AC/II(20-21).2.RUS10

S.P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for

Program: B.Sc. (Physics)

Program Code: RUSPHY

(Choice Based Credit System for the academic year 2022-23)

PROGRAM OUTCOMES

PO	PO Description **A student completing Bachelor's degree in Physics program will be able to:**
PO 1	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.
PO 2	Evaluate scientific ideas critically, analyse problems, explore options for practical demonstrations, illustrate work plans and execute them, organise data and draw inferences
PO 3	Explore and evaluate digital information and use it for knowledge upgradation. Apply relevant information so gathered for analysis and communication using appropriate digital tools.
PO 4	Ask relevant questions, understand scientific relevance, hypothesize a scientific problem, construct and execute a project plan and analyze results.
PO 5	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.
PO 6	Apply scientific information with sensitivity to values of different cultural groups. Disseminate scientific knowledge effectively for upliftment of the society.
PO 7	Follow ethical practices at work place and be unbiased and critical in interpretation of scientific data. Understand the environmental issues and explore sustainable solutions for it.
PO 8	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 SPECIFIC OUTCOMES

PSO	Description **A student completing Bachelor's Degree in BSc program in the subject of Physics will be able to:**
PSO 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
PSO 2	To demonstrate comprehensive, quantitative and conceptual understanding of the core areas of physics.
PSO 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.
PSO 4	To explore and deduce quantitative results in the extents of physics.
PSO 5	To use contemporary experimental apparatus and analysis tools to acquire, analyze and interpret scientific data in the extents of physics.
PSO 6	To communicate scientific results effectively in presentations or posters in the extents of physics to both the scientists and public at large.
PSO 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.

PROGRAM OUTLINE

YEAR	SEM	COURSE CODE Core Course	COURSE TITLE	CREDITS
2022-23	**I**	**RUSPHY101**	**Mechanics, Optics &Thermodynamics**	**2**
			Unit-I: Mechanics	
			Unit-II: Optics	
			Unit-III-Thermodynamics	
		RUSPHY102	**Nuclear Physics & Quantum Mechanics**	**2**
			Unit-I: Nuclear Physics	
			Unit-II: Modern Physics	
			Unit-III: Introduction to Quantum Mechanics	
		RUSPHYP01	**Physics Laboratory Course** (Group A + Group B + Skill Experiments)	**2**
			Total	**6**

YEAR	SEM	COURSE CODE Core Course	COURSE TITLE	CREDITS
2022-23	**II**	**RUSPHY201**	**Mathematical Physics & Mechanics**	**2**
			Unit-I: Vector algebra and Vector calculus	
			Unit-II: Differential equations and Transient response of circuits	
			Unit-III- Harmonic Oscillations and Wave Motion	
		RUSPHY202	**Electronics & Electricity**	**2**
			Unit-I: Circuit theorems and Alternating current	
			Unit-II : Digital and Analog electronics	
			Unit-III : Analog Electronics- Transistor Biasing	
		RUSPHYP02	**Physics Laboratory Course** (Group A + Group B + demonstration Experiments)	**2**
			Total	**6**

YEAR	SEM	COURSE CODE	TITLE	Credits
2022-23	**III**	**RUSPHY301**	**Mechanics & Thermodynamics**	**2**
			Unit I: Mechanics	
			Unit II: Thermal Physics	
			Unit III: Thermodynamics & Statistical Physics	
		RUSPHY302	**Vector calculus, Analog and Digital Electronics**	**2**
			Unit I: Vector Calculus	
			Unit II: Analog Electronics	
			Unit III: Analog and Digital Electronics	
		RUSPHY303	**Applied Physics I**	**2**
			Unit I: Acoustics, laser and Fiber Optics	
			Unit II: Biophysics	
			Unit III: Materials- Properties and Applications	
		RUSPHP03	**Practicals based on above three courses**	**3**
			Total	**9**

YEAR	SEM	COURSE CODE	TITLE	Credits
2022-23	**IV**	**RUSPHY401**	**Optics, Applied optics**	**2**
			Unit I: Diffraction-Fraunhofer, Resolving Power	
			Unit II: Polarization	
			Unit III: Applied Optics	
		RUSPHY402	**Introduction to Quantum Mechanics**	**2**
			Unit I: Quantum Mechanics	
			Unit II: Applications of Schrodinger's Steady State Equation	
			Unit III: Schrödinger's equation and Hydrogen Atom	
		RUSPHY403	**Applied Physics II**	**2**
			Unit I: Synthesis of Nanomaterials	
			Unit II: Analysis techniques	
			Unit III: Microprocessor-8085	
		RUSPHP04	**Practicals based on above three courses**	**3**
			Total	**9**

YEAR	SEM	COURSE CODE	TITLE	Credit
2022-23	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
2022-23	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

AC/II(20-21).2.RUS10

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Ramnarain Ruia Autonomous College

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Syllabus for F.Y.B.Sc. SEM I & II

Program: B.Sc. (Physics)

Program Code: RUSPHY

(Choice Based Credit System for the academic year 2022-23)

CORE COURSE- Course Code: RUSPHY101

Course Title: Mechanics, Optics & Thermodynamics

Academic year 2022-23

Learning Objectives: After successful completion of this course, students would acquire the following knowledge & skills:

(1) The ability to apply the principles of physics to solve innovative and unfamiliar problems
(2) The ability to explore and deduce quantitative results in the extents of physics
(3) The ability to use contemporary experimental apparatus and analysis tools to acquire, analyze and interpret scientific data
(4) The ability to apply laws of mechanics and thermodynamics and to communicate scientific results effectively in presentations or posters
(5) A comprehensive, quantitative and conceptual understanding of the core areas of mechanics, optics, thermodynamics at a level attuned with graduate programs in physics at peer institutions

Learning Outcomes: After the successful completion of this course, the student will be able to:

1. Understand the concepts of Center of Mass and Linear momentum. Apply it to two- and three-dimensional objects. Apply Newton's Second Law to the motion of system of particles.
2. Identify the concept of impulse by its definition. Relate it to momentum. Apply the relationship between impulse, average force, and the time interval taken by the impulse.
3. Apply the conservation of linear momenta to relate the initial momenta of the particles to their momenta at a later instant, in case of isolated system of particles.
4. Distinguish between all types of collisions. Apply the conservation of momentum for an isolated one-dimensional collision to relate the initial momenta of the objects to their momenta after the collision. Identify that in an isolated system, the momentum and velocity of the center of mass are not changed even if the objects collide.
5. Apply the conservation laws for both the total energy and the net momentum of the colliding bodies, for isolated elastic collisions in one dimension.
6. Distinguishing the concepts of Interference, aberrations, and Diffraction and its practical application to Eyepieces in optical instruments.
7. Apply the laws of thermodynamics to formulate the relations necessary to analyze a thermodynamic process.
8. Distinguishing the concepts of specific heat, heat capacity and entropy processes.

DETAILED SYLLABUS- RUSPHY101

CORE COURSE- Course Code:	Unit	Title	Credits/ lectures
RUSPHY101		**Mechanics, Optics & Thermodynamics**	**2 credits**
Unit I	**I**	**Mechanics**	**15 lectures**
		Center of Mass, Motion of the Center of Mass, Linear momentum of a Particle, Linear momentum of a System of Particles. Linear momentum with respect to CM coordinate (shift of origin from Lab to CM). Conservation of Linear Momentum-Elastic and Inelastic collision, coefficient of restitution. Numerical Some Applications of the Momentum Principle System of Variable Mass, Numerical (**HRW**) part I -9.1, 9.2, 9.3, 9.4, 9.5, 9.6,9.7 **Elasticity** – Review of elastic constants Y, K, η and σ Equivalence of shear strain to compression and extension strains, Relation between elastic constants Couple for twist in cylinder Numerical from all topics. **HP**: 15.2A, 15.3A, 15.4A, 15.5A, 15.7A	
Unit II	**II**	**Optics**	**15 lectures**
		Equivalent focal length of two thin lenses, thick lens, cardinal points of thick lens, Ramsden & Huygens Eyepiece. **Aberration**: Spherical Aberration-Derivation - reduction in spherical aberration **BSA**: 6.1, 6.2, 6.2.1 to 6.2.3, 10.10, 10.11 **BSA**: 9.2,9.3,9.4,9.5-9.5.1,9.6,9.10,9.11,9.12,9.13(1) (2) **Interference:** Interference in thin films, Fringes in Wedge shaped films-Application-antireflection coating **Diffraction:** Fresnel's diffraction: Introduction, Huygens's -Fresnel's theory, Fresnel's assumptions, Distinction between interference and	

		diffraction, Fresnel and Fraunhofer types of diffraction, Half period zones, Diffraction due to single edge-Intensity profile on screen, Diffraction due to narrow wire. **BSA**: 15.1, 15.2.1 to 15.2.5, 15.3, 15.5, 15.6.1, 15.6.2 **BSA:** 17.1, 17.2, 17.3, 17.6, 17.7, 17.10, 17.10.1, 17.10.2, 17.11, 17.12, 18.1, 18.2, 18.2.1, 18.4, 18.4.2, 18.7, 18.7.1, 18.7.2, 18.7.8(i to vi)	
Unit III	**III**	**Thermodynamics**	**15 lectures**
		Review-- Zeroth law of Thermodynamics; Concept of Heat; First law of Thermodynamics. Nonadiabatic process & Heat as a path function Internal energy; Heat capacity & specific heat Application of first law to simple processes General Relations from the first law; Indicator diagrams **BSH**: 2.1 to 2.12, 4.1 to 4.14 Clausius theorem, Entropy, Entropy of a cyclic process Reversible process, Entropy change, Reversible heat transfer, Principle of increase in entropy, generalized form of first and second law, entropy change of an ideal gas. **(ABG-HR):** 7.9, 7.10, 7.11, 7.12, 7.12.1, 7.12.2, 7.13, 7.14, 7.14.1, 7.14.3, 7.15, 7.16, 7.17	

