Since 1989

Devoted to Serve

Royal College of Arts Science and Commerce (Autonomous)

Affiliated to University of Mumbai

Program: BSc

Course: Physics

Syllabus for Semester: III and IV

Syllabus for Undergraduate Programme as per National Education Policy (NEP-2020) with effect from the academic year 2025-2026

Principal
ROYAL COLLEGE OF ARTS
SCIENCE & COMMERCE
PENKAR PADA, MIRA ROAD.
DIST : THANE. PIN : 401107

NEP Credit Structure for Science

Level	Sem	Major		Minor	OE	VSC	SEC	AEC	IKS	VEC	OJT/FP /RP/CC /CEP	Cumulative Credits	
		DSC	DSE										
4.5	I	6		6	2	2		2	2	2		22	**UG Certificate Cumulative Credit:44**
	II	6		6	2		2	2		2	2	22	
Exit Option: Award of UG Certificate in Major with 40 -44 Credits and an Additional 4 Credits Core NSQF Course / Internship OR Continue with Major and Minor													
5	III	8		4	2+2		2	2			2	22	**UG Diploma Cumulative Credit:88**
	IV	8		4	2+2		2	2			2	22	
Exit Option: Award of UG Diploma in Major and Minor with 80-88 Credits and an Additional 4 Credits Core NSQF Course / Internship OR Continue with Major and Minor													
5.5	V	10	4			4					4	22	**UG Degree Cumulative Credit:132**
	VI	10	4			4					4	22	
	Total	**48**	**8**	**20**	**12**	**10**	**6**	**8**	**2**	**4**	**14**	**132**	

Proposed List of All Courses offered from Semesters I – VI in Physics

Level	Sem	Major subject Course titles	Minor subject Course titles	Electives Course titles	OE Course titles	VSC Course title/s	SEC Course title/s
4.5 100-199	I	Mechanics and Thermodynamics Modern Physics and Nuclear Physics				Measuring Instruments	
	II	Optics Electricity and Electronics					Digital Electronics
5 200-299	III	Mechanics and Optics Electricity and Magnetism Thermodynamics	Crystal Physics, Renewable Energy				Computational Physics using Python
	IV	Quantum Mechanics Mathematical Physics Electronics	Quantum Mechanics and Radiation Detectors				Arduino Programming
5.5 300-399	V	Solid State Physics Thermal and statistical Physics Atomic and Molecular Physics Electrodynamics		SQL and Data Science I		1. Electronics Instrumentation Java Programming	
	VI	Classical Mechanics Major Subject IKS Nuclear Physics Relativity		Java Programming and Data Science II		1. Advanced Electronics Machine Learning	

Programme Outcomes (POs) for B. Sc.

Sr. No.	On completing B.Sc. the student will have:
PO1	Acquired the basic knowledge related to the subject offered.
PO2	Understood the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevance in day-to-day life.
PO3	Acquired the skills in handling scientific instruments.
PO4	Acquired the skills of planning and performing laboratory experiments, recording observations and drawing logical inferences from the scientific experiments.
PO5	Developed scientific outlook not only with respect to science subjects but also in all aspects related to life.

Programme Specific Outcomes (PSOs) for B.Sc. Physics

Sr. No.	On completing B.Sc. Physics, the student will be able to :
PSO1	Understand basic concepts of physics.
PSO2	Acquire a systematic understanding of the core areas of physics, including mechanics, thermodynamics, Quantum Mechanics, Atomic and Nuclear Physics, Mathematical Physics and Electronics at a level compatible with graduate programs.
PSO3	Be able to analyze and interpret quantitative results, both in the core areas of physics and interdisciplinary areas.
PSO4	Be able to use contemporary experimental apparatus and analysis tools to acquire, analyze and interpret Scientific data.
PSO5	Be able to apply the principles of physics to solve new and unfamiliar problems.
PSO6	Be able to effectively communicate scientific results.
PSO7	Demonstrate professional behavior such as (i) being objective, unbiased and truthful in all aspects of work and avoiding unethical, irrational behavior such as fabricating, falsifying or misrepresenting data or committing plagiarism; (ii)the ability to identify the potential ethical issues in work-related situations; (iii) appreciation of intellectual property and environmental issues.

