AC/II (23-24).2.RUS10

S.P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

RUIA COLLEGE
Explore ● Experience ● Excel

Syllabus for

Program: T.Y.B.Sc.

Program Code: (RUSPHY)

2024-25

(Choice Based Credit System for the academic year 2024-25)

GRADUATE ATTRIBUTES

Graduate Attributes	Graduate Attributes Description **A student completing Bachelor's degree in Physics program will be able to:**
Graduate Attributes - I	Recall and explain acquired scientific knowledge in a comprehensive manner and apply the skills acquired in their chosen discipline. Interpret scientific ideas and relate its interconnectedness to various fields in science.
Graduate Attributes - II	Evaluate scientific ideas critically, analyses problems, explore options for practical demonstrations, illustrate work plans and execute them, organize data and draw inferences
Graduate Attributes - II	Explore and evaluate digital information and use it for knowledge upgradation. Apply relevant information so gathered for analysis and communication using appropriate digital tools.
Graduate Attributes - IV	Ask relevant questions, understand scientific relevance, hypothesize a scientific problem, construct and execute a project plan and analyze results.
Graduate Attributes - V	Take complex challenges, work responsibly and independently, as well as in cohesion with a team for completion of a task. Communicate effectively, convincingly and in an articulate manner.
Graduate Attributes - VI	Apply scientific information with sensitivity to values of different cultural groups. Disseminate scientific knowledge effectively for upliftment of the society.
Graduate Attributes – VII	Follow ethical practices at workplace and be unbiased and critical in interpretation of scientific data. Understand the environmental issues and explore sustainable solutions for it.
Graduate Attributes – VIII	Keep abreast with current scientific developments in the specific discipline and adapt to technological advancements for better application of scientific knowledge as a lifelong learner

PROGRAM OUTCOMES

PO	Description **A student completing bachelor's degree in BSc program in the subject of Physics will be able to:**
PO 1	To demonstrate fundamental and procedural knowledge related to different areas of study in Physics including mechanics, optics, modern physics, thermodynamics, electronics, electrodynamics at a level attuned with graduate programs in physics at peer institutions
PO 2	To demonstrate comprehensive, quantitative and conceptual understanding of the core areas of physics.
PO 3	To apply the principles and acquired skill-set related to physics, to handle innovative and unfamiliar problems, so that effective solution or strategy to deal with, could be developed.
PO 4	To explore and deduce quantitative results in the extents of physics.
PO 5	To use contemporary experimental apparatus and analysis tools to acquire, analyze and interpret scientific data in the extents of physics.
PO 6	To communicate scientific results effectively in presentations or posters in the extents of physics to both the scientists and public at large.
PO 7	Utilize acquired ICT skills, physics practical skills, mathematical skills to prepare for employment, for advancement of a career path and also for lifelong learning in Physics.

YEAR	SEM	COURSE CODE	TITLE	Credit
2023-24	**V**	**RUSPHY501**	**Mathematical Methods of Physics, Thermal & Statistical Physics**	**4**
			Unit I: Probability	
			Unit II: Differential equations	
			Unit III: Statistical & Thermal Physics	
			Unit IV: Statistical Mechanics and Quantum Statistics	
		RUSPHY502	**Solid State Physics**	**4**
			Unit I: Crystal Physics	
			Unit II: Electrical properties of metals	
			Unit III: Conduction in Semiconductors	
			Unit IV: Diode, Magnetism, and superconductivity	
		RUSPHY503	**Atomic & Molecular Physics**	**4**
			Unit I: Schrödinger's equation and Hydrogen atom	
			Unit II: Electron Spin	
			Unit III: Zeeman effect and Paschen-Back effect	
			Unit IV: Molecular Spectra	
		RUSPHY504	**Electrodynamics**	**4**
			Unit I: Electrostatics	
			Unit II: Polarisation & Magnetostatics	
			Unit III: Magnetism & Varying Fields	
			Unit IV: Electromagnetic Waves	
		RUSPHYP501	Physics Practical Course (Group A)	**3**
		RUSPHYP502	Physics Practical Course (Group B)	**3**
			Total	**22**

YEAR	SEM	COURSE CODE	TITLE	Credits
2023-24	**VI**	**RUSPHY601**	**Classical Mechanics& Non-Linear Mechanics**	**4**
			Unit I : Central Force	
			Unit II : Lagrange's equations	
			Unit III : Kinematics	
			Unit IV : Non linear mechanics	
		RUSPHY602	**Electronics**	**4**
			Unit I : FET &SCR	
			Unit II : Regulated DC power supply, Differential Amplifier, Transistor Multivibrators	
			Unit III : Operational Amplifier and 555 Timer	
			Unit IV : Logic family	
		RUSPHY603	**Nuclear Physics**	**4**
			Unit I : Alpha & Beta Decay	
			Unit II : Gamma Decay & Nuclear Models	
			Unit III : Particle Accelerators & Energy Generation	
			Unit IV : Meson theory & Elementary particles	
		RUSPHY604	**Special Theory of Relativity**	**4**
			Unit I : Special Theory of Relativity & Relativistic Kinematics	
			Unit II : Relativistic Kinematics	
			Unit III : Relativistic Dynamics	
			Unit IV : Relativity and Electromagnetism	
		RUSPHYP601	Physics Practical Course (Group A)	**3**
		RUSPHYP602	Physics Practical Course (Group B)	**3**
			Total	**22**

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Syllabus for T.Y.B. Sc. SEM V & VI

Program: B.Sc. (Physics)

Program Code: RUSPHY

(Credit Based Semester and Grading System for academic year 2024–2025)

Course Code: RUSPHY501

Course Title: Mathematical Methods in Physics, Thermal & Statistical

Physics

Academic year 2023-24

Course Outcomes:

After successful completion of this course, a student will be able to:

CO1: Understand the scope of statistical concept for solving the equation of thermal mechanics.

CO2: Comprehend the basic concepts of mathematics & its applications in physical sciences

CO3: Evaluate the statistical relation by using the concepts of probability.

CO4: Demonstrate the thermodynamic relations.

