JAI HIND COLLEGE
BASANTSING INSTITUTE OF SCIENCE
&
J.T.LALVANI COLLEGE OF COMMERCE
(AUTONOMOUS)

"A" Road, Churchgate, Mumbai - 400 020, India.

# Affiliated to
# University of Mumbai

Program: B.Sc.

Proposed Course: Physics

Semester -V

Credit Based Semester and Grading System (CBCS) with effect from the academic year 2020-21

*T.Y.B.S.c Physics Syllabus*

**Academic year 2020-2021**

| **Semester V** | | | |
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| **Course Code** | **Course Title** | **Credits** | **Lectures /Week** |
| SPHY501 | Mathematical, Thermal and Statistical Physics | 4 | 4 |
| SPHY502 | Electronics | 4 | 4 |
| SPHY503 | Atomic and Molecular Physics | 4 | 4 |
| SPHY504 | Electrodynamics | 4 | 4 |
| SPHY5PR1 | Practical –I | 4 | 8 |
| SPHY5PR2 | Practical –II | 4 | 8 |

**Semester V– Theory**

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| **Course Code SPHY501** | **Mathematical, Thermal and Statistical Physics (Credits: 04, Lectures/Week: 04)**<br><br>**Course description:** To study Mathematical and Statistical techniques used in Physics. | |
| | **Objectives:**<br>1. To understand mathematical techniques required to study physical phenomena.<br>2. To get exposure to relevant concepts of Statistical Mechanics. | |
| | **THEORY** | **60 L** |
| **Sub Unit** | **Unit – I:Probability** | **15 L** |
| | Review of basic concepts, introduction, sample space, events, independent events, conditional probability, probability theorems, methods of counting (derivation of formulae not expected), random variables, continuous distributions (omit joint distributions), binomial distribution, the normal distribution, the Poisson distribution. | |
| | **Unit – II: Fourier series and Differential equations** | **15 L** |
| **1.** | Introduction, Fourier cosine and sine series, change of interval, fourier integral, complex form of the fourier series | 7 L |
| **2.** | Second-order nonhomogeneous equations with constant coefficients, partial differential equations, some important partial differential equations in physics, method of separation of variables | 8 L |
| | **Unit – III: Statistical Thermodynamics** | **15 L** |
| **1.** | Particle states, system states, microstates and macrostates of a system, equiprobability postulate, statistical ensemble, number of states accessible to a system, density of states, phase space. | 6 L |
| **2.** | Thermal interaction, Canonical distribution, Partition function, Entropy of a system in heat bath, Adiabatic interaction, General interaction, phase transition. | 9 L |
| | **Unit – IV: Classical and Quantum Statistics** | **15 L** |
| | The probability of distribution, most probable distribution, Maxwell-Boltzmann statistics, Molecular speeds.<br>Bose- Einstein statistics, Black- body radiation, The Rayleigh – Jeans formula, The Planck radiation formula, Fermi-Dirac statistics. | |
| **ICA (Internal Continuous Assessment)** | Class test, Seminars, Assignments and Class performance | |

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|---|---|
| **References:** | 1. Mary L. Boas, 3rd ed., *Mathematical Methods in the Physical sciences*, Wiley India,.<br>2. T. Engel and P. Reid, 3rd ed., *Thermodynamics, Statistical Thermodynamics and Kinetics*, Pearson.<br>3. Arthur Beiser, 7th ed., *Perspectives of Modern Physics*,Mc Graw Hill International.<br>4. Charlie Harper,1st ed., *Introduction to Mathematical Methods* PHI Learning Pvt. Ltd.<br><br>**Additional References**:<br>1. A K Ghatak, Chua, 1995, *Mathematical Physics*, Macmillian India Ltd.<br>2. Riley, Hobson and Bence, 3rd ed., *Mathematical Method of Physics*, Cambridge.<br>3. H. K. Das,7th ed., *Mathematical Physics*, S. Chand & Co.<br>4. F. Reif, 2008, *Statistical Physics* (Berkeley Physics Course),Mc Graw Hill.<br>5. Saha and Srivastava, 3rd ed., *A Treatise on heat*, Indian press, Allahabad.<br>6. S Lokanathan & R S Gambhir, 2008, *Statistical and Thermal Physics*, PHI Learning Pvt. Ltd.<br>7. Clement J. Moses, Curt A. Moyer, Raymond A. Serway, 3rd edition, Modern Physics e book (https://epdf.pub/modern-physics-3rd-edition.html |

