Resolution No.: AC/II (24-25).2.RUS10

S.P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for

Program: Bachelor of Science (B.Sc.) Physics

Program Code: RUSPHY

(As per the guidelines of NEP 2020 Academic Year 2025-26)

Graduate Attributes (GA)

S. P. Mandali's Ramnarain Ruia Autonomous College has adopted the Outcome Based Education model to make its science graduates globally competent and capable of advancing in their careers. The Bachelor's Program in Science also encourages students to reflect on the broader purpose of their education.

A student completing Bachelor's Degree in Physics Program will be able to:	
GA No.	**Description**
GA1	Demonstrate in depth understanding in the relevant science discipline. Recall, explain, extrapolate and organize conceptual scientific knowledge for execution and application and also to evaluate its relevance.
GA2	Critically evaluate, analyse and comprehend a scientific problem. Think creatively, experiment and generate a solution independently, check and validate it and modify if necessary.
GA3	Access, evaluate, understand and compare digital information from various sources and apply it for scientific knowledge acquisition as well as scientific data analysis and presentation.
GA4	Articulate scientific ideas, put forth a hypothesis, design and execute testing tools and draw relevant inferences. Communicate the research. work in appropriate scientific language.
GA5	Demonstrate initiative, competence and tenacity at the workplace. Successfully plan and execute tasks independently as well as with team members. Effectively communicate and present complex information accurately and appropriately to different groups.
GA6	Use an objective, unbiased and non-manipulative approach.in collection and interpretation of scientific data and avoid plagiarism and violation of Intellectual Property Rights. Appreciate and be sensitive to environmental and sustainability issues and understand its scientific significance and global relevance.
GA7	Translate academic research into innovation and creatively design scientific solutions to problems. Exemplify project plans, use management skills and lead a team for planning and execution of a task.
GA8	Understand cross disciplinary relevance of scientific developments and relearn and reskill so as to adapt to technological advancements.

PROGRAM OUTCOMES

A student completing Bachelor's Degree in Physics Program will be able to:	
PO No.	**Description**
PO1	To demonstrate procedural knowledge related to different areas of study in Physics including Quantum Mechanics, Nuclear Physics, Electronics, Classical mechanics, Material Science, Microprocessor.
PO2	To demonstrate comprehensive, quantitative and conceptual understanding of the core areas of Physics and keeping update with current developments in the academic field of Physics
PO3	To demonstrate the ability to use analytical skills in Physics and its related areas of technology to solve a wide range of problems including open ended problems associated with Physics.
PO4	Utilize contemporary experimental apparatus and analysis tools to acquire, analyse and interpret scientific data in the extents of Physics with reference to Research.
PO5	Plan and execute Physics-related experiments or investigations, analyse and interpret data collected using appropriate methods, and report accurately the findings relating to relevant theories of Physics.
PO6	Develop skills in areas related to specialization in the subfields of physics-Microprocessor, Microcontroller, VHDL, ARM7 and Python.
PO7	Demonstrate communication skills, to present complex information in a concise manner and develop personal skills such as the ability to work both independently and in a group.

PROGRAM OUTLINE

Year	Semester	Course Code	Course Title	Credits
2025-26	V	**RUSMJPHYO301**	**Mathematical Methods in Physics (DSC-I)**	**3**
		RUSMJPHYPO301	**Practical Based on Mathematical Methods in Physics (DSC- I)**	**1**
		RUSMJPHYO302	**Solid State Physics (DSC- II)**	**3**
		RUSMJPHYPO302	**Practical Based on Solid State Physics (DSC- II)**	**1**
		RUSMJPHYO303	**Atomic and Molecular Physics (DSC- III)**	**3**
		RUSMJPHYPO303	**Practical Based on Atomic and Molecular Physics (DSC- III)**	**1**
		RUSMJPHYO304 A	Nanotechnology (DSE A)	**3**
		RUSMJPHYPO304 A	Practical Based on Nanotechnology (DSE A)	**1**
		RUSMJPHYO304 B	Special Theory of Relativity (DSC B)	**3**
		RUSMJPHYPO304 B	Practical Based on Special Theory of Relativity (DSE B)	**1**
		RUSMIPHYO305	Electronic Instrumentation (Minor)	**1**
		RUSMIPHYPO305	Practical Based on Electronic Instrumentation (Minor)	**1**
		RUSVSCPHYPO306	Analog Electronics (VSC)	**2**
		RUSFPO307	FP/CC	**2**
		Total Credits		**22**
Year	**Semester**	**Course Code**	**Course Title**	**Credits**
		RUSMJPHYE311	**Classical Mechanics (DSC-I)**	**3**
		RUSMJPHYPE311	**Practical Based on Classical Mechanics (DSC-I)**	**1**
		RUSMJPHYE312	**Electronics (DSC-II)**	**3**

2025-26	**VI**	**RUSMJPHYPE312**	**Practical Based on Electronics (DSC-II)**	**1**
		RUSMJPHYE313	**Nuclear Physics (DSC-III)**	**3**
		RUSMJPHYPE313	**Practical Based on Nuclear Physics (DSC-III)**	**1**
		RUSMJPHYE314 A	Electrodynamics (DSE A)	**3**
		RUSMJPHYPE314 A	Practical Based on Electrodynamics (DSE A)	**1**
		RUSMJPHYE314 B	Elements of Material Science (DSE B)	**3**
		RUSMJPHYPE314 B	Practical Based on Elements of Material Science (DSE B)	**1**
		RUSMIPHYE315	C++ Programming (Minor)	**1**
		RUSMIPHYPE315	Practical Based on C++ Programming (Minor)	**1**
		RUSOIT316	OJT	**4**
		Total Credits		**22**

Course Code: RUSMJPHYO301

Course Title: Mathematical and Statistical Physics (SEM-V)

Academic Year: 2025-26

Course Outcomes:

Course Outcome	Description
CO1	Understand the scope of statistical concept for solving the equation of thermal mechanics.
CO2	Comprehend the basic concepts of mathematics & its applications in physical sciences
CO3	Demonstrate the thermodynamic relations.
CO4	Understand the concepts of MB, BE and FD distribution. Comparison of distribution.
CO5	Understand the concepts by solving the numerical.