CO5: Understand the concepts of MB, BE and FD distribution. Comparison of distribution.

CO6: Understand the concepts by solving the numerical.

DETAILED SYLLABUS

COURSE CODE	Unit	TITLE	Credits/ lectures
RUSPHY501		**Mathematical Methods in Physics, Thermal & Statistical Physics**	**4 credits**
	I	**Probability**	**15 lectures**
		Review of basic concepts: sample space, events, independent events, conditional probability, probability theorems, permutations and combinations, discrete and continuous random variables, binomial distribution, joint distributions and covariance, the normal distribution, the Poisson distribution, statistics and experimental measurements, Chebyshev's inequality, law of large numbers, central limit theorem. **MB: Chapter 15**	
	II	**Differential Equations**	**15 lectures**
		Second-order non-homogeneous linear differential equations with constant coefficients: the method of successive integrations and the method of undetermined coefficients. Forced vibrations and resonance. The Laplace transform and its use in the solution of differential	

		equations **CH – Sections 5.2.4, 8.2.1, 8.2.2, 8.2.4 MB – Sections 8.6, 8.8 and 8.9** Fourier series: Introduction, Fourier cosine and sine series, Change of interval, Fourier Integral, Complex form of the Fourier series **CH: 7.1, 7.1.1, 7.1.2, 7.1.3, 7.1.4, 7.2.** Fourier transforms: Introduction, Formal development of the complex Fourier transform, Cosine and Sine transforms, The transforms of derivatives (with proof) **CH: 8.1, 8.2.1, 8.2.2, 8.2.4, 8.2.5, 8.2.6**	
	III	**Statistical & Thermal Physics**	**15 lectures**
		Description of a system: Why statistical approach, Particle-states, System-states, Microstates and Macrostates of a system, Equilibrium and Fluctuations, Irreversibility, The equi-probability postulate, Statistical ensemble, Number of states accessible to a system, Phase space, Reversible processes. **LG: 1.1 to 1.11** Thermal and Adiabatic Interactions: Thermal interaction, Canonical distribution, Energy fluctuations, Entropy of a system in a heat bath, Helmholtz free energy, Adiabatic interaction and enthalpy, General interaction and the first law of thermodynamics, Infinitesimal general interaction, Gibbs free energy, Phase transitions. **LG: 2.1, 2.3 to 2.11**	
	IV	**Statistical Mechanics and Quantum Statistics**	**15 lectures**
		Statistical Mechanics :Phase space, The probability of a distribution, The most probable distribution, Maxwell-Boltzmann statistics, Molecular speeds. **AB: 15.1 to 15.5** Quantum Statistics: Bose-Einstein statistics, Black-body radiation, The Rayleigh-Jeans formula, The Planck radiation formula, Fermi-Dirac statistics, Comparison of results, Transition between states. **AB: 16.1 to 16.7**	

References:

1. Mathematical Methods in the Physical Sciences – Mary L. Boas (**MB**)
2. Introduction to Mathematical Physics – Charlie Harper (**CH**)
3. Statistical & Thermal Physics by S. Lokanathan & R. S Gambhir (**LG**)
4. Perspectives of Modern Physics – Arthur Beiser (**AB**)

Course Code: RUSPHY502

Course Title: Solid State Physics

Academic year 2023-24

Course Outcomes:

After successful completion of this course, a student will be able to:

CO1: Describe the various aspects related to crystal physics.
CO2: Interpret Electrical properties of metals, Fermi-Dirac statistics and electronic distribution in solids, the Kronig- Penney model, Brillouin zones.
CO3: Describe conductivity related features of electrons and Holes in an Intrinsic Semiconductor, and Hall Effect.
CO4: Describe Diamagnetism and Para-magnetism.
CO5: Analyze Qualitative theory of the p-n junction, temperature dependence of p-n characteristics, Diode resistance.
CO6: Describe phenomenon of Superconductivity and types, effects.

DETAILED SYLLABUS

COURSE CODE	Unit	TITLE	Credits/ lectures
RUSPHY502		**Solid State Physics**	**4 credits**
	I	**Crystal Physics**	**15 lectures**
		Revision-Lattice points and space lattice, The basis and crystal structure, Unit Cells and lattice parameters, Primitive Cells. Crystal Systems, Crystal Symmetry, Bravais space lattices, Metallic crystal structures, Relation between the density of crystal material and lattice constant in a cubic lattice, Directions, Planes, Miller Indices, Important planes in simple cubic structure, separation between lattice planes in a cubic crystal, Reciprocal Lattice, X-ray Diffraction **SOP: Ch. 4 Art – II, III, IV, V, VI, VII, XIV,XV, XVI, XVIII, XX, XXII, XXV, XXVI**	
	II	**Electrical properties of metals**	**15 lectures**
		Electrical properties of metals: Classical free electron theory of metals, drawbacks of classical theory, Relaxation time, Collision time and mean free path, Quantum theory of free electrons, Fermi-Dirac statistics and electronic distribution in solids, Density of energy	

		states and Fermi energy, Heat capacity of the electron gas, Mean energy of electron gas at 0 K **SOP: Ch. 6 Art – I to V, XIV, XV, XVII, XVIII** Band theory of solids, The Kronig- Penney model (Omit eq. 6.184 to 6.188), Brillouin zones, Number of wave functions in a band, Motion of electrons in a one-dimensional periodic potential, Distinction between metals, insulators and intrinsic semiconductors **SOP: Ch. 6 Art – XXXVII, XXXVIII, XXXIX,XXXX, XXXXI**	
	III	**Conduction in Semiconductors**	**15 lectures**
		Electrons and Holes in an Intrinsic Semiconductor, Conductivity, Carrier concentrations in an intrinsic semiconductor, Donor and Acceptor impurities, Charge densities in a semiconductor, Fermi level in extrinsic semiconductors, Diffusion, Carrier lifetime, The continuity equation, Hall Effect 2.Magnetic Properties of matter: Diamagnetism and Paramagnetism, The origin of permanent magnetic dipoles, Diamagnetism and Larmor precession, the static paramagnetic susceptibility **D: 18.1 to 18.4**	
	IV	**Diode, magnetism and superconductivity** Semiconductor-diode Characteristics: Qualitative theory of the p-n junction, the p-n junction as a diode, Band structure of an open-circuit p-n junction **MH: 4.1 to 4.10; 5.1, 5.2, 5.3** The current components in a p-n junction diode, Quantitative theory of p-n diode currents, The Volt-Ampere characteristics, The temperature dependence of p-n characteristics, Diode resistance **MH: 5.4 to 5.8** Superconductivity: survey, Mechanism of Superconductors, Effects of magnetic field, Critical Currents, The Meissner effect, the penetration depth, Type I and Type II Superconductors **SOP: Chapter 8: II, III, IV, VI, VII, XII, XIII**	**15 lectures**