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| **Course: code SPHY502** | **Electronics (Credits 04: Lectures/Week: 04 )**<br>**Course description:** To develop quantitative and conceptual understanding of the core areas of Electronics | |
| | **Objectives:**<br>1. To understand the basics of semiconductor devices and their applications.<br>2. To understand the basic concepts of operational amplifier: its prototype and applications as instrumentation amplifier, active filters, comparators and waveform generation.<br>3. To understand the basic concepts of timing pulse generation and regulated power supplies<br>4. To understand the basic electronic circuits for universal logic building blocks and basic concepts of digital communication.<br>5. To develop quantitative problem solving skills in all the topics covered. | |
| **Unit I** | Field Effect Transistor: JFET: Basic ideas, Drain curve, The transconductance curve, Biasing in the ohmic region and the active region, Transconductance, JFET common source amplifier, JFET analog switch multiplexer, voltage controlled resistor, Current sourcing.<br>MOSFET : Depletion and enhancement mode, MOSFET operation and characteristics, digital switching<br>Thyristors: SCR – Working, Equivalent circuit, important terms, I-V Characteristics, SCR as a switch, Half wave rectifier and Full wave rectifier.<br>TRIAC: Construction, Operation, I-V Characteristics, Applications.<br>DIAC: Construction, Operation, Characteristics and applications | **15 L** |
| **Unit II** | Supply characteristics, series voltage regulator, short circuit protection (current limit and fold back) Monolithic linear IC voltage regulators. (LM 78XX, LM 79XX, LM 317).<br>Differential Amplifier using transistor: The Differential Amplifier, DC and AC analysis of a differential amplifier, Input characteristic-effect of input bias, Offset current and input offset voltage on output, common mode gain, CMRR.<br>Transistor Multivibrators: Astable, Monostable and Bistable Multivibrators, Schmitt trigger. | **15 L** |
| **Unit III** | Op Amp Applications:Log amplifier, Instrumentation amplifiers, Voltage controlled current sources (grounded load), First order Active filters<br>Astable using OP AMP, square wave and triangular wave generator using OP AMP, Wein-bridge oscillator using OP AMP.<br>555 Timer: Block diagram, Monostable and Astable operation ,Voltage controlled Oscillator, Triggered linear ramp generator | **15 L** |
| **Unit IV** | Logic families: Standard TTL NAND, TTL, NOR, Open collector gates, Three state TTL devices, MOS inverters, CMOS NAND and NOR gates, CMOS characteristics.<br>Applications of JK flip flop: Types of registers, 4-bit shift register (serial in-serial out), 4-bit up-down counter, Shift counter.<br>Electronic communication techniques: Modulation factor, Analysis of amplitude modulated wave, Side band frequencies in AM wave, Transistor amplitude modulator, Power in AM wave, Frequency modulation. (qualitative) | **15 L** |