CO-PO Mapping

RUSMJPHYO301 Mathematical and Statistical Physics (SEM-V)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**2**	**2**	**1**	**2**	**1**	**1**	**0**	**1**
CO2	**3**	**2**	**2**	**2**	**1**	**1**	**1**	**2**
CO3	**3**	**3**	**1**	**2**	**2**	**1**	**0**	**2**
CO4	**2**	**2**	**1**	**3**	**2**	**1**	**0**	**2**
CO5	**2**	**2**	**2**	**3**	**2**	**2**	**1**	**3**

Detailed Syllabus

RUSMJPHYO301: Mathematical and Statistical Physics (DSC-I) (SEM-V)

Units	Title	Credits - 03
I	**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 Fourier series: Introduction, Fourier cosine and sine series, Change of interval, Fourier Integral, Complex form of the Fourier series Fourier transforms: Introduction, Formal development of the complex Fourier transform, Cosine and Sine transforms, The transforms of derivatives (with proof)	
II	**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. 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.	
III	**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. 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.	

Course Code: RUSMJPHYPO301	**Practical based on Mathematical and Statistical Physics: DSC- I**	**Credits/Hours**
1	To study the thermal Diffusivity of given material brass	**1 credit /30 hrs**
2	To study thermal conductivity of specific material by Lee's Method	
3	To study and verify Stefan's law of radiation.	
4	To study the p-n junction diode as a temperature sensor.	
5	To study thermistor characteristics	

Main References:

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

Modality of Assessment – RUSMJPHYO301 (SEM-V)

Theory Examination Pattern:

A) Internal Assessment – 40% of 75 Marks = 30 Marks

Sr. No.	Evaluation Type	Marks
1	Internal Class Test	20
2	Test/ Project / Assignment / Presentation	10
Total		**30**

B) External Examination (Semester End) - 60% of 75 Marks = 45 Marks

Semester End Theory Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q. 1 (A)	Any 2 out of 4 (Theory based)	10	Unit – I
Q.1 (B)	Any 1 out of 2 (Numerical)	05	
Q. 2 (A)	Any 2 out of 4 (Theory based)	10	Unit – II
Q. 2 (B)	Any 1 out of 2 (Numerical)	05	
Q. 3 (A)	Any 2 out of 4 (Theory based)	10	Unit – III
Q. 3 (B)	Any 1 out of 2 (Numerical)	05	
TOTAL		**45**	

Practical Examination Pattern (RUSMJPHYPO301)

C) Semester End Examination - 25 Marks

Semester End Practical Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Practical question paper pattern:

Paper Pattern:

Question	Options	Marks
1	Laboratory work	20
2	Journal and Viva voce	05
	TOTAL	**25**

Course Code: RUSMJPHYO302

Course Title: Solid State Physics (SEM-V)

Academic Year: 2025-26

Course Outcomes:

Course Outcome	Description
CO1	Get a brief idea about crystalline and amorphous substances, about lattice, unit cell, miller indices, reciprocal lattice, and concept of Brillouin zones and diffraction of x-rays by different crystalline materials.
CO2	Gain knowledge of lattice vibrations the basics of the optical and acoustic phonons in crystals.
CO3	Understand about different types of magnetism like diamagnetism and Para magnetism. Quantum mechanical formulation of magnetism and application of Langevin diamagnetic equation.
CO4	Carry out the experiments based on the theory that they have learned to measure carrier lifetime, magnetic susceptibility, and dielectric constant. They will also employ to four probe methods to determine electrical conductivity and the Hall setup to determine the hall coefficient of semiconductor.
CO5	Demonstrate cautious problem-solving skills in all above areas.

CO-PO Mapping

RUSMJPHYO302: Solid State Physics (SEM-V)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	2	1	1	0	1
CO2	2	2	2	2	1	1	1	2
CO3	3	3	1	2	2	1	0	2
CO4	2	2	1	3	2	1	0	2
CO5	2	3	2	3	2	2	1	3

Detailed Syllabus

RUSMJPHYO302: Solid State Physics (DSC-II) (SEM-V)

Units	Solid State Physics	Credits - 03
I	**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**.** 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	
II	**Crystal Physics**	**15 Lectures**
	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.	
III	**Conduction in Semiconductors and Magnetism**	**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 Magnetic Properties of matter: Diamagnetism and Paramagnetism, The origin of permanent magnetic dipoles, Diamagnetism and Larmor precession, the static paramagnetic susceptibility.	