References:

1. Fundamental of Physics (extended)Halliday, Resnick & Walker (**HRW**) (6th ed.) part I
2. Mechanics by Hans & Puri **(HP)**
3. Mechanics and thermodynamics-Ghosh and basavraju **(GB)**
4. A textbook of Optics by Brijlal, Subramanyam & Avadhanulu **(BSA)**
5. Optics -Jenkins and white **(JW)**
6. Heat,Thermodynamics &Statistical Physics by Brijlal, Subramanyam & Hemne **(BSH)**
7. Thermal Physics, AB Gupta and H. Roy, Book and Allied (P) Ltd, 2009 **(ABG-HR)**

Additional References:

1. Mechanics – Concepts of Physics by H. C Verma (Vol. 1) **(HCV)**
2. Classical Dynamics by Thornton & Marion (5th Ed)
3. Optics by C. L Arora
4. Ref. Jenkins and white-Optics
5. Fundamentals of Optics – Khanna and Gulati
6. Principles of Optics – B. K. Mathur and T. P. Pandya (3rd Ed.)
7. Heat & Thermodynamics by M. W Zemansky & R. H Dittman
8. Basic Thermodynamics by Evylen Guha
9. Theory and Experiments on Thermal Physics – D. K. Chakrabarti (2006 Ed)
10. Thermal Physics -Sears and Zeemansky

CORE COURSE- Course Code: RUSPHY102

Course Title: Nuclear Physics & Quantum Mechanics

Academic year 2022-23

Learning Objectives: After successful completion of this course, students would acquire the following knowledge & skills:

(1) The ability to apply the principles of physics to solve innovative and unfamiliar problems
(2) The ability to explore and deduce quantitative results in the extents of physics
(3) The ability to use contemporary experimental apparatus and analysis tools to acquire, analyze and interpret scientific data
(4) The ability to apply knowledge in Nuclear Physics, Modern Physics and Quantum Mechanics and communicate scientific results effectively in presentations or posters
(5) A comprehensive, quantitative, and conceptual understanding of the core areas of Nuclear Physics, Modern physics, Quantum Mechanics at a level attuned with graduate programs in physics at peer institutions

Learning Outcomes:

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

1. Understand basic knowledge about Nucleus.
2. Identify practical methods for the detection of specific types of nuclear particles, by taking into account various interactions of the particles with matter
3. Acquire knowledge of the Radioactivity Phenomenon, distinguish between different types of equilibria associated and its application to the abundance of radioactive species in nature.
4. Explore possibility of practical application of radioactivity in the fields of Agriculture, medicine, food.
5. Evaluate energy involved in endothermic and exothermic Nuclear reactions and practical exploitation of fission energy for the society. And further interest of scientific community in the research on Nuclear Fusion.
6. Understand the concepts of physical significance of wavefunction and its properties.
7. Formulate an expression for Schrodinger's time dependent wave equation and time independent wave function.
8. Distinguish between wave equation and Schrodinger's wave equation to find out transition from classical Physics to Quantum Physics in order to explain physics at the level of atom.

DETAILED SYLLABUS- RUSPHY102

CORE COURSE- Course Code:	Unit	Title	Credits/ lectures
RUSPHY102		**Nuclear Physics & Quantum Mechanics**	**2 credits**
Unit I	**I**	**Nuclear Physics**	**15 lectures**
		Rutherford's α-scattering experiment for estimation of nuclear size, Measurement of Nuclear radius – Hofstadter's experiment. **SBP**: 4.1.1, 4.1.2 **Review** -Radioactive Decay, Laws of Radioactive growth & decay, half-life, mean life, units of radioactivity. successive disintegration, radioactive equilibrium (Ideal, Secular & Transient Equilibrium), Determination of age of Earth. Radioactive series, Carbon Dating, Radioactive Isotopes and its applications in Medicine, Food & Agriculture, Industry, Archaeological Field. **SBP**: 2.1, 2.2, 2.3, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13 **IK:** 10.1, 10.2 **AB**: 12.1, 12.2 Interaction between particles and matter-Compton Effect, Ionization chamber, Proportional counter and GM counter, problems **SBP**: 1.1.2, 1.1.3 (I & ii); **IK**: 2.8; BSS: 9.13, 9.14 Nuclear Reactions: Types of Reactions and Conservation Laws. Concept of Compound and Direct Reaction, Q value equation and solution of the Q equation, problems **SBP**: 3.1 to 3.5; **SBS**: 3.3, 3.4, 3.5; 11.2, 11.3, 11.5, 11.6	
Unit II	**II**	**Modern Physics**	**15 lectures**
		Review- Quantum Theory: Black-body Radiation. Stefan-Boltzmann 'law, Wave particle Duality, de-Broglie Waves Experimental Verification of de-Broglie Waves, (G. P Thomson Experiment)-Numerical Heisenberg's Uncertainty Principle, Different forms of Uncertainty principle, Applications of Uncertainty Principle. -problems, Heisenberg's Uncertainty	

		Principle (with thought experiments - γ-ray microscope, electron diffraction experiment.) **SBS**: 2.1 to 2.5, 3.1 to 3.6, 3.9 X-Rays: Production (Coolidge tube), Continuous & Characteristics of x-ray spectra, x-ray diffraction (Laue's diffraction pattern) Bragg's Law, Bragg's x-ray spectrometer, Properties & Applications of x-rays.- problems **SBS**: 6.1, 6.2, 6.3, 6.4; AB: 2.5, 2.6 XRD pattern analysis **SK** -7.5.6	
Unit III	**III**	**Introduction to Quantum Mechanics**	**15 lectures**
		Concept of wave packet, phase velocity, group velocity and relation between them. Physical interpretation of wave function – Max Born Interpretation of wave function. Requirements of Schrodinger's wave function: Schrodinger's time dependent wave equation and time independent wave function (Steady State), Postulates of quantum mechanics. **AB**: 2.2, 2.3, 3.1, 3.2, 3.3, 3.4 MJ: 4.3, 4.4, 4.5, 5.1, 5.2, 5.3 and numerical from chapter 1, 4 and 5 **GA**: 2.1 to 2.10 Analogy between wave equation and Schrodinger's wave equation. (Comparing with optics) Linearity and Superposition, Problems from all topics **MJ**: 4.3, 4.4, 4.5, 5.1, 5.2, 5.3 and numerical from chapter 1, 4 and 5	

References

1. Nuclear Physics ,An Introduction- S. B Patel **(SBP)**
2. Concepts of Modern Physics by Arthur Beiser **(AB)**
3. Nuclear Physics-Irvin Kaplan **(IK)**
4. Atomic and Nuclear Physics – N Subramanyam, Brijlal & Seshan **(SBS)**
5. Nano technology-Principles and Practices--Sulabha Kulkarni **(SK)**
6. Quantum Mechanics by G. Arul Das **(GA)**
7. Quantum Mechanics: A text book for undergraduates by Mahesh Jain **(MJ)**

Additional References:

1. Atomic Physics by S. N Ghoshal
2. Nuclear Physics by S. N Ghoshal
3. Atomic and Nuclear Physics - A. B. Gupta and Deepak Ghosh
4. Basic Quantum Mechanics by Ajoy Ghatak
5. Elements of x-ray diffraction by B. D Cullity.

		SEM-I PRACTICALS	
		Skill Experiments: 1. Absolute and Relative Error Calculation 2. Graph Plotting 3. Use of Digital Multimeter 4. Use of Screw Gauge, Vernier Calipers, 5. Use of Travelling Microscope 6. Spectrometer (Schuster's Method)	
		Regular Experiments: Group A	**Credit 1**
		1. Torsional oscillations	
		2. Y by vibration	
		3. Surface Tension	
		4. Single slit Diffraction	
		5. Narrow wire diffraction-Interference fringes	
		6. J by Electrical method	
		7. Thermistor Characteristics	
		8. Ultrasonic Interferometry to find out the adiabatic compressibility of liquids.	
		9. η by Poiseuille's' s method	
		Regular Experiments: Group B	**Credit 1**
		1. Combination of lenses	
		2. Spectrometer (Angle of Prism)	
		3. Spectrometer (Minimum Angle of deviation & μ)	
		4. Newton's ring / Wedge shaped film	
		5. Verification of Stefan's law	
		6. XRD pattern analysis using Origin	
		7. GM-counter simulation	

- **Any one out of the following is equivalent to two experiments from Group A and/or Group B**
  1. Student doing **mini-project** up to the satisfaction of the Professor or In-Charge of the Practical.
  2. **Study Tour**: Students participated in study tour must submit a **study tour report**
- **Minimum 10 experiments (5 from each group)** from the list should be completed in the first semester and **6 minimum demo-experiments** are to be reported in the Journal
- **Certified Journal is a MUST** for a candidate to be eligible in the **end semester practical examination**.
- **Internal component of Practical examination** Evaluation is based on regular experiments and skill experiments, Journal work
- For **External practical examination**, student will be **examined in 2 regular**

experiments (one from each group).