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| **ICA (Internal Continuous Assessment)** | Class test, Seminars, Assignments and Class performance. |
| **References:** | 1. MB : Electronic Principles : A. P. Malvino and D.J. Bates (7th Ed.) – (TMH).<br>2. VKM : Principles of Electronics : V. K. Mehta and Rohit Mehta. S. Chand Publications. (11th Ed.).<br>3. KVR : Functional Electronics : K .V. Ramanan (TMH).<br>4. ML : Digital Principles and Applications : Malvino and Leach (4th Ed) (TMH).<br>5. MH : Integrated Electronics : Millman and Halkias Mc Graw Hill International.<br>6. AM:Electronic Devices and Circuits:Allen Mottershed,PHI learning 2013Ed<br><br>**Additional References :**<br>1. Electronic Devices and Circuits : S. Salivahanan, N. Suresh Kumar and A. Vallavaraj. (2nd Ed.) (Tata McGraw Hill)<br>2. Pulse, Digital & Switching Waveforms : Millman & Taub. (TMH) |

| Course Code SPHY503 | **Atomic and Molecular Physics(Credits: 04, Lectures/Week: 04)**<br><br>**Course description:** To study the basics of atomic and molecular physics and its application in spectroscopy | |
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| | **Objectives:**<br>1. Understand application of quantum mechanics in atomic physics<br>2. Understand the importance of electron spin, symmetric and antisymmetric wave functions and vector atom model<br>3. Understand the effect of magnetic field on atoms and its application and get an insight into spectroscopy<br>4. Understand Molecular Physics and its applications | |
| | **THEORY** | **60 L** |
| **Sub Unit** | **Unit – I: Hydrogen Atom and electron spin** | **15 L** |
| **1.** | Hydrogen atom: Schrödinger's equation for Hydrogen atom, Separation of variables, Quantum Numbers: Total quantum number, Orbital quantum number, Magnetic quantum number. Angular momentum, Electron probability density (Radial part). | 8 L |
| **2.** | Electron spin: The Stern-Gerlach experiment, Pauli's Exclusion PrincipleSymmetric and Anti-symmetric wave functions. | 7 L |
| **Sub Unit** | **Unit – I: Hydrogen Atom and electron spin** | **15 L** |
| **1.** | Hydrogen atom: Schrödinger's equation for Hydrogen atom, Separation of variables, Quantum Numbers: Total quantum number, Orbital quantum number, Magnetic quantum number. Angular momentum, Electron probability density (Radial part). | 8 L |
| **2.** | Electron spin: The Stern-Gerlach experiment, Pauli's Exclusion PrincipleSymmetric and Anti-symmetric wave functions. | 7 L |
| | **Unit – III: Molecular spectra and spectrometers** | **15 L** |
| **1.** | Molecular spectra (Diatomic Molecules): Rotational energy levels, Rotational spectra, Vibrational energy levels, Vibrational-Rotational spectra. Electronic Spectra of Diatomic molecules: The Born-Oppenheimer approximation, Intensity of vibrational-electronic spectra: The Franck-Condon principle.. | 10 L |
| **2.** | Infrared spectrometer & Microwave spectrometer | 5 L |
| | **Unit –IV: Raman Effect , Electron spin resonance and Nucleqar magnetic resonance** | **15 L** |
| **1.** | Raman effect: Quantum Theory of Raman effect, Pure Rotational Raman spectra: Linear molecules, symmetric top molecules, Asymmetric topmolecules, Vibrational Raman spectra: Raman activity of vibrations, Experimental set up of Raman Effect. | 7 L |
| **2.** | Electron spin resonance: Introduction, Principle of ESR, ESR spectrometer | 4 L |
| **3.** | Nuclear magnetic resonance: Introduction, principle and NMR Instrumentation. | 4 L |

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| **ICA (Internal Continuous Assessment)** | Class test, Seminars, Assignments and Class performance. |
| **References:** | 1. Arthur Beiser, 7th ed., *Perspectives of Modern Physics*: McGrawHill Publications<br>2. Chatwal G.R., Anand, Sham K., 5th edition, 2016, Instrumental Methods for Chemical Analysis, Himalaya Publishing house.<br>3. C. N. Banwell & E. M. McCash, 4th ed., *Fundamentals of Molecular Spectroscopy*, Tata McGraw Hill publications<br>4. G. Aruldhas, 2nd Ed., *Molecular structure and spectroscopy*, PHI learning Pvt Ltd.<br>5. S.N.Ghoshal, 2007, *Atomic Physics (Modern Physics*), S.Chand Publications |