Main References:

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

Additional References:

1. Introduction to Solid State Physics by Charles Kittel, 7th edition John Wiley & sons.
2. Fundamentals of Solid State Physics by J. Richard Christman, John Wiley & sons.
3. Solid State Physics –Structure and properties of Materials by M.A. Wahab, Narosa Publications 1999.
4. Elementary Solid State Physics by M. Ali Omar, Addison Wesley (LPE).
5. Solid State Physics–An Introduction to Principles of Materials Science by H. Ibach and H. Luth, 3rd edition, Springer International Edition (2004)

Course Code: RUSMJPHYPO302	**Practical based on DSC-II**	**Credits/ Hours**
1	To determine Hall coefficient and carrier density of a semiconductor materials by Hall effect.	**1 credit /30 hrs**
2	To measure dielectric constant, Curie temperature and verification of Curie-Weiss law for ferroelectric materials	
3	To study Hysteresis loop and magnetization curve of ferromagnetic material (B-H Curve)	
4	To determine the resistivity and energy band gap of given specimen semiconductor using Four Probe method.	
5	To determine the resistivity and Hall coefficient of given semiconductor by Van der Pauw (VDP) method.	

Modality of Assessment – RUSMJPHYO302 (SEM-V)

Theory Examination Pattern:

A) Internal Assessment – 40% of 75 Marks = 30 Marks

Sr. No.	Evaluation Type	Marks
1	Internal Class Test	20
2	Class Test/ Project / Assignment / Presentation	10
Total		**30**

B) External Examination (Semester End) - 60% of 75 Marks = 45 Marks

Semester End Theory Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q. 1 (A)	Any 2 out of 4 (Theory based)	10	Unit - I
Q.1 (B)	Any 1 out of 2 (Numerical)	05	
Q. 2 (A)	Any 2 out of 4 (Theory based)	10	Unit – II
Q. 2 (B)	Any 1 out of 2 (Numerical)	05	
Q. 3 (A)	Any 2 out of 4 (Theory based)	10	Unit - III
Q. 3 (B)	Any 1 out of 2 (Numerical)	05	
TOTAL		**45**	

Practical Examination Pattern (RUSMJPHYPO302)

C) External Examination (Semester End)- 25 Marks

Semester End Practical Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Practical question paper pattern:

Paper Pattern:

Question	Option	Marks
1	Laboratory work	20
2	Journal and Viva voce	05
	TOTAL	**25**

Course Code: RUSMJPHYO303

Course Title: Atomic and Molecular Physics (SEM-V)

Academic Year: 2025-26

Course Outcomes:

Course Outcome	Description
CO1	Understand the energy level by spin of an electron and its energy level diagram.
CO2	Understand spin of an electron and its experimental proof with exclusive principle.
CO3	Understand the magnetic effect on the atom and their consequences using quantum and classical theories.
CO4	Understand the RAMAN effect on Molecular spectra and its consequences on various energy levels.
CO5	It enhances the knowledge of advanced physics, quantum and classical aspects for the further studies.

CO-PO Mapping

RUSMJPHYO303: Atomic and Molecular Physics (SEM-V)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	2	1	1	0	1
CO2	2	2	2	2	1	1	1	2
CO3	3	3	1	2	2	1	0	2
CO4	2	2	1	3	2	1	0	2
CO5	2	3	2	3	2	2	1	3

Detailed Syllabus

RUSMJPHYO303: Atomic and Molecular Physics (DSC-III) (SEM-V)

Unit/s	Title	Credits – 03
I	**Spin of Electron**	
	Electron Spin: The Stern-Gerlach experiment, Pauli's Exclusion Principle, Symmetric and Antisymmetric wave functions. Spin orbit coupling, Hund's Rule, Total angular momentum, Vector atom model, L-S and j-j coupling. Origin of spectral lines, Selection rules.	**15 Lectures**
II	**Effects of Magnetic Field**	
	Effect of Magnetic field on atoms, Zeeman effect, Earlier discoveries and developments, Experimental arrangement, The normal Zeeman effect and its explanation (Classical and Quantum) The Lande g factor, Anomalous Zeeman effect; Paschen-Back effect, Paschen-Back effect of principal series doublet, Selection rules for Paschen-Back effect.	**15 Lectures**
III	**Molecular Spectra and Raman Effect**	
	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. Raman Effect: Quantum Theory of Raman Effect, Classical theory of Raman Effect, Experimental Setup of Raman Effect, Applications of Raman Spectroscopy.	**15 Lectures**

Main References:

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

Course Code: RUSMJPHYPO 303	Practical based on Atomic and Molecular Physics (DSC-III)	Credits/Hours
1	To Study the effect of magnetic field using Zeeman Effect	**1 credit /30 hrs**
2	To study the double diffraction	
3	To study the characteristics of a given sample using FTIR Spectroscopic technique.	
4	To study of e/m by Thompson method	
5	To study the energy band-gap of Germanium diode.	
6	To study Mutual Inductance by Ballistic Galvanometer.	

Modality of Assessment – RUSMJPHYO303 (SEM-V)

Theory Examination Pattern:

A) Internal Assessment – 40% of 75 Marks = 30 Marks

Sr. No.	Evaluation Type	Marks
1	Internal Class Test	20
2	Test/ Project / Assignment / Presentation	10
Total		**30**

B) External Examination (Semester End) - 60% of 75 Marks = 45 Marks

Semester End Theory Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q. 1 (A)	Any 2 out of 4 (Theory based)	10	Unit - I
Q.1 (B)	Any 1 out of 2 (Numerical)	05	
Q. 2 (A)	Any 2 out of 4 (Theory based)	10	Unit – II
Q. 2 (B)	Any 1 out of 2 (Numerical)	05	
Q. 3 (A)	Any 2 out of 4 (Theory based)	10	Unit - III
Q. 3 (B)	Any 1 out of 2 (Numerical)	05	
TOTAL		**45**	

Practical Examination Pattern (RUSMJPHYPO303):

C) Semester End Examination- 25 Marks

Semester End Practical Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Practical question paper pattern:

Paper Pattern:

Question	Option	Marks
1	Laboratory work	20
2	Journal and Viva voce	05
	TOTAL	**25**

Course Code: RUSMJPHYO304 A

Course Title: Nanotechnology (SEM-V)

Academic Year: 2025-26

Course Outcomes:

Course Outcome	Description
CO1	To Distinguish crystal structure and its properties
CO2	Differentiate between the different spectroscopy techniques
CO3	Demonstrating the analysis of the raw data
CO4	Compare and study of different properties of Nano materials.
CO5	Demonstrate quantitative problem-solving skills in all the topics covered

CO-PO Mapping

RUSMJPHYO304 A: Nanotechnology (SEM-V)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	2	1	2	1	1
CO2	3	2	2	2	1	2	1	1
CO3	2	3	3	2	2	3	2	2
CO4	3	2	2	3	1	2	2	1
CO5	3	3	2	3	3	2	2	2

Detailed Syllabus

RUSMJPHYO304 A: Nanotechnology (SEM-V)

Units	Title	Credits - 03
I	**Introduction to Nanotechnology**	**15 Lectures**
	Introduction to Quantum Mechanics & Crystal structure De-Broglie hypothesis, Uncertainty Principle, Schrödinger Equation, Operator, Particle in a 1D box, Particle in a 3D box (qualitative), Crystal structure, Crystal orientation, Crystal planes, Bravais lattice, Miller Indices, Atomic Packing Density, crystal symmetry, ZnS, Diamond and NaCl crystal structure, Melting point, Coordination number, Atomic Bonding.	
II	**Analysis Techniques**	**15 Lectures**
	Optical spectroscopy: Optical absorption spectroscopy, photoluminescence, FTIR, Raman spectroscopy, Electron spectroscopy: XPS, Ultraviolet photo spectroscopy, Rutherford back scattering spectroscopy(RBS), Secondary ion mass spectroscopy (SIMS).	
III	**Properties of Nanomaterial and Nanolithography**	**15 Lectures**
	Introduction, Mechanical properties, Structural properties, Melting of nanoparticles, Electric conductivity, Optical Properties, Magnetic Properties. Introduction, Lithography using photon, Lithography using particle beams, Scanning probe lithography, Soft lithography.	

Main References:

1. Nanotechnology, Principles & Practices by Sulabha Kulkarni (SK)
2. Introduction to Nanotechnology by C. P. Poole, Jr. and F. J. Owens
3. Instrumental Methods of Analysis by H. H. Willard, I.I. Merit & J. A. Dean
4. X-ray structure Determination by G. H. Stout and I. H. Jensen
5. Fundamentals Of Molecular Spectroscopy by C. Banwell and McCash
6. Nanomaterials by A.K. Bandyopadhyay

Course Code: RUSMJPHYPO304 A	Practical based on Nanotechnology : DSE - I	Credits/Hours
1	To determine the grain size of nanomaterials (powder) using Image J software.	**1 credit / 30 Hrs**
2	To study Characteristics of nanomaterial (powder) using XRD techniques.	
3	To study Characteristics of nanomaterial (powder) using UV techniques.	
4	To study Characteristics of nanomaterial (powder) using FTIR techniques.	
5	To study Characteristics of nanomaterial (powder) using RAMAN techniques	

Modality of Assessment – RUSMJPHYO304 A (SEM-V)

Theory Examination Pattern:

A) Internal Assessment – 40% of 75 Marks = 30 Marks

Sr. No.	Evaluation Type	Marks
1	Internal Class Test	20
2	Test/ Project / Assignment / Presentation	10
Total		**30**

B) External Examination (Semester End) - 60% of 75 Marks = 45 Marks

Semester End Theory Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q. 1 (A)	Any 2 out of 4 (Theory based)	10	Unit - I
Q.1 (B)	Any 1 out of 2 (Numerical)	05	
Q. 2 (A)	Any 2 out of 4 (Theory based)	10	Unit – II
Q. 2 (B)	Any 1 out of 2 (Numerical)	05	
Q. 3 (A)	Any 2 out of 4 (Theory based)	10	Unit - III
Q. 3 (B)	Any 1 out of 2 (Numerical)	05	
TOTAL		**45**	

Practical Examination Pattern (RUSMJPHYPO304 A)

C) External Examination (Semester End)- 25 Marks

Semester End Practical Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Practical question paper pattern:

Paper Pattern:

Question	Option	Marks
1	Laboratory work	20
2	Journal and Viva voce	05
	TOTAL	**25**

Course Code: RUSMJPHYO304 B

Course Title: Special Theory of Relativity (SEM-V)

Academic Year: 2025-26

Course Outcomes:

Course Outcome	Description
CO1	Understand the Lorentz transformation equation.
CO2	Study the concepts of Michelson- Morley experiment, Doppler s effect.
CO3	Understand the Geometric Representation of Space-Time
CO4	Understand the relativistic Mechanics.
CO5	Understand the relativistic Dynamics.

CO-PO Mapping

RUSMJPHYO304 B: Special Theory of Relativity (SEM-V)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	2	1	2	1	1
CO2	3	3	2	2	1	2	1	1
CO3	3	3	2	3	1	2	2	1
CO4	3	3	2	3	2	3	2	2
CO5	3	3	2	3	2	3	2	2

Detailed Syllabus

RUSMJPHYO304 B: Special Theory of Relativity (SEM-V)

Units	Title	Credits - 03
I	**Special Theory of Relativity & Relativistic Kinematics**	**15 Lectures**
	Experimental background of special theory of relativity and relativistic kinematics: Galilean transformations, Newtonian relativity, attempts to locate absolute frame: Michelson-Morley experiment, attempts to preserve the concept of a preferred ether frame: Lorentz Fitzgerald contraction, 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.	
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 .	
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.	