SEMESTER III

Course/ Paper Title	**Mechanics and Optics**
Course offered as	**Major**
Course Code	**RUSPHMJ301**
Semester	**III**
No. of Credits	**2**
No. of lecture Hours/week	**2**

Sr. No.	Course Learning Objectives
1	Understand the fundamentals of SHM.
2	Explore the behavior of coupled oscillations.
3	Understand the principles of damped oscillations.
4	Investigate practical applications of oscillations and develop problem-solving skills in mechanics.
5	To understand the phenomenon diffraction of light
6	To learn about polarization of light and its importance
7	To understand the methods to polarize light and its application

Course Outcome:

	On completing the course, the student will be able to :
CO1	Apply the principles of linear SHM and angular SHM.
CO2	Interpret and generate Lissajous figures.
CO3	Analyze damped oscillations and their real-world applications.
CO4	Describe Fresnel diffraction and diffraction pattern
CO5	Identify plane polarized light using various methods and analyze the type of polarization
CO6	Apply the concept of polarization in making optical devices

CO-PO mapping (RUSPHMJ301)

	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓			
CO2	✓		✓		✓
CO3	✓		✓		✓
CO4	✓	✓			✓
CO5	✓			✓	✓
CO6	✓	✓		✓	✓

CO-PSO mapping (RUSPHMJ301)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓			✓	✓	
CO2	✓	✓	✓		✓	✓	✓
CO3			✓		✓	✓	✓
CO4	✓				✓	✓	
CO5		✓			✓	✓	
CO6		✓			✓	✓	

Detailed Syllabus :

Module	Title with content	No. of lectures	CO Mapping
I	**Mechanics** **1. Undamped free oscillations :** Definition of Simple harmonic motion, Differential equation for SHM and its solution, Energy of SHM, Angular SHM, compound pendulum, Helmholtz resonator, Composition of SHM, Composition of two perpendicular linear S.H.Ms. for frequency ratio 1:1 and 2:1. Lissajous figures, their demonstration (optical and electrical method) and applications, problems. **SP : 2.1-2.2, 2.3.2, 2.3.3, 2.4, 2.4.1, 2.4.3, 2.4.4**	**7**	**CO1** **CO2**
	2. Damped oscillations Introduction, Differential equation for damped harmonic oscillator and its solution, discussion of different cases, Types of damping, Methods of finding damping coefficient : Logarithmic decrement, quality factor of a damped oscillator, Example of Damping in Physical Systems : Electromagnetic damping – Eddy currents, Eddy current and their applications. **SP : 3.1, 3.2, 3.3, 3.3.1, 3.3.3, 3.4, 3.4.2, 3.4.3**	**8**	**CO3**

II	**Diffraction** **1. Fresnel diffraction:** Introduction, Huygens-Fresnel's theory, Fresnel's assumptions, Distinction between interference and diffraction, Fresnel and Fraunhoffer types of diffraction, Diffraction pattern due to straight edge: positions of maximum and minimum intensity**,** Fraunhoffer diffraction (Introduction) **SBA: 17.1,17.2,17.3,17.6,17.7.17.10,17.10.1,17.10.2,18.1** **2. Polarization:** Introduction, Production of Polarized light: Polarization by Reflection, Brewster's law, Polarization by Double Refraction, Polarizer and analyzer, Malus' Law, Retarders: Quarter wave plates and half wave plates (Qualitative) Ordinary and Extra Ordinary Rays, Positive and Negative crystals **SBA: 20.1, 20.6, 20.6.1, 20.6.1.1, 20.6.5, 20.8, 20.9, 20.19, 20.19.1, 20.9.2, 20.11.2, 20.11.3**	**15**	**CO3** **CO4, CO5**

References :

1. SP: Textbook of Vibrations and Waves-S. P. Puri, Tata McGraw-Hill publication
2. SBA: A Textbook of Optics, by Dr. N. Subrhmanyam, Brijlal, and Dr. M. N. Avadhanulu, 25th Revised Edition (2012) S. Chand

Additional Reference:

1. Waves and Oscillations - R.N. Chaudhari, New Age International (p) ltd.
2. Mechanics and Thermodynamics -G. Basavaraju, Dipan Ghosh, Tata McGraw Hill.
3. The Physics of Waves and Oscillations - N. K. Bajaj, Tata McGraw- Hill, publication.
4. Optics Eugene Hect, 5th Edition, Pearson
5. Optics, 6th Edition Mc Graw Hill Education by Ajoy Ghatak

Course/ Paper Title	**Electricity and Magnetism**
Course offered as	**Major**
Course Code	**RUSPHMJ302**
Semester	**III**
No. of Credits	**2**
No. of lecture Hours/week	**2**