References:

1. Solid State Physics: S. O. Pillai, New Age International. 6th Ed**. (SOP)**
2. Electronic Devices and Circuits: Millman, Halkias & Satyabrata Jit. (3rd Ed.) Tata McGraw Hill. **(MH)**
3. Solid State Physics: A. J. Dekker, Prentice Hall**(D)**

Course Code: RUSPHY503

Course Title: Atomic & Molecular Physics

Academic year 2023-24

Course Outcomes:

After successful completion of this course, a student will be able to:

CO1: Understand the basic mathematical concepts of vector calculus and applications of them in physical situations.

CO2: Understand the Schrödinger's equations and their application on hydrogen atom.

CO3: Understand the energy level diagrams using hydrogen atom and comprehend understanding of its quantum numbers.

CO4: Understand spin of an electron and its experimental proof with exclusive principle.

CO5: Understand the magnetic effect on the atom and their consequences using quantum and classical theories.

CO6: Understand the Molecular spectra and its effect on various energy levels using Raman effect.

CO7: It enhances the knowledge of modern, quantum and classical aspects for the further studies.

DETAILED SYLLABUS

COURSE CODE	Unit	TITLE	Credits/ lectures
RUSPHY503		**Atomic & Molecular Physics**	**4 credits**
		Schrödinger's equation and Hydrogen atom	**15 lectures**
	I	Schrödinger's equation for Harmonic oscillator, its solution by operator method. Graphical representation of its energy level and wave functions. **PTM: 5.2; AB: 8.7** 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)	

		AB: 9.1 to 9.9	
	II	**Electron Spin**	**15 lectures**
		Electron Spin: The Stern-Gerlach experiment, Pauli's Exclusion Principle, Symmetric and Antisymmetric wave functions. **AB: 10.1, 1.03** Spin orbit coupling, Hund's Rule, Total angular momentum, Vector atom model, L-S and j-j coupling. Origin of spectral lines, Selection rules. **AB:10.2,10.6,10.7, 10.8, 10.9; 11.1 and 11.2.**	
	III	**Zeeman effect and Paschen-Back effect**	**15 lectures**
		Effect of Magnetic field on atoms, Zeeman effect, Earlier discoveries and developments, Experimental arrangement, The normal Zeeman effect and its explanation(Classical and Quantum) **HSA: 9.14, 9.15** The Lande g factor, Anomalous Zeeman effect; Paschen-Back effect, Paschen-Back effect of principal series doublet, Selection rules for Paschen-Back effect. **HEW: 9.16, 9.17, 10.7, 10.8, 10.9**	
	IV	**Molecular Spectra :**	**15 lectures**
		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. **AB: 14.1, 14.3, 14.5, 14.7** **BM: 6.11, 6.13** Raman Effect: Quantum Theory of Raman Effect, Classical theory of Raman Effect, Experimental Setup of Raman Effect, Applications of Raman Spectroscopy. **BM: 4.1.1, 4.1.2**	

References:

1. Introduction to Quantum mechanics – P. T Mathews (**PTM**)
2. Perspectives of Modern Physics – Arthur Beiser (**AB**)
3. Introduction to Atomic & Nuclear Physics – Henry Semat& J. R Albright (5th Ed) (**HSA**); Introduction to Atomic Spectra – H. E White (**HEW**)
4. Fundamentals of Molecular Spectroscopy – C. N Banwell& E. M McCash (**BM**)

Course Code: RUSPHY504

Course Title: Electrodynamics

Academic year 2023-24

Course Outcomes:

After successful completion of this course, a student will be able to:

CO1: Understand the basic mathematical concepts of vector calculus and its applications of them in Electrodynamics.

CO2: Understand the penetration of electric and magnetic fields in dielectric material and its practical applications.

CO3: Acquired conceptual understanding of Maxwell's laws and its quantitative interpretations.

CO4: Understand basics of electromagnetic waves and their propagation in material and practical applications in waveguide.

CO5: Explore role of Poynting theorem in energy transport via electromagnetic waves.

CO6: It prepares students for the advanced study of electrodynamics with practical applications in communication and energy transport.

DETAILED SYLLABUS

COURSE CODE	Unit	TITLE	Credits/ lectures
RUSPHY504		**Electrodynamics**	**4 credits**
RUSPHY504	**I**	**Electrostatics**	**15 lectures**
		Electric Field lines, Flux and Gauss' law, The divergence of **E**, Applications of Gauss' law, The curl of **E**. Introduction to potential, Comments on potential, Poisson's equation and Laplace's equation, The potential of a localized charge distribution, Review of Conductors & Faraday's Cage **DG: 2.2.1 to 2.2.4, 2.3.1 to 2.3.4. Greiner-1.1,1.2,1.3** First Uniqueness theorem (Without proof),	.