Course Code: RUSMJPHYPO304B	Practical based on DSE- II	Credits/Hours
1	To determine wavelength of given source by Michelson's interferometer.	1Credit / 30 Hrs
2	To determine the frequency of sound wave by Kundt's tube	
3	To determine the width of LASER beam	
4	To determine the wavelength of LASER beam	

Main References:

1. Introduction to Special Relativity by Robert Resnick (Wiley Student Edition)
2. Special theory of Relativity by A. P. French

Modality of Assessment – RUSMJPHYO304B (SEM-V)

Theory Examination Pattern:

A) Internal Assessment – 40% of 75 Marks = 30 Marks

Sr. No.	Evaluation Type	Marks
1	Internal Class Test	20
2	Test/ Project / Assignment / Presentation	10
	Total	**30**

B) External Examination (Semester End) - 60% of 75 Marks = 45 Marks

Semester End Theory Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q. 1 (A)	Any 2 out of 4 (Theory based)	10	Unit – I
Q.1 (B)	Any 1 out of 2 (Numerical)	05	
Q. 2 (A)	Any 2 out of 4 (Theory based)	10	Unit – II
Q. 2 (B)	Any 1 out of 2 (Numerical)	05	
Q. 3 (A)	Any 2 out of 4 (Theory based)	10	Unit – III
Q. 3 (B)	Any 1 out of 2 (Numerical)	05	
TOTAL		**45**	

Practical Examination Pattern (RUSMJPHYPO304B)

C) External Examination (Semester End)- 25 Marks

Semester End Practical Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Practical question paper pattern:

Paper Pattern:

Question	Option	Marks
1	Laboratory work	20
2	Journal and Viva	05
	TOTAL	**25**

Overall Examination and Marks Distribution Pattern:

Course	RUSMJPHYPO301			RUSMJPHYO301			RUSMJPHYO301			RUSMJPHYO304 A/ RUSMJPHYO304 B			RUSMIPHYO305			RUSVSCPHYPO306			Total
	I	E	T	I	E	T	I	E	T	I	E	T	I	E	T	I	E	T	
Theory	30	45	**75**	30	45	**75**	30	45	**75**	30	45	**75**	20	30	**50**		50	**50**	**400**

Course	RUSMJPHYPO301	RUSMJPHYPO302	RUSMJPHYPO303	RUSMJPHYPO304 A/ RUSMJPHYPO304 B	RUSVSCPHYPO306	**Total**
Practical	**25**	**25**	**25**	**25**	**50**	**150**

[Grand Total Marks: 550]

Resolution No.: AC/II (24-25).2.RUS10

S.P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for

Program: Bachelor of Science (B.Sc.) Physics

Program Code: RUSPHY

(As per the guidelines of NEP 2020 Academic Year 2025-26)

Course Code: RUSMJPHYE311

Course Title: Classical Mechanics (SEM-VI)

Academic Year: 2025-26

Course Outcomes:

Course Outcome	Description
CO1	Understanding the modification of Newton's second law by using the concepts of gravitation.
CO2	Study the anharmonic motion of particles and framing the relation for the same.
CO3	Implement formulation of mechanical problem in Lagrange's equations and concept of constraints.
CO4	Explore Application of D'Alembert's principle and Lagrange's equations to Physical configurations.

CO-PO Mapping

RUSMJPHYE311: Classical Mechanics (SEM-VI)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	2	1	2	1	1
CO2	3	3	2	2	1	2	1	1
CO3	3	3	2	3	2	3	2	1
CO4	3	3	2	3	2	3	2	1
CO5	3	3	2	3	2	3	2	1

Detailed Syllabus

RUSMJPHYE311: Classical Mechanics (SEM -VI)

Units	Title	Credits – 03
I	**Motion under a 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. Moving origin of co-ordinates, Rotating co-ordinate systems, Laws of motion on the rotating earth, Foucault pendulum, Larmor's theorem (with proof),	
II	**Lagrangian Mechanics**	**15 Lectures**
	Lagrange's equations: D'Alembert's principle, generalized coordinates, Lagrange's equations using D'Alembert's principle, Examples, Systems subject to constraints, Examples of systems subject to constraints, Constants of motion and ignorable coordinates.	
III	**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.	

Course Code: RUSMJ PHYP E311	Practical based on DSC- I	Credits/Hours
1	To determine of acceleration due to gravity 'g' by Kater's Pendulum	**1 credit / 30 hours**
2	To determine cardinal points by using Goniometer	
3	To determine modulus of rigidity (η) and young's modulus (Y) by flat Spiral Spring.	
4	To determine surface tension of mercury using Quinke's Method.	
5	To determine acceleration due to gravity 'g' by bar pendulum.	
6	To determine velocity of liquid and adiabatic compressibility using Ultrasonic Interferometer.	