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| **Course Code SPHY504** | **Electrodynamics (Credits 04: Lectures/Week: 04 )**<br><br>**Course description:** To Study electrodynamics and apply theory to derive optical principles | |
| | **Objectives**<br>1. Understand the laws of electrodynamics and perform calculations using them.<br>2. Understand Maxwell's electrodynamic equations and its relation to relativity<br>3. Understand how optical principles can be derived from electromagnetic principles.<br>4. Develop quantitative problem solving skills | |
| | **THEORY** | **60 L** |
| **Sub Unit** | **Unit – I: Electrostatics** | **15 L** |
| **1.** | Review of Coulomb & Gauss law, The divergence of **E**, Applications of Gauss' law, The curl of **E**. Introduction to potential, Comments on potential, The potential of a localized charge distribution. Poisson's equation and Laplace's equation. Solution and properties of 1D Laplace equation. Properties of 2D and 3D Laplace equation (without proof). | 8 L |
| **2.** | Boundary conditions and Uniqueness theorems, Conductors and Second Uniqueness theorem, The classic image problem- point charge and grounded infinite conducting plane and conducting sphere. | 7 L |
| | **Unit – II: Electrostatics in Matter and Magnetostatics** | **15 L** |
| **1.** | Dielectrics, Induced Dipoles, Alignment of polar molecules, Polarization, Bound charges and their physical interpretation, Gauss' law in presence of dielectrics, A deceptive parallel, Susceptibility, Permittivity, Dielectric constant and relation between them, Energy in dielectric systems. | 8 L |
| **2.** | Boundary conditions and Uniqueness theorems, Conductors and Second Uniqueness theorem, The classic image problem- point charge and grounded infinite conducting plane and conducting sphere. | 7 L |
| | **Unit – II: Electrostatics in Matter and Magnetostatics** | **15 L** |
| **1.** | Dielectrics, Induced Dipoles, Alignment of polar molecules, Polarization, Bound charges and their physical interpretation, Gauss' law in presence of dielectrics, A deceptive parallel, Susceptibility, Permittivity, Dielectric constant and relation between them, Energy in dielectric systems. | 8 L |
| **2.** | Boundary conditions and Uniqueness theorems, Conductors and Second Uniqueness theorem, The classic image problem- point charge and grounded infinite conducting plane and conducting sphere. | 7 L |
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| **1.** | Dielectrics, Induced Dipoles, Alignment of polar molecules, Polarization, Bound charges and their physical interpretation, Gauss' law in presence of dielectrics, A deceptive parallel, Susceptibility, Permittivity, Dielectric constant and relation between them, Energy in dielectric systems. | 8 L |

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| **ICA (Internal Continuous Assessment)** | Class test, Seminars, Assignments and Class performance. |
| **References:** | 1. David J. Griffiths, 3rd Edition, *Introduction to Electrodynamics,* Prentice Hall of India.<br>2. A. Z. Capria and P. V. Panat, 2002, *Introduction to Electrodynamics,* Narosa Publishing House.<br>3. Hayt Jr. & John H. Buck, *Engineering Electrodynamics*: William (TMH).<br>4. Reitz, Milford and Christy, 4th Edition, *Foundations of Electromagnetic Theory.*<br>5. David J. Griffiths, 3rd Edition, *Solutions to Introduction to Electrodynamics:* Prentice Hall of India. |