		The classic image problem- Infinite conducting plane **DG: 3.2.1 to 3.2.3.** **Greiner—**chapter2-Green's theorems, Green's function, Ex 2.1(Image charge problem)	
	II	**Polarisation & Magnetostatics**	**15 lectures**
		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, Energy in dielectric systems. **DG: 4.1.1 to 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.4.1, 4.4.3.** Straight-line currents, The Divergence and Curl of **B**, Applications of Ampere's law in the case of a long straight wire and a long solenoid, Comparison of Magneto-statics and Electrostatics. **DG: 5.3.1 to 5.3.4.**	
	III	**Magnetism & Varying Fields**	**15 lectures**
		Magnetization, Bound currents and their physical interpretation, Ampere's law in magnetized materials, A deceptive parallel, Magnetic susceptibility and permeability. **DG: 6.2.1, 6.2.2, 6.3.1, 6.3.2, 6.4.1.** Energy in magnetic fields, Electrodynamics before Maxwell, Maxwell's correction to Ampere's law, Maxwell's equations, Magnetic charge, Maxwell's equations in matter, Boundary conditions. **DG: 7.2.4, 7.3.1 to 7.3.6.**	
	IV	**Electromagnetic Waves**	**15 lectures**
		The continuity equation, Poynting's theorem, Newton's third law in electrodynamics. **DG: 8.1.1, 8.1.2., 8.2.1.** The wave equation for **E** and **B**, Monochromatic Plane waves, Energy and momentum in electromagnetic waves, Propagation in linear media, Reflection and transmission of EM waves at normal incidence, Electromagnetic waves in conductors, guided waves-wave guides **DG: 9.2.1 to 9.2.3, 9.3.1 to 9.3.2, 9.4.1, 9.5.1**	

References:

1. Introduction to Electrodynamics by David Griffith (3 rd edition)-Prentice hall of India **(DG)**
2. Introduction to Electrodynamics: A. Z. Capria and P. V. Panat.
3. Electricity and Magnetism: Navina Wadhwani

RUSPHYP05 – Physics Laboratory Course

The T. Y. B. Sc. Syllabus integrates the regular practical work with a series of demonstration and skill experiments. During the teaching and examination of Physics laboratory work, simple modifications of experimental parameters may be attempted. Attention should be given to basic skills of experimentation which include:

i) Understanding relevant concepts
ii) Planning of the experiments
iii) Layout and adjustments of the equipment
iv) Recording of observations and plotting of graphs
v) Calculation of results and estimation of possible errors in the observation of results

Regular Physics Experiments: A minimum of 8 experiments from each of the course are to be performed and reported in the journal

Skill Experiments: All the 8 skills 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 8 Skills in semester V.**

A separate index and certificate in journal is must for each semester course. There will be two turns of three hours each for the examination of practical courses

- Internal component of Practical examination Evaluation is based on regular experiments and skill experiments.
- For external practical examination, the learner will be examined in two experiments (one from each group)
- A learner will be allowed to appear for the semester end practical examination only if he submits a certified journal of Physics

Skill experiments		1.	Lateral shift removal on optical bench	
		2.	Dual Trace CRO: Phase Shift Measurement.	
		3.	Study of advanced Optics setup- Hologram making Apparatus	
		4.	BG: C1 /C2 by comparing θ1 / θ2	
		5.	Use of electronic balance: Radius of a small ball bearing or suitable another skill expt.	
		6.	Soldering technique	
		7.	Temperature and Pressure measurement-BMP --Sensor and Arduino board, PC.	
		8.	Bread Board Circuit using three IC	
Group A (RUSPHYP501)		1.	Determination of g by Kater's Pendulum	
		2.	Resolving power of prism	
		3.	Diameter of Lycopodium Powder	
		4.	Goniometer	

		5.	Thermal Diffusivity of Brass	
		6.	Fresnel's biprism: determination of wavelength of sodium yellow line.	
		7.	Diode as Temperature Sensor	
		8.	Hall Effect	
		9.	Hologram Making	
Group B (RUSPHYP502)		1.	Mutual Inductance by BG	
		2.	Hysteresis by Magnetometer	
		3.	Maxwell's Bridge	
		4.	Curie-Weiss Law	
		5.	Band-gap Energy	
		6.	Log Amplifier using OP Amp	
		7.	First Order Active High/Low Pass Filter	
		8.	Schmitt Trigger using OPAMP	
		9.	Wein Bridge Oscillator-OPAMP	

References:

1. Advanced course in Practical Physics: D. Chattopadhya, PC. Rakshit& B. Saha (8th Edition) Book & Allied Pvt. Ltd.
2. BSc Practical Physics: Harnam Singh. S. Chand & Co. Ltd. – 2001
3. A Text book of Practical Physics: Samir Kumar Ghosh New Central Book Agency (4rd edition)
4. B Sc. Practical Physics: C. L. Arora (1st Edition) – 2001 S. Chand & Co. Ltd
5. Practical Physics: C. L. Squires – (3rd Edition) Cambridge University Press.
6. University Practical Physics: D C Tayal. Himalaya Publication.
7. Advanced Practical Physics: Worsnop& Flint.
8. DSO –tektronics, Aplab manual CD.
9. Hologram –Holmark manual

MODALITY OF ASSESSMENT – SEM V

Theory Examination Pattern: -

A) Internal Assessment - 40% = 40 marks.

Theory Paper-Paper code	**Test** (Marks)	**Assignment**	**Marks distribution (Assignment)**	**Total Marks per paper**
Math. Methods of Physics, Thermal & Statistical Physics RUSPHY501	20	15 questions on units1,2,3	Assessment- 15 mark Viva on it --05 mark ---------- Total= 20 mark	40
Solid State Physics RUSPHY502	20	15 questions on units1,2,3	Assessment- 15 mark Viva on it --05 mark ---------- Total= 20 mark	40
Atomic & Molecular Physics RUSPHY503	20	15 questions on units1,2,3	Assessment- 15 mark Viva on it --05 mark ---------- Total= 20 mark	40
Electrodynamics RUSPHY504	20	15 questions on units1,2,3	Assessment- 15 mark Viva on it --05 mark ---------- Total= 20 mark	40

B) Internal test pattern (half an hour test)

Questions	**Options**	**Marks**
Q.1	20 objective questions, all compulsory, each question with 4 options; (half mark each)	10
Q.2	Attempt any two numerical out of four. (3 marks each)	06
Q.3	Attempt any one numerical out of two. (4 marks each)	04
	Total marks	**20**

C) External examination - 60 % = 60 marks

Semester-end Theory Assessment - 60 marks

1. Duration - These examinations shall be **2 hours** duration.
2. Paper Pattern:
   I. There shall be **5** questions each of **12** marks. On each unit there will be one question & last question will be based on all the 4 units.
   II. All questions shall be compulsory with internal choice within the questions.