Main References:

1. Mechanics by Keith R. Symon (KRS)
2. Classical Mechanics by 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 by Daniel Kleppner& Robert Kolenkow
2. Chaotic Dynamics – An Introduction by Baker and Gollup

Modality of Assessment – RUSMJPHYE311 (SEM-VI)

Theory Examination Pattern:

A) Internal Assessment – 40% of 75 Marks = 30 Marks

Sr. No.	Evaluation Type	Marks
1	Internal Class Test	20
2	Class Test/ Project / Assignment / Presentation	10
Total		**30**

B) External Examination (Semester End) - 60% of 75 Marks = 45 Marks

Semester End Theory Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q. 1 (A)	Any 2 out of 4 (Theory based)	10	Unit – I
Q.1 (B)	Any 1 out of 2 (Numerical)	05	
Q. 2 (A)	Any 2 out of 4 (Theory based)	10	Unit – II
Q. 2 (B)	Any 1 out of 2 (Numerical)	05	
Q. 3 (A)	Any 2 out of 4 (Theory based)	10	Unit – III
Q. 3 (B)	Any 1 out of 2 (Numerical)	05	
TOTAL		**45**	

Practical Examination Pattern (RUSMJPHYPE311):

C) External Examination (Semester End)- 25 Marks

Semester End Practical Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Practical question paper pattern:

Paper Pattern:

Question	Option	Marks
1	Laboratory work	20
2	Viva voce	05
	TOTAL	**25**

Course Code: RUSMJPHYE312

Course Title: Electronics (SEM-VI)

Academic Year: 2025-26

Course Outcomes:

Course Outcome	Description
CO1	Understand the basic electronic components FET, MOSFET, SCR and their applications.
CO2	Understand the selection and requirement of components based on Op-Amp component and its characteristics for various applications.
CO3	Understand the theory and applied aspects of DC power supply, Multivibrator OP-Amp and IC 555 Timer.
CO4	Understand the circuit assembling of various devices.
CO5	Understand Logic families- flip-flops and counters.
CO6	Understand Electronic communication techniques of modulations.

CO-PO Mapping

RUSMJPHYE312: Electronics (SEM-VI)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	2	1	2	1	1
CO2	3	3	2	2	2	2	1	1
CO3	3	3	2	3	2	3	2	1
CO4	2	3	2	3	2	3	2	1
CO5	3	3	2	3	2	3	2	1
CO6	3	3	2	3	2	3	2	1

Detailed Syllabus

RUSMJPHYE312: Electronics (SEM-VI)

Units	Title	Credits - 03
I	**Transistors**	**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 as an 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.	
II	**Operational Amplifier and 555 Timer**	**15 Lectures**
	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, 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.	
III	**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).	

Main References:

1. Electronic Principles by A. P. Malvino and D.J. Bates (7th Ed.) – (TMH).
2. Principles of Electronics by V.K. Mehta and Rohit Mehta. S. Chand Publications. (11th Ed.).
3. Functional Electronics by K.V. Ramanan (TMH).
4. Digital Principles and Applications by Malvino and Leach (4th Ed) (TMH).
5. Integrated Electronics by Millman & Halkias Mc Graw Hill International.

Additional References:

1. Electronic Devices and Circuits by S. Salivahanan, N. Suresh Kumar and A. Vallavaraj. (2nd Ed.) (Tata McGraw Hill)

Course Code RUSMJPHYPE312	Practical based on DSC- II	Credits/ Hours
1.	To study the Schmitt trigger using IC 741 OpAmp	1 credit/ 30 hours
2.	To study the IC-555 timer as a Astable Multivibrator	
3.	To study the IC-555 timer as ramp generator	
4.	To study FET characteristics	
5.	To study UJT as relaxation oscillator	
6.	To study SCR characteristics	
7.	To study SCR Half wave rectifier	
8.	To study Photodiode/Phototransistor characteristics	

Modality of Assessment – RUSMJPHYE312 (SEM-VI)

Theory Examination Pattern:

A) Internal Assessment – 40% of 75 Marks = 30 Marks

Sr. No.	Evaluation Type	Marks
1	Internal Class Test	20
2	Test/ Project / Assignment / Presentation	10
Total		**30**

B) External Examination (Semester End) - 60% of 75 Marks = 45 Marks

Semester End Theory Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q. 1 (A)	Any 2 out of 4 (Theory based)	10	Unit - I
Q.1 (B)	Any 1 out of 2 (Numerical)	05	
Q. 2 (A)	Any 2 out of 4 (Theory based)	10	Unit – II
Q. 2 (B)	Any 1 out of 2 (Numerical)	05	
Q. 3 (A)	Any 2 out of 4 (Theory based)	10	Unit - III
Q. 3 (B)	Any 1 out of 2 (Numerical)	05	
TOTAL		**45**	

Practical Examination Pattern (RUSMJPHYPE312):

C) External Examination (Semester End)- 25 Marks

Semester End Practical Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Practical question paper pattern:

Paper Pattern:

Question	Option	Marks
1	Laboratory work	20
2	Journal / Viva voce	05
	TOTAL	**25**

Course Code: RUSMJPHYE313

Course Title: Nuclear Physics (SEM - VI)

Academic Year: 2025-26

Course Outcomes:

Course Outcome	Description
CO1	Distinguish Gamow theory of alpha decay and derive Geiger- Nuttal law.
CO2	Compare the performances of different accelerators.
CO3	Evaluate each term involved in Weizsacker 's semi empirical mass formula and derive the equation of it.
CO4	Distinguish of discovery of basic elementary particle.
CO5	Understand the basics of Meson theory of nuclear force.
CO6	Understand the different elementary particle and their conservation laws.
CO7	Demonstrate quantitative problem-solving skills in all the topics covered.

