Members Present:**

| S.No | Board of Studies Members |
|---|---|
| 1 | **Dr. T.S. Natarajan**, Department of Physics, IIT Madras/ IIT Tirupati. |
| 2 | **Dr. N. Vijayan,** Senior Scientist<br>Crystal Growth and X-Ray Analysis Section,<br>CSIR-National Physical Laboratory, New Delhi-110012. |
| 3 | **Dr. D. Siva Prahasam**, International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI), Centre for Automated Energy Materials, IITM Research Park, Taramani. |
| 4 | **Dr. S. Ravichandran**<br>Professor & Head / Department of Physics<br>Sathyabama Institute of Science & Technology, Chennai. |
| 5 | **Dr. Helen Marina Albert.**<br>Professor/ Department of Physics<br>Sathyabama Institute of Science & Technology, Chennai. |
| 6 | **Dr. C. Rameshkumar,**<br>Associate Professor/ Department of Physics<br>Sathyabama Institute of Science & Technology, Chennai. |

- **I B.E/ B.Tech Theory**

  Based on the suggestions given by the board members, a new syllabus is framed which is common for all I year B.E /B.Tech.

- **I B.E/ B.Tech Lab**
  - Recommended to do six experiments instead of ten experiments.

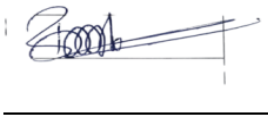
- **B.Sc (Physics) Theory**
  1. Mathematical physics, in unit 3 cylindrical coordinate system is removed and surface geometry is added. In Unit 4, arbitrary period expansion of non-periodic functions is removed and Sum of Fourier series and Parseval's identity (statement only) is included. In unit 5, error Function is removed.
  2. In atomic physics in the unit 2, De Broglie Wavelength; Heisenberg's Uncertainty Principle; Atomic Spectra; Bohr's Atomic Model is removed. Included the Principal quantum number, Orbital angular momentum quantum number (or azimuthal quantum number), Magnetic quantum number and the electron spin quantum number. In the unit 5, - Recombination Radiation and Calculate the energy of the absorbed photons and find the energy of the transitions resulting in radiation at visible wavelengths.is included.
- **B.Sc (Physics) Lab**
  1. Two new experiments are included in mechanics lab.
  2. MATHEMATICAL PHYSICS (SPH4215) LAB is added in Final year.
  3. ENCODER and DECODER Experiments added in DIGITAL AND ANALOG ELECTRONICS LAB (SPH4216). Electronics Lab - In expensive – simulation based experiments need to be included.

- **M.Sc (Physics) Theory**
  1. In semester- I, Solid State Physics - I is removed and Material Science is included.
  2. Numerical methods and computer programming – C++ programming is to be removed. MATLAB and LABVIEW to be included.
  3. In semester – II, Microprocessor, Microcontroller and Embedded System – the deleted units are Microcontroller (8051), Advanced Microcontroller, Hardware and Software. The added units are ARM microcontroller, Python programming and IoT and Embedded system design and development.
  4. In semester III, Solid state physics – II is removed and Condensed Matter Physics is included.
  5. A new course on 'Introduction to Research Methodology' in M. Sc Programme of 2 credits has been introduced in the 3rd semester.
  6. Elective subjects added – Energy Materials, Industry 4.0, Intellectual Property Law, Introduction to Computational Materials Science, Thin Film Technology, Physics of Dielectrics and Radiation Physics. High Pressure Physics and Nonlinear Dynamics courses to be removed.
- **M.Sc (Physics) Lab**
  1. "General Physics lab – I" is revised and some new experiments are added and renamed as "General Physics lab"
  2. General Physics Lab - The following experiments may be included - Meyer disc-Viscosity of a liquid, Acoustic Diffraction, Cornu's Method – Determination of Elastic

Constants of Transparent Materials (Elliptical fringes), Fabry-Perot etalon interferometer, Arc spectra, Stefan's Constant.