Questions	Options	Marks	Questions on
Q.1)A)	Any 1 out of 2	6	Unit I
Q.1)B)	Any 1 out of 2	6	
Q.2)A)	Any 1 out of 2	6	Unit II
Q.2)B)	Any 1 out of 2	6	
Q.3)A)	Any 1 out of 2	6	Unit III
Q.3)B)	Any 1 out of 2	6	
Q.4)A)	Any 1 out of 2	6	Unit IV
Q.4)B)	Any 1 out of 2	6	
Q.5)A)	Any 1 out of 2	3	Unit I
Q.5)B)	Any 1 out of 2	3	Unit II
Q.5C)	Any 1 out of 2	3	Unit III
Q.5)D)	Any 1 out of 2	3	Unit IV

Practical Examination Pattern:

(A) Internal Examination:

Sr. No.	Activity	Practical-Group-A (Marks)	Practical-Group-B (Marks)
1.	**Seminar on one experiment:** Content- 2 mark, Presentation-2 mark, Q(Teacher) --2 mark Q(Student) -2 mark.	8	8
2.	**Continuous Assessment** (2 mark per experiment/ 8 regular and 4 skill experiment)	24	24
3.	**Main Journal** (1 mark per regular experiment)	8	8
	Total (1+2+3)	**40**	**40**
	Requirement for the certification **8 Skill experiments and 16 regular experiments**		

(B) External (Semester end practical examination):

Particulars	Practical I (Marks)	Practical II(Marks)
Laboratory work	50	50
Viva	10	10
Total	**60**	**60**

PRACTICAL BOOK/JOURNAL

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Coordinator / In-charge of the department; failing which the student will not be allowed to appear for the practical examination.

Overall Examination and Marks Distribution Pattern

Semester V

Course	RUSPHY501 (Marks)			RUSPHY502 (Marks)			RUSPHY503 (Marks)			RUSPHY504 (Marks)			Total (Marks)
	Int.	Ext.	Total	I	E	T	I	E	T	I	E	T	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400

Course	RUSPHYP501 (Marks)			RUSPHYP502 (Marks)			Total (Marks)
	Int.	Ext.	Total	Int.	Ext.	Total	
Practicals	40	60	100	40	60	100	200

(GRAND TOTAL MARKS: 600)

Course Code: RUSPHY601

Course Title: Classical Mechanics& Non-Linear Mechanics

Academic year 2023-24

Course Outcomes:

After successful completion of this course, a student will be able to:

CO1: Understanding the modification of Newton's second law by using the concepts of gravitation.

CO2: Study the anharmonic motion of particles and framing the relation for the same.

CO3: Implement formulation of mechanical problem in Lagrange's equations and concept of constraints.

CO4: Explore Application of D'Alembert's principle and Lagrange's equations to Physical configurations.

DETAILED SYLLABUS

COURSE CODE	Unit	TITLE	Credits/ lectures
RUSPHY601		**Classical Mechanics& Non Linear Mechanics**	**4 credits**
	I	**Central Force**	**15 lectures**
		Motion under a central force, central force inversely proportional to the square of the distance, Elliptical orbits. The Kepler's problem. Hyperbolic Orbits: The Rutherford problem – Scattering cross section. **KRS: Art. 3.13 to 3.16** Moving origin of co-ordinates, Rotating co-ordinate systems, Laws of motion on the rotating earth, Foucault pendulum, Larmor's theorem (with proof) **KRS: Art. 7.1 to 7.5**	
	II	**Lagrange's equations**	**15 lectures**
		Lagrange's equations: D'Alembert's principle, generalized coordinates, Lagrange's equations using D'Alembert's principle, Examples, Systems subject to constraints, Examples of systems subject to constraints, Constants of motion and ignorable coordinates. **KRS: Art. 9.1 to 9.6; G:1.4**	
	III	**Kinematics**	**15 lectures**
		Kinematics of moving fluids, Equation of motion for an ideal fluid, Conservation laws for fluid motion, Steady flow. **KRS: Art. 8.6 to 8.9** The rotation of a Rigid body: Motion of a rigid body in space,	

		Euler's equations of motion for a rigid body, Euler's angles, Heavy symmetrical top (without notation). **KRS: Art. 11.1, 11.2, 11.4, 11.5;** **BO: 6.7**	
	IV	**Non-linear mechanics**	**15 lectures**
		Non-linear mechanics: Qualitative approach to chaos, The anharmonic oscillator, Numerical solution of Duffing's equation, Transition to chaos: Bifurcations and strange attractors, Aspects of chaotic behaviour. **BO: Art. 11.1, 11.3 to 11.5**	

References:

1. Mechanics by Keith R. Symon **(KRS)**
2. Classical Mechanics – A Modern Perspective by V. D Barger & M. S Olsson **(BO)**
3. Classical Mechanics by Herbert Goldstein **(G)**

Additional References:

1. An Introduction to Mechanics – Daniel Kleppner& Robert Kolenkow
2. Chaotic Dynamics – An Introduction – Baker and Gollup

Course Code: RUSPHY602

Course Title: Electronics

Academic year 2023-24

Course Outcomes:

After successful completion of this course, a student will be able to:

CO1: Understand the basic electronic components FET, MOSFET, SCR and their working wrt circuit applications.

CO2: Understand the selection and requirement of components based on component characteristics for various applications.

CO3: Understand the theory and applied aspects of OP-Amp and 555 Timer.

CO4: Understand the circuit assembling of various devices.

CO5: Understand DC power supply, Transistor Multivibrators, **Logic** families- flip-flops and counters.

CO6: Understand Electronic communication techniques of modulations.