CO-PO Mapping

RUSMJPHYE313: Nuclear Physics (SEM-VI)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	1	2	1	2	1	1
CO2	3	2	2	2	1	2	1	1
CO3	3	3	2	3	2	2	1	1
CO4	3	2	1	2	1	2	1	1
CO5	3	3	2	3	2	3	1	1
CO6	3	3	2	3	2	3	1	1
CO7	3	3	3	3	3	3	3	1

Detailed Syllabus

RUSMJPHYE313: Nuclear Physics (SEM- VI)

Unit/s	Title	Credits - 03
I	**Radioactive Decays and Nuclear Models**	**15 Lectures**
	Alpha Decay, Beta Decay, Gamma decay: Introduction, Internal conversion, nuclear isomerism, Mossbauer effect Nuclear Models: Liquid drop model, Weizsacker'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.	
II	**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, Neutron cycle in a thermal nuclear reactor (Four Factor Formula), Nuclear reactors, Natural fusion, Possibility of controlled fusion.	
III	**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).	

Main References:

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

Additional References:

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

Course Code: RUSMJP HYPE313	Practical based on DSC- III	Credits/ Hours
1	Characteristics of a radioactive material using Geiger Muller counter and measurement of dead time.	**1 credit / 30 Hrs**
2	Verification of Inverse Square Law for Gamma Rays.	
3	Linear and Mass attenuation coefficient using Gamma Source.	
4	To study Beta Particle Range and Maximum Energy.	
5	Tutorials on Unit-I	
6	Tutorials on Unit-II	
7	Tutorials on Unit-III	

Modality of Assessment – RUSMJPHYE313 (SEM-VI)

Theory Examination Pattern:

A) Internal Assessment – 40% of 75 Marks = 30 Marks

Sr. No.	Evaluation Type	Marks
1	Internal Class Test	20
2	Class Test/ Project / Assignment / Presentation	10
Total		**30**

B) External Examination (Semester End) - 60% of 75 Marks = 45 Marks

Semester End Theory Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q. 1 (A)	Any 2 out of 4 (Theory based)	10	Unit - I
Q.1 (B)	Any 1 out of 2 (Numerical)	05	
Q. 2 (A)	Any 2 out of 4 (Theory based)	10	Unit – II
Q. 2 (B)	Any 1 out of 2 (Numerical)	05	
Q. 3 (A)	Any 2 out of 4 (Theory based)	10	Unit – III
Q. 3 (B)	Any 1 out of 2 (Numerical)	05	
TOTAL		**45**	

Practical Examination Pattern (RUSMJPHYPE313):

C) External Examination (Semester End)- 25 Marks

Semester End Practical Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Practical question paper pattern:

Paper Pattern:

Question	Option	Marks
1	Laboratory work	20
2	Viva voce	05
	TOTAL	**25**

Course Code: RUSMJPHYE314 A

Course Title: Electrodynamics (SEM-VI)

Academic Year: 2025-26

Course Outcomes:

Course Outcome	Description
CO1	Understand the basic mathematical concepts of vector calculus and its applications of them in Electrodynamics
CO2	Understand the basic laws of electrodynamics and be able to perform calculations in the problems related to Physical situations.
CO3	Understand the penetration of electric and magnetic field in dielectric material and its practical applications
CO4	Acquired conceptual understanding of the Maxwell's laws and its quantitative interpretations.

CO-PO Mapping

RUSMJPHYE314 A – Electrodynamics (SEM-VI)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**3**	**2**	**2**	**3**	**1**	**1**	**1**	**1**
CO2	**3**	**3**	**2**	**3**	**2**	**2**	**1**	**1**
CO3	**3**	**2**	**2**	**2**	**1**	**2**	**1**	**1**
CO4	**3**	**3**	**2**	**3**	**2**	**2**	**1**	**1**

Detailed Syllabus

RUSMJPHYE314 A: Electrodynamics (SEM-VI)

Units	Title	Credits – 03
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 First Uniqueness theorem (Without proof), The classic image problem- Infinite conducting plane. Greiner— chapter 2- Green's theorems, Green's function, Ex 2.1 (Image charge problems)	
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. 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.	
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. 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.	

Main References:

1. Introduction to Electrodynamics by David Griffith (3rd edition)-Prentice Hall of India (DG)
2. Introduction to Electrodynamics by A. Z. Capria and P. V. Panat.

3. Electricity and Magnetism by Navina Wadhwani
4. Classical Electrodynamics by J D Jackson.

Course Code: RUSMJ PHYP31 4 A	**Practical based on DSE- I**	**Credits/Hours**
1	To Study Simple Dipole (λ /2) antenna.	**1 credit/ 30 Hrs**
2	To study the Polar graph/ radiation pattern of an Antenna using software.	
3	To study SWR Measurement of waves using Antenna kit.	
4	Amplitude Modulation.	
5	Frequency Modulation.	

Modality of Assessment – RUSMJPHYE314 A (SEM-VI)

Theory Examination Pattern:

A) Internal Assessment – 40% of 75 Marks = 30 Marks

Sr. No.	**Evaluation Type**	**Marks**
1	Internal Class Test	20
2	Test/ Project / Assignment / Presentation	10
Total		**30**

B) External Examination (Semester End) - 60% of 75 Marks = 45 Marks

Semester End Theory Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q. 1 (A)	Any 2 out of 4 (Theory based)	10	Unit - I
Q.1 (B)	Any 1 out of 2 (Numerical)	05	
Q. 2 (A)	Any 2 out of 4 (Theory based)	10	Unit – II
Q. 2 (B)	Any 1 out of 2 (Numerical)	05	
Q. 3 (A)	Any 2 out of 4 (Theory based)	10	Unit - III
Q. 3 (B)	Any 1 out of 2 (Numerical)	05	
TOTAL		**45**	

Practical Examination Pattern (RUSMJPHYPE314 A):

C) External Examination (Semester End)- 25 Marks

Semester End Practical Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Practical question paper pattern:

Paper Pattern:

Question	Option	Marks
1	Laboratory work	20
2	Journal / Viva voce	05
	TOTAL	**25**

Course Code: RUSMJPHYE314 B

Course Title: Elements of Material Science (SEM-VI)

Academic Year: 2025-26

Course Outcomes:

Course Outcome	Description
CO1	Describe types of materials, their properties and identify types of defects.
CO2	Explain functional properties of ceramic bulk materials.
CO3	Differentiate between special Nanomaterials CNT's, porous silicon & Aerogels.
CO4	Formulate the different parameters from XRD, SEM, TEM, etc.
CO5	Explore the application of Nanomaterials in different fields.