| Course Code SPHY5PR1 and SPHY5PR2 | Practical-I and Practical- II | 8 Credits |
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| **Learning Objectives:** | 1. To correlate theory concepts.<br>2. Develop basic experimental skills through conduct of experiments. | |
| | **SEMESTER-V PRACTICALS** | |
| **SPHY5PR1** | 1. 1.SCR characteristics<br>2. Wien Bridge oscillator<br>3. First order active low pass filter<br>4. Transistorized a stable multi-vibrator<br>5. Transistorized bi-stable multi-vibrator<br>6. Application of IC 555 timer as a ramp generator (BB)<br>7. LM 317 as constant current source<br>8. Counters Mod 2, 5, 10 (2 x 5, 5 x 2)<br>9. Design and study of first order active high pass filter circuit (BB) | 4 credits |
| **SPHY5PR2** | 1. Determination of 'g' by Kater's pendulum<br>2. Determination of Rydberg's constant<br>3. Searle's Goniometer<br>4. 4.Determination of wavelength of light by Edser's 'A' pattern<br>5. 5.Determination of e/m by Thomson's method<br>6. 6.Study of Hysteresis using magnetometer<br>7. Study of use of diode as temperature sensor<br>8. Determination of energy band gap of a diode<br>9. Determination of surface tension using Quincke's method<br>10. Determination of thermal conductivity using Lee's method | 4 credits |
| Both **SPHY5PR1 and SPHY5PR2** Skills | 1. Estimation of errors from actual experimental data<br>2. Soldering and testing of an electronic circuit on PCB<br>3. Optical Levelling of Spectrometer<br>4. Schuster's method<br>5. Use of electronic balance: Radius of small ball bearings<br>6. .Dual trace CRO: Phase shift measurement<br>7. .C1/C2 by B G<br>8. Bread board circuit using ICs | |
| **ICA (Internal Continuous Assessment)** | Continuous practical evaluation /seminar / Journal Report and Viva-voce. | |
| **References:** | 1. D. Chattopadhya, P.C. Rakshit & B. Saha, (8th Edition ), *Advanced course in Practical Physics:* Book & Allied Pvt. Ltd.<br>2. Harnam Singh, (17 th edition 2001), *BSc Practical Physics:* S. Chand & Co. Ltd.<br>3. Samir Kumar Ghosh, (4th edition), *A Text book of Practical Physics:* New Central Book Agency<br>4. C. L. Arora, (1st Edition) – 2001), *B Sc. Practical Physics*: S. Chand & Co.Ltd.<br>5. C. L. Squires, *Practical Physics*: (3rd Edition) , Cambridge University Press.<br>6. D C Tayal,( I st edition, 2000) , *University Practical Physics:* Himalaya Publication.<br>7. Worsnop & Flint, *Advanced Practical Physics*: | |

**i) Students are required to come for 4 turns of 3 hours each per week for the laboratory session (Performing practical).**

**ii) Regular Physics Experiments:** A minimum of **08** experiments from each group of the practical course are to be performed and reported in the journal.

**iii) Skill experiments :** All the skill experiments are compulsory and must be reported in the journal. Skills will be tested during the examination through viva or practical.

The certified journal must contain a minimum of **16** regular experiments (8 from each group) with **all skill experiments** in semester V. A separate index and certificate in journal is must for each course.

**Evaluation Scheme**

**[A] Evaluation scheme for Theory courses SPHY501, SPHY502 and SPHY503 and SPHY504**

- **Continuous Assessment ( C.A.) - 40 Marks**
- C.A.-I : Test – 20 Marks of 40 mins. Duration
- C.A. –II: Assignment of problems/seminar/class performance
- **Semester End Examination ( SEE)- 60 Marks**

**[B] Evaluation scheme for Practical course**

<table>
<tr><td colspan="6">Total marks : 200</td></tr>
<tr><td colspan="3">Continuous Internal Assessment (CIA)<br><br>40% (80 marks )</td><td colspan="2">Semester End Examination ( SEE)<br><br>60% (120 marks )</td><td>Total</td></tr>
<tr><td>Rough journal</td><td>Journal</td><td>Viva-voce</td><td>Exp. -I</td><td>Exp.- II</td><td></td></tr>
<tr><td>(20+20)</td><td>20</td><td>20</td><td>60</td><td>60</td><td>200</td></tr>
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Practical examination will be of **5 hours**. Students will perform **2** experiments of **two and half** hours each from group-A and B .

**Note: Certified journal is a must for the student to appear for practical examination.**