DETAILED SYLLABUS

COURSE CODE	Unit	TITLE	Credits/ lectures
RUSPHY602		**Electronics**	**4 credits**
	I	**FET and SCR:**	**15 lectures**
		Field Effect Transistors: JFET: Basic ideas, Drain Curve, The trans-conductance curve, Biasing in the ohmic region and the active region, Trans-conductance, JFET common source amplifier, JFET analog switch, multiplexer, voltage controlled resistor, Current sourcing. MOSFET: Depletion and enhancement mode, MOSFET operation and characteristics, digital switching. Thyristors: SCR – Working, Equivalent circuit, important terms, I-V Characteristics, SCR as a switch, half wave rectifier and full wave rectifier. TRIAC: Construction, Operation, I-V Characteristics, Applications. DIAC: Construction, Operation, Characteristics and applications. **1. MB: Art. 13.1 to 13.9, 14.1, 14.2, 14.4, 14.6.** **2. VKM: Art. 20.1 to 20.10, 21.1 to 21.6, 21.8, 21.9,**	

		21.10. **3. VKM: Art 7.7 to 7.11. MB: 7.10.**	
	II	**Regulated DC power supply, Differential Amplifier and Transistor Multivibrators**	**15 lectures**
		Regulated DC power supply: Supply characteristics, series voltage regulator, short circuit protection (current limit and fold back) Monolithic linear IC voltage regulators. (LM 78XX, LM 79XX, LM 317). Differential Amplifier using transistor: The Differential Amplifier, DC and AC analysis of a differential amplifier, Input characteristic-effect of input bias, Off-set current and input offset voltage on output, common mode gain, CMRR. Transistor Multivibrators: Astable, Monostable and Bistable Multivibrators, Schmitt trigger. **1. MB: Art 17.1 to 17.5.** **2.KVR:Art. 14.5.2.1, 14.5.2.5, 14.5.2.6, 14.5.4.1.** **3.MB: Art. 20.5, 20.8, 21.4, 22.7,22.8, 23.2.** **MH: 16.14**	
	III	**Operational Amplifier and 555 Timer**	**15 lectures**
		Op Amp Applications: Log amplifier, Instrumentation amplifiers, Voltage controlled current sources (grounded load), First order Active filters, Astable using OP AMP, square wave and triangular wave generator using OPAMP, Wein-bridge oscillator using OP AMP. 555 Timer: Block diagram, Triggered linear ramp generator. **1. MB: Art. 23.7 to 23.9.** **2. ML: Art. 6.2, 6.4, 6.6, 6.7, 7.2 to 7.4.**	
	IV	**Logic families**	**15 lectures**
		Logic families: Standard TTL NAND, TTL NOR, Open collector gates, Three state TTL devices, MOS inverters, CMOS NAND and NOR gates, CMOS characteristics. Applications of JK flip flop: Types of registers, 4-bit shift register (serial in-serial out), Asynchronous counters, 4-bit up-down counter, MOD-3, MOD-5, Decade counter, Shift counter. Electronic communication techniques: Radio broadcasting, Transmission and reception, Modulation, Amplitude modulation, Modulation factor, Analysis of amplitude modulated wave, Side band frequencies in AM wave, Transistor amplitude modulator, Power in AM wave, Limitations of AM, Frequency modulation. (Qualitative) **1 ML: Art 10.1, 10.2, 11.1, 11.3 to 11.5, 11.7.**	

		2. MB: Art 24.1, 24.3, 24.4. **3. VKM: Art. 16.1 to 16.11.**	

References:

1. MB: Electronic Principles: A. P. Malvino and D.J. Bates (7th Ed.) – (TMH).

2. VKM: Principles of Electronics: V.K. Mehta and Rohit Mehta. S. Chand Publications. (11th Ed.).

3. KVR: Functional Electronics: K.V. Ramanan (TMH).

4. ML: Digital Principles and Applications: Malvino and Leach (4th Ed) (TMH).

5. MH: Integrated Electronics: Millman & Halkias Mc Graw Hill International.

Additional References:

1. Electronic Devices and Circuits: S. Salivahanan, N. Suresh Kumar and A. Vallavaraj. (2nd Ed.) (Tata McGraw Hill)
2. Pulse, Digital & Switching Waveforms: Millman & Taub. (TMH)

Course Code: RUSPHY603

Course Title: Nuclear Physics

Academic year 2023-24

Course Outcomes:

After successful completion of this course, a student will be able to:

CO1: Distinguish Gamow theory of alpha decay and derive Geiger- Nuttal law.

CO2: Compare the performances of different accelerators.

CO3: Evaluate each term involved in Weizsacher 's semi empirical mass formula and derive the equation of it.

CO4: Distinguish of discovery of basic elementary particle.

CO5: Understand the basics of Meson theory of nuclear force.

CO6: Understand the different elementary particle and their conservation laws.

CO7: Demonstrate quantitative problem-solving skills in all the topics covered.

DETAILED SYLLABUS

COURSE CODE	Unit	TITLE	Credits/ lectures
RUSPHY603		**Nuclear Physics**	**4 credits**
	I	**Alpha & Beta Decay**	**15 lectures**
		Alpha Decay: Velocity, energy, and Absorption of alpha particles: Range, Ionization and stopping power, Nuclear energy levels. Range of alpha particles, alpha particle spectrum, Fine structure, long range alpha particles, Alpha decay paradox: Barrier penetration (Gamow's theory of alpha decay and Geiger-Nuttal law), Beta decay: Introduction, Velocity and energy of beta particles, Energy levels and decay schemes, Continuous beta ray spectrum-Difficulties encountered to understand it, Pauli's neutrino hypothesis, Detection of neutrino, Energetics of beta decay. **K: 13.1,13.2,13.5; P: 4. II. 1, 4. II. 2, 4. II. 3, 1.II.3** **K:14.1,14.7 P: 4.III.1,4.III.2, 4.III.3, 4.III.5; G: 5.5.**	
	II	**Gamma Decay & Nuclear Models**	**15 lectures**
		Gamma decay: Introduction, Internal conversion, nuclear isomerism, Mossbauer effect Nuclear Models: Liquid drop model, Weizsacher's semi-	