CO-PO Mapping

RUSMJPHYE314 B – Elements of Material Science (SEM-VI)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	2	2	1	1	1
CO2	3	3	2	2	2	2	1	1
CO3	3	3	3	3	2	2	1	1
CO4	3	3	3	3	2	2	1	2
CO5	3	3	3	3	3	2	2	2

Detailed Syllabus

RUSMJPHYE314 B – Elements of Material Science (SEM-VI)

Units	Title	Credits - 03
I	**Materials and their properties**	**15 Lectures**
	Materials and their properties: Types of materials: Conductors, Semiconductors and Insulators, Materials properties: Mechanical, Electrical and thermal, Impurities in solids. Defects in solids: Point, Line, Surface and Volume. Deformation, Electromagnetic behaviour of ceramics - Electric properties: dielectrics, semiconductors, piezoelectric, Magnetic Properties: Magnetic Ceramics, hard and soft ferrites.	
II	**Characterization techniques**	**15 Lectures**
	i) XRD, Small angle X – ray scattering (SAXS), Low energy electron diffraction (LEED) ii) Electron Microscopy: SEM, EDAX, TEM, Environmental TEM iii) SPM, AFM, STM iv) Nano magnetic techniques: Super conducting quantum interface device measurement (SQUID), Magneto resistance measurement technique.	
III	**Nanomaterials and its applications**	**15 Lectures**
	i) Some Special Nanomaterial Introduction, Carbon nanotubes (CNTs), Porous Silicon, Aerogels, Zeolites, Ordered Porous Materials Using Micelles as Templates. **ii) Applications of nanomaterial** Introduction, Electronics, Energy, Automobiles, Sports and Toys, Textiles, Cosmetics, Domestics Appliances, Biotechnology and Medical Field, Space and Defense, Nanotechnology and Environment.	

Main References:

1. Materials Science and Engineering by V. Raghavan (5th Edition) **(VR)**
2. Nanotechnology, Principles & Practices by Sulabha Kulkarni **(SK)**

3. Elements of Materials Science and Engineering by L. H. Van Vlack (6th Edition)
4. Elements of X-Ray diffraction by B. D. Cullity.
5. X – ray Structure Determination by G.H. Stout and I.H. Jensen
6. Fundamentals of Molecular Spectroscopy by C. Banwell and E. McCash
7. Nanomaterial by A.K. Bandyopadhyay

Course Code: RUSMJPHYPE314B	**Practical based on DSE II**	**Credits/Hours**
1	Characterization study of nanomaterial (Powder) using XRD techniques.	**1 credit / 30 Hrs**
2	To study average grain size using Image J software.	
3	Characterization study of nanomaterial (Powder) using UV techniques.	
4	Characterization study of nanomaterial (Powder) using FTIR techniques.	
5	Characterization study of nanomaterial (Powder) using RAMAN techniques.	

Modality of Assessment – RUSMJPHYE314 B (SEM-V)

Theory Examination Pattern:

A) Internal Assessment – 40% of 75 Marks = 30 Marks

Sr. No.	**Evaluation Type**	**Marks**
1	Internal Class Test	20
2	Test/ Project / Assignment / Presentation	10
	Total	**30**

B) External Examination (Semester End) - 60% of 75 Marks = 45 Marks

Semester End Theory Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q. 1 (A)	Any 2 out of 4 (Theory based)	10	Unit – I
Q.1 (B)	Any 1 out of 2 (Numerical)	05	
Q. 2 (A)	Any 2 out of 4 (Theory based)	10	Unit – II
Q. 2 (B)	Any 1 out of 2 (Numerical)	05	
Q. 3 (A)	Any 2 out of 4 (Theory based)	10	Unit – III
Q. 3 (B)	Any 1 out of 2 (Numerical)	05	
TOTAL		**45**	

Practical Examination Pattern (RUSMJPHYPE314 B)

C) External Examination (Semester End)- 25 Marks

Semester End Practical Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Practical question paper pattern:

Paper Pattern:

Question	Option	Marks
1	Laboratory work	20
2	Journal/ Viva voce	05
	TOTAL	**25**

Overall Examination and Marks Distribution Pattern:

Course	RUSMJPHYE 311			RUSMJPHYE 312			RUSMJPHYE 313			RUSMJPHYE 314 A/ RUSMJPHYE 314 B			RUSMIPHYP315			RUSOIT316			Total
	I	E	T	I	E	T	I	E	T	I	E	T	I	E	T	I	E	T	
Theory	30	45	75	30	45	75	30	45	75	30	45	75	20	30	50	50	50	100	450

Course	RUSMJPHYPE 311	RUSMJPHYPE 312	RUSMJPHYPE 313	RUSMJPHYPE 314 A/ RUSMJPHYPE 314 B	Total
Practical	25	25	25	25	100

[Grand Total Marks: 550]