MODALITY OF ASSESSMENT –SEM-I

Theory Examination Pattern:

A) Internal Assessment – (40% of 100 marks) = **40 marks.**

Theory Paper-Paper code	Internal test marks	Assignment	Marks distribution (Assignment)	Total Marks per paper
Mechanics, Optics &Thermodynamics RUSPHY101	**20**	15 questions on units1,2,3	Assessment- 15 Viva on it --05 ---------- **Total= 20 mark**	**40**
Nuclear Physics & Quantum Mechanics RUSPHY102	**20**	15 questions on units1,2,3	Assessment- 15 Viva on it --05 ---------- **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 % of 100 marks = 60 marks

Semester-end Theory Assessment - 60 marks

1. Duration - These examinations shall be of **2 hours** duration.
2. Paper Pattern: All questions shall be compulsory with internal choice within the questions.

Questions	Options	Marks	Questions on
Q.1)A)	Any 2 out of 4	14	Unit I
Q.1)B)	Any 1 out of 2	01	
Q.2)A)	Any 2 out of 4	14	Unit II
Q.2)B)	Any 1 out of 2	01	
Q.3)A)	Any 2 out of 4	14	Unit III
Q.3)B)	Any 1 out of 2	01	
Q.4)A)	Any 1 out of 2	5	Unit I
Q.4)B)	Any 1 out of 2	5	Unit II
Q.4)C)	Any 1 out of 2	5	Unit III
Total marks		**60**	

Practical Examination Pattern:

(A) Internal Examination:

Sr. No.	Activity	Practical-Group-A (Marks)	Practical-Group-B (Marks)
1.	**Continuous Assessment** (1.5 marks per experiment/ 5 regular and 3 skill experiment)	12	12
2.	**Main Journal** (one mark per experiment for 5 regular and 3 skill experiment)	8	8
	Total (= 1 + 2)	**20**	**20**
	Skill experiments= 06 for certified journal Main experiments = minimum 10 for certified Journal per Semester (5 each from experiment group A and B)		

(B) External (Semester-end practical examination):

Sr. No.	Particulars	Practical-Group-A (Marks)	Practical-Group-B (Marks)
1.	Laboratory work	25	25
2.	Viva	5	5
	Total **(= 1 + 2)**	**30**	**30**

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/Practical- 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

Course	RUSPHY101 (Marks)			RUSPHY102 (Marks)			Total (Marks)
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Practical	20	30	50	20	30	50	100

(GRAND TOTAL MARKS : 300)

CORE COURSE- Course Code: RUSPHY201

Course Title: Mathematical Physics & Mechanics

Academic year 2022-23

Learning Objectives: After successful completion of this course, students would acquire the following knowledge & skills:

1. The ability to apply the principles of physics to solve innovative and unfamiliar problems
2. The ability to explore and deduce quantitative results in the extents of physics
3. The ability to use contemporary experimental apparatus and analysis tools to acquire, analyze and interpret scientific data
4. The ability to communicate scientific results effectively in presentations or posters
5. Able to assimilate the fundamental of mathematical Physics.
6. Student can exercise the application of mathematical physics in realizing the various concept of physics.
7. A comprehensive, quantitative and conceptual understanding of the core areas of 'physics, including mechanics, optics, modern physics, thermodynamics, electrostatics at a level attuned with graduate programs in physics at peer institutions.

Learning Outcomes:

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

1. Recognise the basic mathematical concepts of vector calculus and implementation of them in physical situations.
2. Understand physical significance of various concepts such as gradient, curl and divergence.
3. Evaluating differential equations and its application to Transient response of electrical circuits.
4. Understand basics of Wave Motion, illustrate the application of Lissajous figures on CRO.
5. Differentiate between Travelling & Standing waves on a string and Normal modes of vibrations.
6. Demonstrate quantitative problem solving skills in all the topics covered.

DETAILED SYLLABUS- RUSPHY201

CORE COURSE- Course Code:	Unit	Title	Credits/ lectures
RUSPHY201		**Mathematical Physics & Mechanics**	**2 credits**
Unit I	**I**	**Vector algebra and Vector calculus**	**15 lectures**
		Review-Vector algebra, Laws of Vector algebra, Unit vector, rectangular unit vectors, Components of a vector. Scalar fields, Vector fields, Dot or Scalar product, Cross or Vector product, Commutative and Distributive Laws Scalar Triple product, Vector Triple product (proofs) Applications based on Dot, Cross and Triple products **Ref.-MS: Ch. 1, 2(Omit Reciprocal sets of vectors)** Gradient, divergence and curl: The ∇ operator, Definitions and physical significance of Gradient, Divergence and Curl of a vector, Distributive Laws for Gradient, Divergence and Curl (Omit proofs)	
Unit II	**II**	**Differential equations and Transient response of circuits**	**15 lectures**
		Review-{Introduction, Ordinary differential equations} First order homogeneous, First order non-homogeneous equations with variable coefficients, exact differentials, General first order Linear Differential Equation. Second-order homogeneous and Non-homogenous equations with constant coefficients. Transient response of circuits: Series LR, CR, LCR circuits. Growth and decay of currents/charge CR-Theory, Numerical **CR:**14.1, 14.2, 14.3, CH: 5.1, 5.2, 5.2.1 (A, B, C) (Omit D), 5.2.3	
Unit III	**III**	**Harmonic Oscillations and Wave Motion** **Review**-{Composition of two Collinear Harmonic Oscillations- Linearity & Superposition Principle} Superposition of two Collinear Oscillations having (i) equal frequencies, and (ii) different frequencies (Beats)	**15 lectures**

		Superposition of two mutually perpendicular harmonic oscillations: Graphical & Analytical methods, Lissajous figures with equal & unequal frequencies; its uses **Wave Motion**: Transverse waves on string-differential wave equation, velocity expression Review-Travelling & Standing waves on a string, Normal modes of a string. Group velocity, Phase Velocity-Dispersive medium and non-dispersive medium-relation SPP: 2.4.1, 2.4.3, 2.4.4, 2.4.1, 2.3.4 FC: 1.5 **Introduction to Ultrasonics**-Generation of ultrasonics and Applications. Ref.- CD	

References:

1. Schaum's outline of Theory and problems of Vector Analysis – Murray Spiegel **(MS)**
2. **Schaum's outline -** Vector Analysis and introduction to tensor Analysis – **Murray Spiegel (MS)** –
3. Electricity and Magnetism by D. Chattopadhaya & P. C. Rakshit **(CR)**
4. Fundamentals of Vibrations & Strings by S. P Puri **(SPP)**
5. Berkeley Physics Course, vol. 3, Francis Crawford **(FC)**
6. Fundamentals and applications of ultrasonic waves- Cheeke J., David N**(CD)**
7. Ultrasonics- Methods and Applications by Blitz **(B)**

Additional References:

1. Mathematical Methods in the Physical Sciences -Mary boas
2. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
3. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
4. Additional References:
5. BrijLal,N. Subrahmanyam, JivanSeshan, Mechanics and Electrodynamics, , (S. Chand) (Revised & Enlarged ED. 2005)
6. A K Ghatak, Chua, Mathematical Physics, 1995, Macmillan India Ltd.
7. Ken Riley, Michael Hobsonand Stephen Bence, Mathematical Methods for Physics and Engineering, Cambridge (Indian edition).
8. H. K. Dass, Mathematical Physics, S. Chand & Co.
9. Jon Mathews & R. L. Walker, Mathematical Methods of Physics: W A Benjamin Inc

CORE COURSE- **Course Code:** RUSPHY202

Course Title: Electronics

Academic year 2022-23

Learning Objectives: After successful completion of this course, students would acquire the following knowledge & skills:

1. The ability to apply the principles of physics to solve innovative and unfamiliar problems
2. The ability to explore and deduce quantitative results in the extents of physics
3. The ability to use contemporary experimental apparatus and analysis tools to acquire, analyze and interpret scientific data
4. The ability to communicate scientific results effectively in presentations or posters
5. A comprehensive, quantitative and conceptual understanding of the core areas of physics, including mechanics, optics, modern physics, thermodynamics, electrostatics at a level attuned with graduate programs in physics at peer institutions

Learning Outcomes:

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

1. Understand the basic concepts of electrical circuit theorems, its applications at various levels and basic concepts of working of alternating current circuits.
2. Understand the working of electronic equipment -rectifier
3. Understand the conversion from among various number system viz decimal, Binary and hexadecimal and difference between digital and analog system.
4. Understand the working of digital electronic equipment such digital sensors and adder using logic gates etc.
5. Able to understand the construction and working of bipolar transistor.
6. Designing for the desired biasing of the transistor.
7. Demonstration qualitative problem-solving skills in the topics covered.