3. General Physics lab II revised and named as Advanced Physics Lab - The following experiments may be included - Impedance measurement thermal based transmittance/ absorbance characteristics of PV cells/thin films.
4. Minimum of 15 experiments need to be exercised for General Physics Lab and Advanced Physics Lab; 10 experiments for Electronics lab and microprocessor lab.

The members had the brain storming discussion and interaction among them. BOS members reviewed and resolved to approve the syllabus offed by the department of Physics.

| External members | Signature | Internal members | signature |
|---|---|---|---|
| Dr.N.Vijayan |  | Dr.S.Ravichandran |  |
| Dr.T.S.N.Natarajan |  | Dr.HelenMerina Albert |  |
| Dr. D.SivaPrahasam |  | Dr.C.Ramesh Kumar |  |

| SPH1215 | MATHEMATICAL PHYSICS (2017 ) | L | T | P | Credits | Total Marks |
|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 | 100 |

**COURSE OBJECTIVE**

- To demonstrate how to differentiate a function of two variables.
- To describe smooth distribution of energy
- To understand the properties of a particle in universe.
- To introduce fourier series and its applications to the solution of partial differential equation.
- To describe differential equation through Frobenius Method and Integrals using Beta and Gamma functions.

**Unit 1 Calculus of functions of more than one variable** **9 Hrs**

Partial derivatives, exact and inexact differentials.Integrating factor, with simple illustration.Constrained Maximization using Lagrange Multipliers.

**Unit 2 Dirac Delta function and its properties**: **9 Hrs**

Definition of Dirac delta function.Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.

**Unit 3 Orthogonal Curvilinear Coordinates**: **9 Hrs**

Orthogonal Curvilinear Coordinates.Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. Comparison of velocity and acceleration in cylindrical and spherical coordinate system.

**Unit 4 Fourier Series** **9 Hrs**

Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only).Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Expansion of functions with arbitrary period.Expansion of non-periodic functions over an interval.Even and odd functions and their Fourier expansions.Application.Summing of Infinite Series.

**Unit 5 Frobenius Method and Some Special Integrals** **9 Hrs**

Singular Points of Second Order Linear Differential Equations and their importance.Frobenius method and its applications to differential equations.Beta and Gamma Functions and Relation between them.Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).

**Max. 45 Hours**

**Learning Outcomes:**

Upon successful completion of this course, students should be able to:

CO1: Know how to recognise and differentiate a function of two variables
CO2: Know distribution energy of the particles or materials.
CO3: Know the properties of a particle in universe using Orthogonal Curvilinear Coordinates
CO4: Know Fourier series representation of function of one variable to find solution of wave, diffusion and Laplace equations

**TEXT / REFERENCE BOOKS**


1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013,7thEdn., Elsevier.
2. Fourier analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
3. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
4. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
5. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.


**END SEMESTER EXAM QUESTION PAPER PATTERN**

**Max. Marks: 100** **Exam Duration: 3 Hrs.**

**PART A:** 10 Questions of 2 mark each - No choice. **20 Marks**
**PART B:** 2 Questions from each unit of internal choice, each carrying 16 marks. **80 Marks**

| SPH1215 | MATHEMATICAL PHYSICS(2019) | L | T | P | Credits | Total Marks |
|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 | 100 |

**COURSE OBJECTIVE**

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**Unit 2 Dirac Delta function and its properties**: **9 Hrs**

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**Unit 3 Orthogonal Curvilinear Coordinates**: **9 Hrs**

Orthogonal Curvilinear Coordinates.Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical. Comparison of velocity and acceleration in cylindrical and spherical coordinate system-surface geometry.

**Unit 4 Fourier Series** **9 Hrs**

Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only).Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Sum of Fourier series. Expansion of functions with over an interval.Even and odd functions and their Fourier expansions. Parseval's identity (statement only).Application.Summing of Infinite Series.

**Unit 5 Frobenius Method and Some Special Integrals** **9 Hrs**

Singular Points of Second Order Linear Differential Equations and their importance.Frobenius method and its applications to differential equations.Beta and Gamma Functions and Relation between them.Expression of Integrals in terms of Gamma Functions. (Probability Integral).