		empirical mass formula, Mass parabolas - Prediction of stability against beta decay for members of an isobaric family, Stability limits against spontaneous fission. Shell model (Qualitative), Magic numbers in the nucleus **P 4. IV. 1, 4. IV. 3, 4. IV. 4, 9.4.** **P: 5.1, 5.3, 5.4, 5.5. AB: 11.6-pages (460,461)**	
	III	**Particle Accelerators & Energy Generation**	**15 lectures**
		Particle Accelerators: Van de Graff Generator, Cyclotron, Synchrotron, Betatron and Idea of Large Hadron Collider Nuclear energy: Introduction, Asymmetric fission - Mass yield, Emission of delayed neutrons, Nuclear release in fission, Nature of fission fragments, Energy released in the fission of U235, Fission of lighter nuclei, Fission chain reaction, Neutron cycle in a thermal nuclear reactor (Four Factor Formula), Nuclear reactors, Natural fusion, Possibility of controlled fusion **P: 1.I.4 (i), 1.I.4 (ii), 1.I.4 (iii), 1.I.4 (iv), AB 15.7** **P: 6.1, 6.3 to 6.9, 9.6, 9.7**	
	IV	**Meson theory & Elementary particles**	**15 lectures**
		Meson theory of Nuclear Force- A qualitative discussion Elementary particles: Introduction, Classification of elementary particles, Particle interactions, Conservation laws(linear &angular momentum ,energy, charge, baryon number & lepton number),particles and anti-particles(Electrons and positrons, Protons and anti-protons, Neutrons and anti- neutrons, Neutrinos and anti-neutrinos), Photons, Mesons, Quark model(Qualitative). **1. P:8.6** **2. T: 18.1, 18.2,18.3, 18.4, 18.5 to 18.9 AB: 13.5**	

References

1. AB: Concepts of Modern Physics: Arthur Beiser, Shobhit Mahajan, S Rai Choudhury (6th Ed.) (TMH).
2. P: Nuclear Physics: S.B. Patel (Wiley Eastern Ltd.).
3. K: Nuclear Physics: Irving Kaplan (2nd Ed.) (Addison Wesley).
4. G: Nuclear Physics: S. N. Ghoshal (S. Chand & Co.)
5. T: Nuclear Physics: D. C. Tayal (Himalayan Publishing House) 5th Ed.

Additional References.

1. Modern Physics: Kenneth Krane (2nd Ed.) John Wiley & Sons.
2. Atomic & Nuclear Physics: N Subrahmanyam, Brij Lal. (Revised by JivanSeshan.) S. Chand.
3. Atomic & Nuclear Physics: A B Gupta & Dipak Ghosh Books & Allied (P) Ltd.
4. Introduction to Elementary Particles: David Griffiths, Second Revised Edition, Wiley-VCH

Course Code: RUSPHY604

Course Title: Special Theory of Relativity

Academic year 2023-24

Course Outcomes:

After successful completion of this course, a student will be able to:

CO1: Understand the Lorentz transformation equation.

CO2: Study the concepts of Michelson- Morley experiment, Doppler s effect.

CO3: Comparison of general and special theory of relativity.

CO4: Understand the relativistic Mechanics.

CO5: Understand relativistic electromagnetism.

CO6: Solving conceptual numerical by using above concepts

DETAILED SYLLABUS

COURSE CODE	Unit	TITLE	Credits/ lectures
RUSPHY604		**Special Theory of Relativity**	**4 credits**
	I	**Special Theory of Relativity & Relativistic Kinematics**	**15 lectures**
		Experimental background of special theory of relativity and relativistic kinematics: Galilean transformations, Newtonian relativity, Electromagnetism and Newtonian relativity. Attempts to locate absolute frame: Michelson-Morley experiment, Attempts to preserve the concept of a preferred ether frame: Lorentz Fitzgerald contraction and ether drag hypothesis, Attempt to modify electrodynamics, postulates of the special theory of relativity. Relativistic Kinematics: Simultaneity, Derivation of Lorentz transformation equations, Some consequences of the Lorentz transformation equations: length contraction, time dilation and meson experiment, The observer in relativity **RR: 1.1 to 1.6, 1.8, 1.9, 2.1, to 2.5**	
	II	**Relativistic Kinematics**	**15 lectures**
		Relativistic Kinematics (continued): The relativistic addition of velocities and acceleration transformation	

		equations, Aberration and Doppler Effect in relativity, The common sense of special relativity. The Geometric Representation of Space-Time: Space-Time Diagrams, Simultaneity, Length contraction and Time dilation, The time order and space separation of events, The twin paradox **RR 2.6 to 2.8, Supplementary topics A1, A2, A3 , B1 ,B2 , B3**	
	III	**Relativistic Dynamics**	**15 lectures**
		Relativistic Dynamics: Mechanics and Relativity, the need to redefine momentum, Relativistic momentum, Alternative views of mass in relativity, The relativistic force law and the dynamics of a single particle, The equivalence of mass and energy, The transformation properties of momentum, energy and mass. **RR 3.1 to 3.7**	
	IV	**Relativity and Electromagnetism**	**15 lectures**
		Relativity and Electromagnetism: Introduction, The interdependence of Electric and Magnetic fields, The Transformation for E and B, The field of a uniformly moving point charge, Force and fields near a current-carrying wire, Force between moving charges, The invariance of Maxwell's equations. The principle of equivalence and general relativity, Gravitational red shift. **RR 4.1 to 4.7 Supplementary topic C1, C2, C3, C4**	

References:

1. RR: Introduction to Special Relativity: Robert Resnick (Wiley Student Edition)

2. Special theory of Relativity: A. P. French

Semester VI------Practicals

RUSPHYP06 – Physics Laboratory Course

The T. Y. B. Sc. Syllabus integrates the regular practical work with a series of demonstration and skill experiments. During the teaching and examination of Physics laboratory work, simple modifications of experimental parameters may be attempted. Attention should be given to basic skills of experimentation which include:

i. Understanding relevant concepts.
ii. Planning of the experiments
iii. Layout and adjustments of the equipment
iv. Recording of observations and plotting of graphs
v. Calculation of results and estimation of possible errors in the observation of results.