DETAILED SYLLABUS-RUSPHY202

CORE COURSE- Course Code:	Unit	Title	Credits/ lectures
RUSPHY202		**Electronics**	**2 credits**
Unit I	**I**	**Circuit theorems, Rectifier, Alternating Current theory**	**15 lectures**
		Circuit theorems: -Thevenin theorem, Norton theorem, Reciprocity theorem, Maximum power transfer theorem. CR: 7.7, 7.8, 7.9, 7.10, 7.11 Bridge rectifier: Efficiency and Ripple factor of Full wave Rectifier, capacitor filter, LC filter, Pi-Filter, Zener diode as voltage stabilizer **VKM**: 9.10 to 9.20, 9.22, 9.2 **Alternating Current:** **Review-**{Sinusoidal AC response of a Resistance, Inductance and a capacitance, Representation of sinusoids by complex numbers} sinusoidal voltage to series RL circuit, sinusoidal voltage series RC circuit, sinusoidal voltage to series RLC circuit, Series and parallel resonance. **CR: 15.1, 15.2, 15.5, 15.6, 15.7, 15.8, 15.9, 15.11**	
Unit II	**II**	**Digital and Analog electronics**	**15 lectures**
		Review - Logic Gates-AND,OR,NOT,NOR,NAND,EX-OR Implementation of basic gates using NAND & NOR gates and their applications VKM: 28.8 to 28.14, 28.19, LMS: 6.7 binary addition and subtraction Half Adder, Full adder Decimal, binary, hexadecimal number system and their mutual conversions. **LMS-**5.2 to 5.5, 5.7 Transistor as an amplifier: Definition of gain α, β (dc & ac gains) and relation between them. CE amplifier: operation, dc and ac-Load line Analysis, operating point, cut off and saturation points **VKM**: 11.7 to 11.17, 11.21 Operational Amplifiers: Introduction, Schematic symbol of OPAMP, Output voltage from OPAMP, Inverting Amplifier, Non-Inverting Amplifier, Voltage Follower **M M:**	

Unit III	**III**	**Analog Electronics-Transistor Biasing.**	**15 lectures**
		Inherent Variations of Transistor Parameters, Stabilization- Essentials of a Transistor Biasing Circuit, Stability Factor, Methods of Transistor Biasing: Base Resistor Method, Emitter Bias Circuit, Circuit analysis of Emitter Bias, Biasing with Collector Feedback Resistor, Voltage Divider Bias Method, Stability factor for Potential Divider Bias. **MM:** 9.2 to 9.13 Practical circuit of transistor amplifier, phase reversal, frequency response, Decibel gain and Band width **MM:** 13.4, 13.5	

References:

1. Principles of Electronics – V. K. Mehta & Rohit Mehta **(VKM)**
2. Electricity and Magnetism by D. Chattopadhaya & P. C. Rakshit **(CR)**
3. Digital Principles and Applications – Leach & Malvino Goutam Saha**(LM)**(13th ed)
4. Principles of Electronics – V. K. Mehta and Rohit Mehta. (S. Chand – Multi-colored illustrative edition) (**MM**)

Additional References:

1. Digital Principles and Applications by Leach & Malvino
2. Digital Electronics by Tolkheim

		SEM-II PRACTICALS	
		Demonstration Experiments: 1. Use of Cathode Ray Oscilloscope (or Digital Storage Oscilloscope) 2. Conservation of Angular Momentum 3. Laser Beam Divergence, Intensity 4. Charging Discharging of a Capacitor 5. Use of PC for graph Plotting 6. Light Dependent Switch 7. Clipper & Clamper Circuits	
		Regular Experiments: Group A	**Credit 1**
		1. LR Circuit	
		2. CR Circuit	
		3. Frequency of A.C. Mains	
		4. Helmholtz Resonator	
		5. LDR Characteristics	
		6. Ultrasonic Interferometry for determining the velocity of sound in liquids.	
		Regular Experiments: Group B	**Credit 1**
		1. Thevenin' s Theorem	
		2. Norton's Theorem	
		3. Bridge Rectifier – Load Regulation	
		4. Zener diode as Regulator	
		5. NAND, NOR gates as Universal Building Blocks	
		6. EX-OR gate, Half Adder & Full Adder	

- **Any one out of the following is equivalent to two experiments from Group A and/or Group B**
  1. Student doing **mini-project** up to the satisfaction of the Professor or In-Charge of the Practical.
  2. Study Tour: Students participated in study tour must submit a **study tour report**
- **Minimum 10 experiments (5 from each group)** from the list should be completed in the first semester and **6 minimum demo-experiments** are to be reported in the Journal
- **Certified Journal is a MUST** for a candidate to be eligible in the **end semester practical examination**.
- **Internal component of Practical examination** Evaluation is based on regular experiments and skill experiments, Journal work

For **External practical examination**, student will be **examined in 2 regular experiments** (one from each group).

MODALITY OF ASSESSMENT –SEM-II

Theory Examination Pattern:

A) Internal Assessment – (40% of 100 marks) = **40 marks.**

Theory Paper-Paper code	Internal test marks	Assignment	Marks distribution (Assignment)	Total Marks per paper
Mathematical Physics & Mechanics RUSPHY201	**20**	15 questions on units1,2,3	Assessment- 15 Viva on it --05 ---------- **Total= 20 mark**	**40**
Electronics & Electricity **RUSPHY202**	**20**	15 questions on units1,2,3	Assessment- 15 Viva on it --05 ---------- **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 % of 100 marks = 60 Marks

Semester-end Theory Assessment - 60 Marks

1. Duration - These examinations shall be of **2 hours** duration.
2. Paper Pattern: All questions shall be compulsory with internal choice within the questions.

Questions	Options	Marks	Questions on
Q.1)A)	Any 2 out of 4	14	Unit I
Q.1)B)	Any 1 out of 2	01	
Q.2)A)	Any 2 out of 4	14	Unit II
Q.2)B)	Any 1 out of 2	01	
Q.3)A)	Any 2 out of 4	14	Unit III
Q.3)B)	Any 1 out of 2	01	
Q.4)A)	Any 1 out of 2	5	Unit I
Q.4)B)	Any 1 out of 2	5	Unit II
Q.4)C)	Any 1 out of 2	5	Unit III
Total marks		**60**	

Practical Examination Pattern:

(A) Internal Examination:

Sr. No.	Activity	Practical-Group-A (Marks)	Practical-Group-B (Marks)
1.	**Continuous Assessment** (1.5 marks per experiment/ 5 regular and 3 demo-experiment)	12	12
2.	**Main Journal** (one mark per experiment for 5 regular and 3 demo experiment)	8	8
	Total (= 1 + 2)	**20**	**20**
	Demo- experiments= 06 for certified journal Main experiments = minimum 10 for certified Journal per Semester (5 each from experiment group A and B)		

(B) External (Semester-end practical examination):

Sr. No.	Particulars	Practical-Group-A (Marks)	Practical-Group-B (Marks)
1.	Laboratory work	25	25
2.	Viva	5	5
	Total **(= 1 + 2)**	**30**	**30**

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/Practical 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 II

Course	RUSPHY 201 (Marks)			RUSPHY 202 (Marks)			Total (Marks)
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Practicals	20	30	50	20	30	50	100

(GRAND TOTAL MARKS : 300)

AC/II(20-21).2.RUS10

S.P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for S.Y.B.Sc. SEM III & IV

Program: B.Sc. (Physics)

Program Code: RUSPHY

(Credit Based Semester and Grading System for academic year 2022–2023)

Course Code: RUSPHY301

Course Title: Mechanics and thermodynamics

Academic year 2022-23

Learning Outcomes:

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

1. Understand the concepts of mechanics & properties of matter, how to apply them to problems
2. Comprehend the basic concepts of thermodynamics & its applications in physical situation
3. Learn about situations at low temperature
4. Demonstrate cautious problem solving skills in all above areas

DETAILED SYLLABUS

Course Code	Unit	Title	Credits/ lectures
RUSPHY 301		**Mechanics and thermodynamics**	**2 credits**
Unit I	**I**	**Mechanics**	**15 lectures**
		Torque Acting on a Particle, Angular Momentum of a Particle, Angular Momentum of System of Particles, and total angular momentum with respect to CM coordinates. Conservation of Angular Momentum.—6 lectures **Halliday and Resnick -Physics part I** **12.1, 12.2, 12.3, 13.4** **Compound pendulum**: Expression for period, maximum and minimum time period, centers of suspension and oscillations, reversible compound pendulum. Kater's reversible pendulum, Advantages of a compound pendulum over a simple pendulum; Problems from all topics-4 lectures **HP: 9.1.1 (pages 279 to 289)** **Lagrange's equations**, Lagrange's equations: -- D'Alembert's principle, Generalized coordinates, Lagrange's equations using D'Alembert's principle, Examples.--- 5 lectures KRS: Art. 9.1 to 9.6; G:1.4	