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**TEXT / REFERENCE BOOKS**


6. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013,7$^{th}$Edn., Elsevier.
7. Fourier analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
8. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
9. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
10. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.


**END SEMESTER EXAM QUESTION PAPER PATTERN**

**Max. Marks: 100** **Exam Duration: 3 Hrs.**

**PART A:** 10 Questions of 2 mark each - No choice. **20 Marks**
**PART B:** 2 Questions from each unit of internal choice, each carrying 16 marks. **80 Marks**

| SPH1311 | ATOMIC PHYSICS (2017) | L | T | P | Credits | Total Marks |
|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 | 100 |

**COURSE OBJECTIVE**

- To understand the basics of atomic physics terminology, Atomic physics, the scientific study of the structure of the atom, its energy states and its interactions with other particles and with electric and magnetic fields.
- Atomic physics has proved to be a spectacularly successful application of quantum mechanics, which is one of the cornerstones of modern physics.

**Unit 1 Concept of the Atom** **9 Hrs**

Brief introduction to history of atom - Rutherford's model and Niels Bohr's model of an atom - Sommerfeld's extension of atomic structure - Electronic configuration and quantum numbers; Cathode Rays; Measurement of the Elementary Charge e – JJ Thomson and Millikan's experiments to find charge of an electron; Free Electrons; Generation of Free Ions; The Mass of the Isotopes.

**Unit 2 Quantum Concepts on Atom** **9 Hrs**

Blackbody Radiation; Planck's Radiation Law; Wien's Law; Stefan–Boltzmann's Radiation Law Photoelectric Effect ; Compton Effect; Properties of Photons; Wave and Particle Aspects of Light; De Broglie Wavelength; Heisenberg's Uncertainty Principle; Atomic Spectra; Bohr's Atomic Model.

**Unit 3 Atom with One Electron - Hydrogen Atom** **9 Hrs**

Electron Spin - Normal and anomalous Zeeman Effect; The Stern–Gerlach Experiment; fine structure - Lamb Shift; Hyperfine Structure- Magnetic Dipole-Dipole Interaction; Zeeman Effect of Hyperfine Structure.

**Unit 4 Atoms with more than One Electron** **9 Hrs**

The Helium Atom - Consideration of the Electron Spin - The Pauli Principle - Energy Levels of the Helium Atom - Helium Spectrum; Building-up Principle of the Electron Shell for Larger Atoms; Alkali Atoms - Electron Configuration - LS Coupling - jj Coupling - the Designation of States.

**Unit 5 Emission and Absorption of Electromagnetic Radiation** **9 Hrs**

Transition Probabilities; Induced and Spontaneous Transitions, Einstein Coefficients; Transition Probabilities for Absorption and Induced Emission; Selection Rules - Magnetic Quantum Number - Spin Quantum Number – Lifetime; Characteristic X-Ray - Scattering and Absorption of X-Rays - X-ray Fluorescence - Measurements of X-Ray Wavelengths - Continuous Absorption and Emission Spectra - Photoionization - Recombination Radiation.

**Max. 45 Hours**

**Learning Outcomes:**

Upon successful completion of this course, students should be able to:

CO1: Understand the quantum numbers, including their physical significance, and quantum mechanical states of the hydrogen atom.
CO2: Understand time independent perturbation theory including its derivation and be able to apply it to simple systems, including the Stark-Effect and Zeeman Effect.
CO3: Know about the origins of fine structure in atomic spectra and understand the exchange degeneracy and how this affects the excited states of helium.
CO4: Understand the Periodic table from the viewpoint of the electronic structure and understand and be able to apply to simple cases time dependent perturbation theory.
CO5:Understand the derivation of and be able to apply the selection rules for the interaction of electric dipole radiation and atoms.

**TEXT / REFERENCE BOOKS**

1. Laser Principles and Applications – A. K. Ghatak and K. Tyagrajan (Tata – McGraw Hill).
2. Optics and Atomic Physics – B. P. Khandelwal (SiblalAgarwala).