Regular Physics Experiments: A minimum of 8 experiments from each of the practical course are to be performed and reported in the journal.

Demo Experiments: The demonstration experiments are to be performed by the teacher in the laboratory and students should be encouraged to participate and take observation wherever possible. Demonstration experiments are designed to bring about interest and excitement in Physics. Students are required to enter details of these 'demo' experiments in their journal. The certified journal must contain a minimum of **16 regular experiments (8 from each practical course), with a minimum of 8 demonstration experiments** in semester VI. A separate index and certificate in journal is a must for each semester course. There will be two turns of three hours each for the examination of practical courses

Demonstration Experiments:

1.	Amplitude Modulation
2.	Frequency Modulation
3.	Iodine absorption spectra
4.	Equation Solver
5.	Michelson's interferometer
6.	CRO, power Supply, Signal Generator: Block Diagram
7.	Firing of TRIAC using DIAC
8.	Use of PC / Microprocessor to control real world parameters
9.	Standing waves in liquid using Ultrasonic waves
10.	Zeeman Effect
11.	Velocity of Sound.
12.	Seven segment display.
13.	Data sheets reading for Diodes, transistor, Op-Amp, and Optoelectronic devices
14.	Circuit Designing – single stage amplifier, Transistor Multivibrator etc. and designing on Breadboard.

Group A (RUSPHYP601)		1.	Quincke' s method for surface tension of Mercury	
		2.	Lloyd's mirror	
		3.	Double refraction	
		4.	FET characteristics	
		5.	UJT as relaxation oscillator	
		6.	SCR characteristics	
		7.	Photodiode characteristics	
		8.	Applications of MOSFET	
		9.	SCR-Half Wave rectifier	
Group B (RUSPHYP602)		1.	Capacitance by using parallel bridge	
		2.	Calibration of Si diode & copper constantan thermocouple as temperature sensor	
		3.	Maxwell's, desauty' s and Maxwell -Wein Bridge	
		4.	555 timer as Monostable Multivibrator	
		5.	555 timer as Astable Multivibrator	
		6.	Transistor series regulator – fold-back	
		7.	555 timer as ramp generator	
		8.	LM317 as current regulator	
		9.	OPAMP as Monostable /Astable multivibrator using breadboard	

MODALITY OF ASSESSMENT-SEM VI

Theory Examination Pattern: -

A) Internal Assessment - 40% = 40 marks.

Theory Paper- Paper code	Test Marks	Assignment	Marks distribution (Assignment)	Total Marks per paper
Math. Methods of Physics, Thermal & Statistical Physics RUSPHY501	20	15 questions on units1,2,3	Assessment- 15 mark Viva on it --05 mark ---------- Total= 20 mark	40
Solid State Physics RUSPHY502	20	15 questions on units1,2,3	Assessment- 15 mark Viva on it --05 mark ---------- Total= 20 mark	40
Atomic & Molecular Physics RUSPHY503	20	15 questions on units1,2,3	Assessment- 15 mark Viva on it --05 mark ---------- Total= 20 mark	40
Electrodynamics RUSPHY504	20	15 questions on units1,2,3	Assessment- 15 mark Viva on it --05 mark ---------- Total= 20 mark	40

B) Internal test pattern (half an hour test)

Questions	options	Marks
Q.1	20 objective questions, all compulsory, each question with 4 options; (half mark each)	10
Q.2	Attempt any two numerical out of four. (3 marks each)	06
Q.3	Attempt any one numerical out of two. (4 marks each)	04
	Total marks	**20**

C) External examination - Semester-end Theory Assessment - 60 marks

vi. Duration - These examinations shall be **2 hours in** duration.

vii. Paper Pattern:

III. There shall be **5** questions for each of **12** marks. On each unit there will be one question & last question will be based on all the 4 units.

IV. All questions shall be compulsory with internal choice within the questions.

Questions	Options	Marks	Questions on
Q.1)A)	Any 1 out of 2	6	Unit I
Q.1)B)	Any 1 out of 2	6	
Q.2)A)	Any 1 out of 2	6	Unit II
Q.2)B)	Any 1 out of 2	6	
Q.3)A)	Any 1 out of 2	6	Unit III
Q.3)B)	Any 1 out of 2	6	
Q.4)A)	Any 1 out of 2	6	Unit IV
Q.4)B)	Any 1 out of 2	6	
Q.5)A)	Any 1 out of 2	3	Unit I
Q.5)B)	Any 1 out of 2	3	Unit II
Q.5C)	Any 1 out of 2	3	Unit III
Q.5)D)	Any 1 out of 2	3	Unit IV

Practical Examination Pattern:

(A)Internal Examination:

Sr. No.	Activity	Practical-Group-A (Marks)	Practical-Group-B (Marks)
1.	**Seminar on one experiment :** Content- 2 mark Presentation-2 mark Q(Teacher) --2 mark Q(Student) -2 mark	8	8
2.	**Continuous Assessment** (2 mark per experiment/ 8 regular and 4 demo experiment)	24	24
3.	**Main Journal** (1 mark per regular experiment)	8	8
	Total (1+2+3)	40	40
	Requirement for the certification 8 demo experiments and 16 regular experiments		

(B) External (Semester end practical examination):

Particulars	**Practical I** (Marks)	**Practical II** (Marks)
Laboratory work	*50*	*50*
Viva	*10*	*10*
Total	**60**	**60**

PRACTICAL BOOK/JOURNAL

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Coordinator / In-charge of the department; failing which the student will not be allowed to appear for the practical examination.

Overall Examination and Marks Distribution Pattern

Semester---- VI

Course	**RUSPHY601 (Marks)**			**RUSPHY602 (Marks)**			**RUSPHY603 (Marks)**			**RUSPHY604 (Marks)**			**Total (Marks**
	Int.	Ext.	Total	I	E	T	I	E	T	I	E	T	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400

Course	**RUSPHYP601 (Marks)**			**RUSPHYP602 (Marks)**			**Total (Marks)**
	Int.	Ext.	Total	Int.	Ext.	Total	
Practicals	40	60	100	40	60	100	200

(GRAND TOTAL MARKS: 600)

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