Unit II	**II**	**Thermal Physics & Statistical Physics**	**15 lectures**
		(Review of Zeroeth and first law of thermodynamics) Heat engine, Carnot's cycle, Second law of Thermodynamics, Statement, Equivalence of Kelvin & Planck Statement, Carnot's Theorem, Reversible & Irreversible Process, Absolute scale of Temperature.- 7 lectures **ABG: 7.1,7.2,7.3,7.5, 7.5.1, 7.6, 7.7, 7.8** **Statistical Physics** 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.—8 lectures **LG: 1.1 to 1.11**	
Unit III	**III**	**Heat, Thermodynamics & Statistical Physics**	**15 lectures**
		Third law of thermodynamics, Nernst heat theorem, Consequences of the third law, Maxwell's thermodynamic relations, Clausius – Clapeyron equation. **ABG: 10.12, 10.12.1, 10.12.2 BS: 6.3, 6.11** Steam engine, Rankin cycle **ABG: 11.2, 11.3** Low temp Physics: Different methods of liquefaction of gases, methods of freezing mixtures, Cooling by evaporation under reduced pressure, cooling by adiabatic expansion. **BS: 7.1, 7.2, 7.3, 7.4** Joule - Thompson effect, JT effect of Van der Waal's gas, Liquefaction of helium, properties and uses of liquid Helium **ABG: 10.2, 10.2.2, 10.6,10.6.1**	

References:

1. Resnick and Halliday : Physics – I
2. Mechanics – H. S. Hans and S. P. Puri, Tata McGraw Hill (2nd ED.)
3. Mechanics by Keith R. Symon **(KRS)**
4. Thermal Physics, AB Gupta and H. Roy, Book and Allied (P) Ltd, Reprint 2008, 2009.
5. Heat thermodynamics and Statistical Physics, Brijlal, N. Subramanyam, P. S. Hemne, S. Chand , edition 2007.
6. Statistical & Thermal Physics by S. Lokanathan & R. S Gambhir (**LG**)

Additional reference:

7. Classical Dynamics of particles and systems by Thornton and Marian, (CENGAGE

Learning)
8. Basic Thermodynamics: Evelyn Guha (Narosa Publications)
9. Classical mechanics by Kleppener, Kollenkov
10. A treatise on heat : Meghanad Saha and BN Srivastava , 1969, India Press
11. Mechanics and Electrodynamics Rev Edn. 2005 by Brijlal and Subramanyan and Jeevan Seshan
12. Thermal Physics: Philip M. Morse (W.A. Benjamin Inc. New York)
13. Heat & Thermodynamics: Robert and Miller (ELBS)

Course Code: RUSPHY302

Course Title: Vector calculus, Analog and Digital Electronics

Academic year 2022-23

Learning Outcomes:

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

1. Understand the basic concepts of mathematical physics and their applications in physical situations
2. Understand the basic laws of electrodynamics and be able to perform calculations using them
3. Understand the basics of transistor biasing, operational amplifiers, their applications
4. Understand the basic concepts of oscillators and be able to perform calculations using them
5. Demonstrate quantitative problem solving skill in all the topics covered

DETAILED SYLLABUS

Course Code	Unit	Title	Credits/ lectures
RUSPHY 302		**Vector calculus, Analog and Digital Electronics**	**2 credits**
Unit I		**Vector Calculus**	**15 lectures**
	I	Line, Surface and Volume Integrals, The Fundamental Theorem of Calculus: The Fundamental Theorem of Gradient, The Fundamental Theorem of Divergence, The Fundamental Theorem of Curl (Statement and Geometrical interpretation is included, Proof of these theorems are omitted). Problems based on these theorems are required to be done. **DG: 3.1, 3.2, 3.3, 3.4, 3.5** Curvilinear Coordinates: Spherical Coordinates, Cylindrical Coordinates **DG: 4.1, 4.2**	

Unit II		**Analog Electronics**	**15 lectures**
	II	General amplifier characteristics: Concept of amplification, amplifier notations, current gain, Voltage gain, power gain, input resistance, output resistance, general theory of feedback, reasons for negative feedback, loop gain. **AM: 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 17.1, 17.2, 17.3** **SC: 9.3, 9.4** **JFET,MOSFET:-** 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. MB: Art. 13.1 to 13.9, 14.1, 14.2, 14.4, 14.6.	
Unit III		**Analog and Digital Electronics**	**15 lectures**
	III	Oscillators: Introduction, effect of positive feedback. Requirements for oscillations, phase shift oscillator, Wien Bridge Oscillator, Colpitt's oscillator. **MM: 14.1 to 14.11, 14.13, 14.14.** **Operational Amplifiers**: AC analysis, Bandwidth of an OPAMP, Slew rate, Frequency Response of an OPAMP, OPAMP with Negative feedback, Summing Amplifier, Applications of Summing amplifier, OPAMP Integrator and Differentiator, Comparator **Digital Electronics** Flip-flops and counters: R-S flip flops, Clocked R-S, D Flip flop, J K Master slave flip flop, counters: Synchronous and Asynchronous: 3 bit ripple up counter, mod-3. **Digital Principles and Applications – Donald Leach, A Malvino, Goutam Saha (13th Edition): 8.1, 8.2,8.5, 8.8 , 10.1** 555 Timer: Block diagram, Monostable and Astable Operation **Electronic Principles – A. P Malvino and D. J Bates (7th Ed.): 23.7, 23.8, 23.9**	

References:

1. Introduction to Electrodynamics 3rd Ed by D.J. Griffith
2. Principles of Electronics – V. K. Mehta and Rohit Mehta. (S. Chand – Multi-colored illustrative edition)
3. Electronic devices and circuits – An introduction Allan Mottershed (PHI Pvt. Ltd.– EEE – Reprint – 2013)

Course Code: RUSPHY303

Course Title: Applied Physics – I

Academic year 2022-23

Learning Outcomes:

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

1. Students will appreciate the role of Physics in 'interdisciplinary areas related to Materials, Nano-sciences, Bio-physics , Acoustics etc.
2. The learner will understand the scope of the subject in Industry & Research
3. Experimental learning opportunities will faster creative thinking.
4. Understand the importance of instrumentation in biological sciences.
5. Understanding the method for solving the numerical which based on above concepts.

DETAILED SYLLABUS

Course Code	Unit	Title	Credits/ lectures
RUSPHY303		**Applied Physics – I**	**2 credits**
Unit I		**Acoustics, Lasers and fiber optics**	**15 lectures**
	I	1) **Acoustics of Buildings**: Reverberation, Sabine's formula (without derivation) Absorption coefficient, Acoustics of Buildings, factors affecting Acoustics of Buildings, Sound distribution in an auditorium. **Reference**: – M. S.—5.9,5.10, 5.12,5.13,5.14, 5.15 2) **Laser:** Introduction, transition between Atomic energy states (without derivation), Principle of Laser, Properties of Laser, Helium–Neon Laser, Application of Laser, Holography. **Reference**:-—SP-9.1 to 9.6 , 9.10, 9.11 3) **Fiber Optics**: Light propagation through Fibers, Fiber Geometry, Internal reflection, Numerical Aperture, Step-Index and Graded-Index Fibers, Applications of Fibers. **Reference**: SP— 13.3, 13.5, 13.9	
Unit II		**Biophysics**	**15 lectures**
	II	Introduction, definition, History & scope of biophysics, biological fluids, physico-chemical properties, viscosity, surface tension, pH, osmosis, osmotic pressure. Diffusion, Ficks' laws of diffusion, dialysis, Cell is unit of life, fundamental understanding prokaryotic and eukaryotic cell structure and function, eukaryotic cell	

		membrane, Fundamentals of transport process through biological membrane, membrane channels. electrical properties of cell, Action potential, propagation of action potential, methods of measurement of action potential, Nernst equation, Golman equation, The Hodgkin-Huxely model of action potential, voltage clamp technique, Patch clamp technique, cell impedance and capacitance . **Reference**:- Biophysics-principles and techniques by M.A. Subramanian-MJP publishers-chapter3 and 8 full.	
Unit III		**Materials – properties and applications**	**15 lectures**
	III	Classification and selection of materials: Classification of materials, organic, inorganic and biological materials, semiconductor materials, current trends and advances in materials. Material structure and examination, selection of materials. Crystal geometry and structure: Crystals, single crystal, Whiskers, lattice point and space lattice. Unit cell, primitive cell, Atomic radius, Density of crystal, Direction lattice planes, Miller indices, Inter planar spacing, Crystal planes in cubic unit cell, common planes in simple cubic structure. Coordination number, Crystal growth. **KK: CHAPTER 1(3 TO 9) KK CHAPTER 3 (1 TO 18, 33)**	

References:

1. Properties of matter and Acoustics – R Murugeshan and K. Shivaprasath, S Chand & Co.Ltd. (2005-Ed
2. Modern Physics Concept and Applications – Sanjeev Puri, Narosa Publication
3. Biophysics-principles and techniques by M.A. Subramanian-MJP publishers
4. Material Science – S. K. Kakani and Amit Kakani, New Age International (P) Ltd. – Reprint 2004 (**KK)**
5. Electronic Properties of Materials, Rolf E Hummel
6. Materials Science and Engineering: A First Course by V. Raghavan

Additional References:

1. Cellular and Molecular Biology: Concept and Experiment by Gerald Karp
2. The Cell: A Molecular Approach by Geoffery Cooper
3. Introductory Biophysics: Perspective on living state by James Claycomb
4. Medical Physiology by Guyton
5. Molecular Biology of Cell by Bruce Albert
6. Text Book of Biophysics by R N Roy

RUSPHYP03 – Physics Laboratory Course

The S.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

- Note: Exemption of two experiments from section A and / or B and / or C may be given if student carries out any one of the following activity.
  - Execute a mini project to the satisfaction of teacher in-charge of practical
- Each experiment will be of three hours' duration. Minimum 5 from each group A/B/C and in all minimum 15 experiments from three groups A+B+C must be reported in certified journal along with 9 skill experiments
- All the skill experiments are required to be completed compulsorily.
- Internal component of Practical examination Evaluation is based on regular experiments and skill experiments.
- A learner will be allowed to appear for the semester end practical examination only if he/she submits a certified journal of Physics (9 Skill experiments and 15 regular experiments for certified Journal)
- For external practical examination, the learner will be examined in three experiments (one from each group)

References:

1. Advanced course in Practical Physics D. Chattopadhya, PC Rakshit & B Saha. (6th Edition)
2. B.Sc Practical Physics – Harnam Singh S.Chand & Co. Ld. 2001
3. A test book of advanced practical PHYSICS _ SAMIR Kumar Ghosh, New Central Book Agency (3rd edition)
4. B.Sc. Practical Physics – CL Arora (1st Edition) -2001 S. Chand and Co Ltd
5. Practical Physics CL Squires (3rd Edition) Cambridge University
6. University Practical Physics – DC Tayal. Himalaya Publication
7. Advanced Practical Physics – Worsnop &Flint.