3. Physics of Atoms and Molecules – B. H. Bransden and C. J. Joachain(Pearson Education)
4. Atomic and Nuclear Physics – S. K. Sharma (Pearson Education).

**END SEMESTER EXAM QUESTION PAPER PATTERN**

**Max. Marks: 100 Exam Duration: 3 Hrs.**

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**PART B:** 2 Questions from each unit of internal choice, each carrying 16 marks. **80 Marks**

| SPH1311 | ATOMIC PHYSICS(2019) | L | T | P | Credits | Total Marks |
|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 | 100 |

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**Unit 1 Concept of the Atom** **9 Hrs**

Brief introduction to history of atom - Rutherford's model and Niels Bohr's model of an atom - Sommerfeld's extension of atomic structure - Electronic configuration and quantum numbers; Cathode Rays; Measurement of the Elementary Charge e – JJ Thomson and Millikan's experiments to find charge of an electron; Free Electrons; Generation of Free Ions; The Mass of the Isotopes.

**Unit 2 Quantum Concepts on Atom** **9 Hrs**

Blackbody Radiation; Planck's Radiation Law; Wien's Law; Stefan–Boltzmann's Radiation Law Photoelectric Effect ; Compton Effect; Properties of Photons; Wave and Particle Aspects of Light; Principal quantum number Orbital angular momentum quantum number (or azimuthal quantum number). Magnetic quantum number, The electron spin quantum number

**Unit 3 Atom with One Electron - Hydrogen Atom** **9 Hrs**

Electron Spin - Normal and anomalous Zeeman Effect; The Stern–Gerlach Experiment; fine structure - Lamb Shift; Hyperfine Structure- Magnetic Dipole-Dipole Interaction; Zeeman Effect of Hyperfine Structure.

**Unit 4 Atoms with more than One Electron** **9 Hrs**

The Helium Atom - Consideration of the Electron Spin - The Pauli Principle - Energy Levels of the Helium Atom - Helium Spectrum; Building-up Principle of the Electron Shell for Larger Atoms; Alkali Atoms - Electron Configuration - LS Coupling - jj Coupling - the Designation of States.

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Transition Probabilities; Induced and Spontaneous Transitions, Einstein Coefficients; Transition Probabilities for Absorption and Induced Emission; Selection Rules - Magnetic Quantum Number - Spin Quantum Number – Lifetime; Characteristic X-Ray - Scattering and Absorption of X-Rays - X-ray Fluorescence - Measurements of X-Ray Wavelengths - Continuous Absorption and Emission Spectra - Photoionization - Calculate the energy of the absorbed photons, Find the energy of the transitions resulting in radiation at visible wavelengths.

**Max. 45 Hours**

**Learning Outcomes:**

Upon successful completion of this course, students should be able to:

CO1: Understand the quantum numbers, including their physical significance, and quantum mechanical states of the hydrogen atom.
CO2: Understand time independent perturbation theory including its derivation and be able to apply it to simple systems, including the Stark-Effect and Zeeman Effect.
CO3: Know about the origins of fine structure in atomic spectra and understand the exchange degeneracy and how this affects the excited states of helium.
CO4: Understand the Periodic table from the viewpoint of the electronic structure and understand and be able to apply to simple cases time dependent perturbation theory.
CO5:Understand the derivation of and be able to apply the selection rules for the interaction of electric dipole radiation and atoms.

**TEXT / REFERENCE BOOKS**


5. Laser Principles and Applications – A. K. Ghatak and K. Tyagrajan (Tata – McGraw Hill).
6. Optics and Atomic Physics – B. P. Khandelwal (SiblalAgarwala).
7. Physics of Atoms and Molecules – B. H. Bransden and C. J. Joachain(Pearson Education)
8. Atomic and Nuclear Physics – S. K. Sharma (Pearson Education).