Skill experiments		**Skill-Group-A**	
	1.	Drawing of graph on Semi-logarithmic or Logarithmic Scale	
	2.	Radius of ball bearings (single pan balance)	
	3.	Spectrometer: mean μ of yellow doublet of mercury source.	
		Skill-Group-B	
	4.	Component testing: resistor, capacitor, diode, transistor on CRO	
	5.	Use of Digital Storage Oscilloscope (DSO)	
	6.	Wiring of a simple circuit on a Bread Board	
		Skill-Group-C	
	7.	Study of LT-Spice, free software for simulation of electronic circuits	
	8.	Using Eagle Software draw PCB pattern for electronic circuit	
	9.	Study of SRIM (Stopping and range of ions in matter)- free software.	
RUSPHP03 (A)	1.	Y by bending(metal beam)	**Credit 1**
	2.	Flat spiral spring (Y)	
	3.	Optical lever: determination of refractive index of glass (μ)	
	4.	Resolving Power of telescope.	
	5.	Finding moment of inertia of flywheel	
	6.	Determination of wavelength of He-Ne laser using grating	
	7.	Determination of refractive index of liquid by diode laser	
RUSPHP03 (B)	1.	Figure of merit of a mirror galvanometer.	Credit 1
	2.	Common emitter transistor(NPN) amplifier	
	3.	OpAmp: Inverting amplifier with different gains	
	4.	OpAmp: Non inverting amplifier with different gains	
	5.	Passive low pass filter/high pass filter	
	6.	MS-JK flip-flop	-
	7.	Transistorized Wien Bridge Oscillator	
RUSPHP03 (C)	1.	Standardization of pH meter	**Credit 1**
	2.	Surface tension of Biological fluid	
	3.	Solar cell panel- study of Current-voltage characteristics	
	4.	Determination of thermal conductivity of bad conductor by Lee's Method	
	5.	Specific heat of a graphite	
	6.	Concept of beats	
	7.	Thermal relaxation time constant of a series bulb— checking with apparatus requirement	

MODALITY OF ASSESSMENT SEM---III

Theory Examination Pattern:

A) Internal Assessment (40% of 100 marks) = 40 marks**.**

Theory Paper-Paper code	Internal test marks	Assignment	Marks distribution	Total Marks per paper
Mechanics & Thermodynamics RUSPHY301	**20**	15 questions on units1,2,3	Assessment- 15 Viva on it --05 ---------- **Total= 20 mark**	**40**
Vector calculus, Analog and Digital Electronics RUSPHY302	**20**	15 questions on units1,2,3	Assessment- 15 Viva on it --05 ---------- **Total= 20 mark**	**40**
Applied Physics- I RUSPHY303	**20**	15 questions on units1,2,3	Assessment- 15 Viva on it --05 ---------- **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 % of 100 marks = 60 MARKS,
Semester End Theory Question paper of 60 marks

I. These examinations shall be of **2 hours** duration.
II. Paper Pattern: All questions shall be compulsory with internal choice within.

Questions	Options	Marks	Questions on
Q.1)A)	Any 2 out of 4	14	Unit I
Q.1)B)	Any 1 out of 2	01	
Q.2)A)	Any 2 out of 4	14	Unit II
Q.2)B)	Any 1 out of 2	01	
Q.3)A)	Any 2 out of 4	14	Unit III
Q.3)B)	Any 1 out of 2	01	
Q.4)A)	Any 1 out of 2	5	Unit I
Q.4)B)	Any 1 out of 2	5	Unit II
Q.4)C)	Any 1 out of 2	5	Unit III
Total marks		**60**	

Practical Examination Pattern:

(A) Internal Examination:

Sr. No.	Activity	Practical-Group-A (Marks)	Practical-Group-B (Marks)	Practical-Group-C (Marks)
1.	**Continuous Assessment** (1.5 marks per experiment/ 5 regular and 3 skill experiment)	12	12	12
2.	**Main Journal** (one mark per experiment for 5 regular and 3 skill experiment)	8	8	8
	Total (=1 + 2)	**20**	**20**	**20**
	9 Skill experiments required for certified Journal. 15 Main experiments required for certified Journal.			

(B) External (Semester-end practical examination):

Particulars	Practical-Group-A (Marks)	Practical-Group-B (Marks)	Practical-Group-C (Marks)
Laboratory work	*25*	*25*	*25*
Viva	*5*	*5*	*5*
Total	**30**	**30**	**30**

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 of the department / laboratory In-charge of the respective class by presenting working(rough) journal to the HOD. If the student did not present such lost certificate at the practical examination, he/she will not be allowed to appear for the practical examination.

Overall Examination and Marks Distribution Pattern- Semester-III

Course	RUSPHY301 (Marks)			RUSPHY302 (Marks)			RUSPHY303 (Marks)			Total (Marks)
	Internal	External	Total	Int.	Ext.	Total	Int.	Ext.	Total	
Theory	40	60	100	40	60	100	40	60	100	**300**
Practicals	20	30	50	20	30	50	20	30	50	**150**

(GRAND TOTAL MARKS= 450)

Course Code: RUSPHY401

Course Title: Optics, Applied optics

Academic year 2022-23

Learning Outcomes:

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

1. Acquire knowledge of diffraction optical phenomenon and diffraction categories-Fresnel and Fraunhofer. Understand the concept of Huygens's half period zone and apply it for diffraction caused in various situations. Analyse mathematically diffraction patterns created by different optical devices.
2. Understand the basics of polarization, different methods of its production.
3. Demonstrate application of Polarisation in practical devices as half wave plate and quarter wave plate. Work out analysis of polarised light using polariser and wave plates and evaluate polarisation status of light beam
4. Understand concept of interference and its application in Michelson interferometers. And exploring evaluation of thickness of thin optical plate, refractive index change.
5. Principles of optics applied to develop fiber optic sensors, non–reflecting and high reflecting thin films, grating structure in optical fiber which are of immense use both in Research and Industry

DETAILED SYLLABUS

Course Code	Unit	Title	Credits/ lectures
RUSPHY 401		**Optics, Applied optics**	**2 credits**
Unit I	**I**	**Diffraction- Fraunhofer and Resolving Power**	**15 lectures**
		Review of Fresnel Diffraction- diffraction due to a narrow slit, **Fraunhofer diffraction**: introduction, Fraunhofer diffraction at a single slit, intensity distribution in diffraction pattern due to single slit, Fraunhofer diffraction due to double slit, distinction between single slit and double slit diffraction patterns, plane diffraction grating, theory of plane transmission grating, width of principal maxima, prism and grating spectra. SBA: 17.1, 17.2, 17.3, 17.6, 17.7, 17.10, 17.10.1, 17.10.2, 17.11, 17.12, 18.1, 18.2, 18.2.1, 18.4, 18.4.2, 18.7, 18.7.1, 18.7.2, 18.7.8(i to vi) **Resolving Power of Optical Instruments** Rayleigh's criterion, Limit of resolution of the Eye, Criterion	

		of resolution, R, P.-telescope, Microscope, Prism, Diffraction Transmission Grating and Numerical SBA- 19. 1,2, 3, 6,7, 8, 11, 12	
Unit II	**II**	**Polarization** **Types** of polarization, Plane polarized light, circularly polarized light, Elliptically polarized light, Partially polarized light, **Production** of Plane polarized light, Polarization by reflection from dielectric surface, Polarization by refraction – pile of plates, Polarization by scattering, Polarization by selective Absorption, Polarization by double refraction, Polarizer and Analyser, Malus' Law, Anisotropic crystal, Calcite crystal, Optic Axis, **Double refraction** in calcite crystal, Huygens' explanation of double refraction, Ordinary and Extra ordinary rays, Positive and Negative crystals, **Superposition** of waves linearly polarized at right angles, Superposition of e-Ray and o-Ray, **Retarders**, Quarter wave plate, Half wave plate, Production of linearly polarized light, **Production of elliptically polarized light**, Production of circularly polarized light, Analysis of polarized light, **Applications** of polarized light. **AG: 19.1, 19.2.1, 19.2.2, 19.2.3, 19.3, 19.4, 19.4.1, 19.5, 19.6.**	**15 lectures**
Unit III	**III**	**Applied Optics**	**15 lectures**
		Non-reflecting films (13.4 but not 13.4.1, 13.4.2), high reflectivity by thin film deposition (13.5), reflection by a periodic structure (13.6), Fiber –Bragg gratings (13.6.1) Newton's rings (13.10, Ex. 13.2, Ex. 13.3), Michelson interferometer (13.11) Self focusing phenomenon (16.11) Fiber optic sensors (24.14) **Reference: AG**	

References:-

1. A textbook of Optics –Subramanyam, Brijlal, Avadhanulu (SBA)
2. OPTICS by Ajoy Ghatak-3rd edition, McGraw-Hill publications.

Additional References:

3. Fundamentals of Optics – Jenkins and White. (4th Ed) 2.Optics by C. L Arora

Course Code: RUSPHY402

Course Title: Introduction to Quantum Mechanics

Academic year 2022-23

Learning Outcomes:

1. After successful completion of this course, a student will be able to:
2. Understand the postulates of quantum mechanics and to understand its importance in explaining significant phenomena in Physics
3. Demonstrate quantitative problem solving skills in all the topics covered
4. Formulate the Schrodinger time independent and dependent equation and Derive equation of continuity with physical significance.
5. Understand the different operators and Commutator brackets in quantum mechanics.
6. Understand the application of Schrodinger steady state equation.
7. Understand the basics of infinite potential well and particle in cube.
8. Recognize barrier potential, tunneling effect, step potential and solutions to it.

DETAILED SYLLABUS

Course Code	Unit	Title	Credits/ lectures
RUSPHY 402		**Introduction to Quantum Mechanics**	**2 credits**
Unit I	**I**	**Quantum Mechanics**	**15 lectures**
		Probability current density, equation of continuity, and its physical significance Definition of an operator, Eigen value and Eigen function Operators in Quantum Mechanics –Position, Momentum, and total energy (Hamiltonian) operators Basic Commutator Algebra in Quantum Mechanics Commutator brackets using position and momentum operators Expectation Values , Problems from all topics. Reference: SPS: 4.9 MJ: 6.1 to 6.8	
Unit II	**II**	**Applications of Schrodinger's Steady State Equation:**	**15 lectures**
		Particle in an infinitely deep potential well (in detail – its relation with Heisenberg's uncertainty principle), Particle in a cube, Step potential, free particle, barrier potential and tunneling- infinitely deep potential well, concepts of cube, step potential, free particle, barrier potential and tunneling (no mathematical formulations required) Problems from all topics **References:** SPS: 5.1 to 5.6, 6.1 to 6.3 MJ: 6.9, 7.1 to 7.4	

		GA: 4.1 to 4.3	
Unit III	III	**Schrödinger's equation and Hydrogen Atom**	**15 lectures**
		Schrödinger's equation for one dimensional 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_2: 9.1 to 9.9**	

References:

1. Concepts of modern physics by Arthur Beiser (AB)
2. Quantum Mechanics: A text book for undergraduates by Mahesh Jain (MJ)
3. Quantum Mechanics by G. Arul Das
4. Quantum Mechanics (2nd edition) by H. C Verma - Additional Reference
5. Quantum Mechanics by S. P Singh, M. K Bagade, Kamal Singh
6. Quantum Mechanics: A text book for undergraduates by Mahesh Jain
7. Introduction to Quantum mechanics – P. T Mathews (**PTM**)
8. Perspectives of modern physics by Arthur Beiser (AB_2)

Additional References:

1. Basic Quantum Mechanics – Ajoy Ghatak
2. Introduction to Quantum Mechanics by D. J Griffith
3. Introductory Quantum Mechanics (4th Edition) by R. Liboff
4. ***The Feynman Lectures on Physics, Volume III*** by Leighton, Feynman, and Sands (transcribed from a lecture series given by Richard Feynman at Caltech)
5. Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles 2nd Edition by Robert Eisberg , Robert Resnick
6. For problems of all units: 500 problems on Quantum Mechanics by G Aruldhas - chapters 1, 2, 3, 4

Course Code: RUSPHY403

Course Title: Applied Physics – II

Academic year 2022-23

Learning Outcomes:

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

1. Students will appreciate the role of Physics in interdisciplinary areas related to Nano-sciences, Nano-materials, Acoustics etc.
2. The learner will understand the scope of the subject of Microprocessors.
3. The learner will understand the scope of Analysis Techniques used regularly in material science.
4. The learner will understand the scope of the subject in Industry & Research
5. Experimental learning opportunities will faster creative thinking

DETAILED SYLLABUS

Course Code	Unit	Title	Credits/ lectures
RUSPHY403		**Applied Physics – II**	**2 credits**
Unit I	**I**	**Synthesis of Nano-materials**	**15 lectures**
		Synthesis of Nano-materials – Physical Methods: Introduction, Mechanical Methods – High Energy Ball Milling, Melt Mixing; Methods based on Evaporation – Physical, Vapor Deposition, Ionized cluster beam deposition, Ablation (laser vaporization), Laser Pyrolysis, Chemical Vapor Deposition **SK: 3.1, 3.2. 3.2.1, 3.2.2, 3.3, 3.3.1, 3.3.2, 3.3.3, 3.3.4, 3.5** **Synthesis of Nano-materials – Chemical Methods** Introduction, Colloids & Colloids in Solution, Nucleation& Growth of Nanoparticles, Langmuir-Bodgett (LB) Method, Micro-emulsions, Sol-Gel Method **SK: 4.1, 4.2, 4.3, 4.6, 4.7, 4.8** **Synthesis of Nanomaterials – Biological Methods** Introduction, Synthesis using Microorganisms, Synthesis using Plant extracts, Use of Proteins, Templates like DNA, S-Layers, etc., Synthesis of Nanoparticles using DNA **SK: 5.1, 5.2, 5.3, 5.4, 5.5**	

Unit II	**II**	**Analysis Techniques**	**15 lectures**
		Introduction, Microscopes, Electron Microscope – Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Diffraction Techniques – X-Ray Diffraction (XRD), Atomic Scattering Factor, Bragg's Law of Diffraction, Diffraction from different types of Samples. **SK: 7.1, 7.2, 7.3, 7.3.1, 7.3.2, 7.5, 7.5.1, 7.5.2, 7.5.3, 7.5.4**	
Unit III	**III**	**Microprocessors**	**15 lectures**
		8085 Microprocessor and Basic Assembly Language Programming Introduction, Historical Perspective, Organization of a Microprocessor Based system, how does the Microprocessor works, Machine Language, Assembly Language, High Level Languages, Writing and executing an Assembly Language Program. **RG: 1.1, 1.1.2, 1.1.3, 1.2 (omit 1.2.4)** 8085 Bus Organization, 8085 Programming Model, The 8085 Microprocessor, Pin connection diagram and function of each pin, A detailed look at 8085 Microprocessor. **RG: 3.1.1, 2.1.1, 2.1.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.1.5** Basic definitions: Instruction, Op-code, operand. Instruction word Size, instruction Format, data format, Addressing Modes, The 8085 Instruction Set(Classification) Data transfer Operations, Arithmetic Operations, Logical Operations Branch Operations, Introduction to Advanced Instructions Flowchart **RG: 2.3.1, 2.3.2, 6.11, 2.11, 6.1, 7.2.1, 7.2.2, 7.3.3, 6.2, 7.2.4, 7.3.1, 6.3, 7.4, 7.5, 6.4, 9.2 (omit 9.2.1, 9.2.2), 9.3, 10.7, 6.1.2**	

References:

1. Sulabha Kukarni – Nanotechnology Principles and Practices **(SK)**

2.Microprocessor Architecture, programming and Applications with 8085 - Ramesh Gaonkar, 5th Edition, Prentice Hall of India **(RG)**

RUSPHYP03 – Physics Laboratory Course

The S.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:

vi) Understanding relevant concepts
vii) Planning of the experiments
viii) Layout and adjustments of the equipment
ix) Recording of observations and plotting of graphs
x) Calculation of results and estimation of possible errors in the observation of results

- Note: Exemption of two experiments from section A and / or B and / or C may be given if student carries out any one of the following activity.
  - Execute a mini project to the satisfaction of teacher in-charge of practical
- Each experiment will be of three hours' duration. Minimum 5 from each group A/B/C and in all minimum 15 experiments from three groups A+B+C must be reported in certified journal along with 9 demo experiments
- All the demonstration experiments are required to be completed compulsorily.
- Internal component of Practical examination Evaluation is based on regular experiments and demo- experiments.
- A learner will be allowed to appear for the semester end practical examination only if he/she submits a certified journal of Physics (9 Demonstration experiments and 15 regular experiments for certified Journal)
- For external practical examination, the learner will be examined in three experiments (one from each group)

RUSPHP04		**PRACTICALS-Group-A**	**1 credit**
		1. Flat spiral spring (n)	
		2. Young's modulus by Koenig's method.	
		3. Optical fiber: transmission of signal	
		4. Brewster's/ Malus's law verification	
		5. R.P. of grating	
		6. Cylindrical obstacle: determination of λ	
		7. Single slit diffraction	
RUSPHP04		**PRACTICALS- Group-B**	**1 credit**
		1. Determination of absolute capacitance using BG	
		2. Measurement of resistance of galvanometer (G by shunting)	
		3. Transistorized Astable multivibrator -	
		4. Passive band pass filter.	
		5. CE amplifier: variation of gain with load	
		6. Colpitt's oscillator-	
		7. Op-Amp: Integrator and Differentiator-	

RUSPHP04		PRACTICALS- Group-C	1 credit
		1. Study of 8085 microprocessor kit and commands	
		2. 8 -bit addition, subtraction and display	
		3. 8 -bit addition, subtraction with carry and display	
		4. 8 –bit multiplication	
		5. Memory block transfer from one location to another	
		6. Find largest/smallest number in given block.	
		7. Arrange given number in ascending/descending order	
		Demonstration Experiments: 1. Error Analysis and Concept of Beats 2. Study of stepper motor 3. Wave-form Generation using Op-amp 4. Double Refraction 5. Straight Edge Fresnel Diffraction 6. Hysteresis Experiment 7. Coupled Oscillations and Resonance 8. First Order Active Filter-LP and HP 9. PC simulation of 8085. 10. Use of DAD instruction in programming of 8085.	