**END SEMESTER EXAM QUESTION PAPER PATTERN**

**Max. Marks: 100 Exam Duration: 3 Hrs.**

**PART A:** 10 Questions of 2 mark each - No choice. **20 Marks**

**PART B:** 2 Questions from each unit of internal choice, each carrying 16 marks. **80 Marks**

| SPH 4112 | MECHANICS LAB | L | T | P | Credits | Total Marks |
|---|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 | 100 |

**Learning Objectives:**

- To make the students to understand a broad range of experimental techniques in mechanics lab.
- To expose the students to random error measurements
- To help them understand viscosity measurements
- To determine elastic constants by different methods
- To determine acceleration due to gravity by different methods

**LIST OF EXPERIMENTS**

1. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c)Modulus of rigidity
2. To investigate SHM using an oscillating spring
3. To determine the Moment of Inertia of a Flywheel
4. To determine the elastic Constants of a wire by Searle's method
5. To determine the Modulus of Rigidity of a Wire by Maxwell's needle
6. To determine the meta centric height of ship model
7. To determine the value of g using Kater's Pendulum
8. To determine the value of g and K using Compound Bar Pendulum
9. To determine of g using simple pendulum
10. Verification of Law of floatation

**Learning Outcomes:**

By the end of this course students will be able to

CO1: Enhance their ability to use the techniques in conducting scientific experiments and observations.
CO2: Develop knowledge to conduct random error experiments using Sextant.
CO3: Determine the value of g using Bar Pendulum and Digital Timing Technique.
CO4: Determine the Modulus of Rigidity of a Wire by Maxwell's needle, Searle's method.

| SPH4215 | MATHEMATICAL PHYSICS LAB (2019) | L | T | P | Credits | Total Marks |
|---|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 | 100 |

**COURSE OBJECTIVE**

- To demonstrate how to differentiate a function of two variables.
- To describe smooth distribution of energy
- To understand the properties of a particle in universe.
- To introduce fourier series and its applications to the solution of partial differential equation.
- To describe differential equation through Frobenius Method and Integrals using Beta and Gamma functions.

**LIST OF EXPERIMENTS (USING MATLAB)**

1. Matrix operations
2. Plotting curve
3. Differentiation of the given function
4. Integration of the given function
5. First order differential equation
6. Contour plotting
7. Fourier plot
8. Fourier series
9. Linear equation
10. Eigen values and eigen vector
11. Solution of differential equation
12. Roots of polynomial equation
13. Summation of the given series
14. Average of n values
15. Gradient, Divergence and Curl

**Learning Outcomes:**

The student will be able to

CO1: Know how to recognise and differentiate a function of two variables
CO2: Know distribution energy of the particles or materials.
CO3: Know the properties of a particle in universe using Orthogonal Curvilinear Coordinates
CO4: Know Fourier series representation of function of one variable to find solution of wave, diffusion and Laplace equations
CO5: Know how to handle differentiation using Frobenius Method and Integrals using Beta and Gamma functions.

| SPH4216 | DIGITAL AND ANALOG ELECTRONICS LAB (2019) | L | T | P | Credits | Total Marks |
|---|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 | 100 |

**COURSE OBJECTIVE**

- It introduces to the fundamental and broad range of digital and analog experiments related to amplifiers, oscillators, timers, logic gates, multiplexers and demultiplexers

**LIST OF EXPERIMENTS**

1. Inverting and Non inverting Amplifier
2. Summing and Differential Amplifier
3. Linear Op amp circuits such as Instrumentation amplifier, Integrator and Differentiator
4. RC Phase Shift Oscillator
5. Wien Bridge Oscillator
6. Study of IC 555 Timer
7. Study of Logic Gates
8. Study of Flip Flops using Gates
9. Multiplexers and Demultiplexers
10. Encoders and Decoders

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**Learning Outcomes:**

Upon successful completion of this course, students should be able toUnderstand and acquire basic practical knowledge on the various digital and analog experiments related to amplifiers, oscillators, timers, logic gates, multiplexers and demultiplexers