References:

1. Advanced course in Practical Physics D. Chattopadhya, PC Rakshit & B Saha. (6th Edition) Book and Allied Pvt Ltd
2. B. Sc Practical Physics – Harnam Singh S. Chand & Co. Ld. 2001
3. A test book of advanced practical PHYSICS _ SAMIR Kumar Ghosh, New Central Book Agency (3rd edition)
4. B.Sc. Practical Physics – CL Arora (1st Edition) -2001 S. Chand and Co Ltd
5. Practical Physics CL Squires (3rd Edition) Cambridge University
6. University Practical Physics – DC Tayal. Himalaya Publication
7. Advanced Practical Physics – Worsnop &Flint.

MODALITY OF ASSESSMENT- SEM IV

Theory Examination Pattern:

A) Internal Assessment (40% of 100 Marks) = 40 Marks**.**

Theory Paper- Paper code	Internal test marks	Assignment	Marks distribution	Total Marks per paper
Optics, Applied optics **RUSPHY401**	**20**	15 questions on units1,2,3	Assessment- 15 Viva on it --05 ---------- **Total= 20 mark**	**40**
Introduction to Quantum Mechanics **RUSPHY402**	**20**	15 questions on units1,2,3	Assessment- 15 Viva on it --05 ---------- **Total= 20 mark**	**40**
Applied Physics- II **RUSPHY403**	**20**	15 questions on units1,2,3	Assessment- 15 Viva on it --05 ---------- **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 % of 100 marks = 60 Marks

Semester End Theory Assessment - 60 marks

I. Duration - These examinations shall be of **2 hours** duration.
II. Paper Pattern: All questions shall be compulsory with internal choice within.

Questions	Options	Marks	Questions on
Q.1)A)	Any 2 out of 4	14	Unit I
Q.1)B)	Any 1 out of 2	01	

Q.2)A)	Any 2 out of 4	14	Unit II
Q.2)B)	Any 1 out of 2	01	
Q.3)A)	Any 2 out of 4	14	Unit III
Q.3)B)	Any 1 out of 2	01	
Q.4)A)	Any 1 out of 2	5	Unit I
Q.4)B)	Any 1 out of 2	5	Unit II
Q.4)C)	Any 1 out of 2	5	Unit III
Total marks		**60**	

Practical Examination Pattern:

(A) Internal Examination:

Sr. No.	Activity	Practical-Group-A (Marks)	Practical-Group-B (Marks)	Practical-Group-C (Marks)
1.	**Continuous Assessment** (1.5 marks per experiment/ 5 regular and 3 demo experiment)	12	12	12
2.	**Main Journal** (one mark per experiment for 5 regular and 3 demo experiment)	8	8	8
	Total (=1 + 2)	**20**	**20**	**20**
	9 demo experiments required for certified Journal. 15 Main experiments required for certified Journal.			

(B) External (Semester-end practical examination):

Particulars	Practical-Group-A (Marks)	Practical-Group-B (Marks)	Practical-Group-C (Marks)
Laboratory work	*25*	*25*	*25*
Viva	*5*	*5*	*5*
Total	30	30	30

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 of the department / laboratory In-charge of the respective class by presenting working(rough) journal to the HOD. If the student did not present such lost certificate at the practical examination, he/she will not be allowed to appear for the practical examination.

Overall Examination and Marks Distribution Pattern

Semester IV

Course	**RUSPHY401 (Marks)**			**RUSPHY402 (Marks)**			**RUSPHY403 (Marks)**			**Total (Marks)**
	Internal	External	Total	Int.	Ext.	Total	Int.	Ext.	Total	
Theory	40	60	100	40	60	100	40	60	100	**300**
Practicals	20	30	50	20	30	50	20	30	50	**150**

(GRAND TOTAL MARKS= 450)

AC/II(20-21).2.RUS10

S.P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

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 2022–2023)

Course Code: RUSPHY501

Course Title: Mathematical Methods in Physics, Thermal & Statistical

Physics

Academic year 2022-23

COURSE Outcomes:

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

1. Understand the scope of statistical concept for solving the equation of thermal mechanics.
2. Comprehend the basic concepts of mathematics & its applications in physical sciences
3. Evaluate the statistical relation by using the concepts of probability.
4. Demonstrate the thermodynamical relations.
5. Understand the concepts of MB,BE and FD distribution.
6. Comparison of distribution
7. 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 2022-23

Course Outcomes:

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

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

DETAILED SYLLABUS

COURSE CODE	Unit	TITLE	Credits/ lectures
RUSPHY502		**Solid State Physics**	**4 credits**
		Crystal Physics	**15 lectures**
	I	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 2022-23

Course Outcomes:

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

1. Understand the basic mathematical concepts of vector calculus and applications of them in physical situations.
2. Understand the Schrödinger's equations and their application on hydrogen atom.
3. Understand the energy level diagrams using hydrogen atom and comprehend understanding of its quantum numbers.
4. Understand spin of an electron and its experimental proof with exclusive principle.
5. Understand the magnetic effect on the atom and their consequences using quantum and classical theories.
6. Understand the Molecular spectra and its effect on various energy levels using Raman effect
7. 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**
	I	**Schrödinger's equation and Hydrogen atom**	**15 lectures**
		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 2022-23

Course Outcomes:

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

1. Understand the basic mathematical concepts of vector calculus and its applications of them in Electrodynamics
2. Understand the basic laws of electrodynamics and be able to perform calculations in the problems related to Physical situations.
3. Understand the penetration of electric and magnetic field in dielectric material and its practical applications
4. Acquired conceptual understanding of the Maxwell's laws and its quantitative interpretations.
5. Understand basics of electromagnetic waves and its propagation in material and practical applications in waveguide.
6. Understand Poynting theorem and its application in energy transport via electromagnetic waves.
7. It prepares student for the advanced study of electrodynamics with practical applications in communication, 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:

xi) Understanding relevant concepts
xii) Planning of the experiments
xiii) Layout and adjustments of the equipment
xiv) Recording of observations and plotting of graphs
xv) 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 of **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 2022-23

Course Outcomes:

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

1. Understanding the modification of Newton's second law by using the concepts of gravitation
2. Study the anharmonic motion of particle and framing the relation for the same.
3. Understand formulation of mechanical problem in Lagrange's equations and concept of constraints
4. Application of D'Alembert's principle
5. Application of Lagrange's equations
6. Study conceptual numerical on Newton's second law by using the concepts of gravitation
7. Apply Lagrange's equations for interpreting physical concepts.

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**	
		Lagrange's equations	**15 lectures**
	II	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 2022-23

Course Outcomes:

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

1. Understand the basic electronic components FET, MOSFET, SCR and their working applications.
2. Understand the circuitry action for various applications.
3. Understand the selection and requirement of components based on component characteristics for various applications.
4. Understand the theory and applied aspects of OP-Amp and 555 Timer.
5. Understand the circuit assembling of various devices.
6. Understand DC power supply, Transistor Multivibrators, **Logic** families- flip-flops and counters
7. 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 2022-23

Course Outcomes:

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

1. Distinguish Gamow theory of alpha decay and derive Geiger- Nuttal law.
2. Compare the performances of different accelerators.
3. Evaluate each term involved in Weizsacher 's semi empirical mass formula and derive the equation of it.
4. Distinguish of discovery of basic elementary particle.
5. Understand the basics of Meson theory of nuclear force.
6. Understand the different elementary particle and their conservation laws.
7. 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 2022-23

Course Outcomes:

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

1. Understand the transformation equation
2. Verify the laws of physics
3. Study the concepts of Michelson- Morley experiment, Doppler s effect
4. Comparison of general and special theory of relativity
5. Understand the relativistic Mechanics
6. Understand the relativistic electromagnetism
7. 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 minimum 8 demonstration experiments** in semester VI. 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

Demonstration Experiments:

1.	Amplitude Modulation
2.	Frequency Modulation
3.	Iodine absorption spectra
4.	Equation Solver
5.	Michelson's interferometer
6.	Open CRO, power Supply, Signal Generator: Discuss 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.	Millikan's oil drop experiment
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 - 60 %

Semester-end Theory Assessment - 60 marks

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

vii. Paper Pattern:

III. 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.

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)

----------X----------X----------X----------