Sr. No.	Course Learning Objectives
1	To make students analyze and determine the Thevenin voltage and Thevenin resistance.
2	To help student determine the Norton equivalent current and Norton equivalent resistance
3	To make students understand the principle of reciprocity theorem and maximum power transfer theorem
4	To enable students to apply Gauss's law to determine the capacitance of different capacitor configurations. To help students explore dielectric materials and their impact on capacitor performance.
5	To enable students to understand the motion of a Charged Particle in electric and magnetic field and explore its applications.
6	To help students to study the Working Principles of Cyclotrons and Synchrotrons.
7	To make students understand the Del Operator and Its Significance.
8	To make student understand the gradient of a scalar field and divergence and curl of a vector field. Understand the Fundamental Theorems of Divergence and Curl.
9	To help the student to explore Ampère’s Law and Its Applications.

Course Outcome:

	On completing the course, the student will be able to:
CO1	Apply Thevenin’s theorem in real-world electrical networks and problem-solving.
CO2	Analyze circuit behavior using Norton’s theorem, Reciprocity theorem and maximum power transfer theorem.
CO3	Utilize Gauss’s law to compute the capacitance of parallel plate and cylindrical capacitors.
CO4	Demonstrate the working principles of capacitors in real-world applications
CO5	Analyze the motion of charged particles in electric and magnetic fields.
CO6	Explain the working principles of Cyclotrons and Synchrotrons.
CO7	Apply del operator and gradient, divergence and curl to solve Physics problems.
CO8	Apply Ampère’s Law to long straight wires, solenoids, and toroid.

CO-PO mapping (RUSPHMJ302)

	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓			
CO2	✓	✓		✓	
CO3	✓	✓			
CO4	✓	✓			✓
CO5	✓	✓		✓	
CO6	✓	✓	✓		✓
CO7	✓	✓		✓	
CO8	✓	✓		✓	

CO-PSO mapping (RUSPHMJ302)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	✓		✓	✓	
CO2	✓	✓	✓		✓	✓	
CO3	✓	✓	✓		✓		
CO4	✓	✓	✓		✓	✓	
CO5	✓	✓	✓		✓		
CO6	✓	✓	✓	✓	✓	✓	
CO7	✓	✓	✓		✓		
CO8	✓	✓	✓		✓		

Detailed Syllabus:

Module	Title with content	No. of lectures	CO Mapping
I	**Circuit theorems**: -Thevenin theorem, Norton theorem, Reciprocity theorem, Maximum power transfer theorem. **CR: 7.7, 7.8, 7.9, 7.10, 7.11**	**15**	**CO1, CO2**
	Capacitance and Dielectric: Review of basics of capacitor and capacitance. Application of Gauss law to find capacitance of the parallel plate capacitor and cylindrical capacitor, Energy Stored in an Electric Field, Dielectrics, Capacitor with a dielectric, Application of capacitors: Condenser microphone, camera flash, touch screen, Super Capacitors. **HR: 25.2, 25.4, 25.5, only till equation no. 25.29** **SZ: 24.1, 24.4**		**CO3, CO4**

II	**Charged Particle Dynamics** Motion of a charged particle in a constant electric field, Force on a charged particle in a magnetic field. (Only Case I: crossed electric field field) Charged particle in an alternating electric field. Charged particle in a uniform and constant magnetic field Lorentz force, Cyclotrons and Synchrotrons (description) **HP-13.2, 13.3, 13.4, 13.5, 13.4.1** **HR- 28.5**	**15**	**CO5, CO6**
	Differential Calculus: The Del Operator, Gradient, The Divergence, The Curl, Fundamental theorems of divergence and curl (only statement) **Divergence and curl of B**: Straight-Line Currents, Ampère's Law, Divergence of E, Application of Ampere's law (straight wire, solenoid, toroid) **DG: 1.2.2 – 1.2.5, 5.3.1 and 5.3.3** **CR: 8.5**		**CO7, CO8**

References :

1. CR: Electricity and Magnetism - D. Chattopadhyay and P. C. Rakshit Books and allied (P) Ltd. Reprint 2000 (4th Ed.)
2. HR: Halliday and Resnick Fundamentals of Physics by J. Walker - John Wiley & Sons ()
3. SZ: Sears and Zemansky's University Physics, by R.A. Freedman and H.D. Young – Pearson 14th Edition.
4. HP: Mechanics – Hans and Puri, 2nd Ed. Tata McGraw Hill.
5. DG: Introduction to Electrodynamics, David J. Griffiths (4th Ed) Prentice Hall of India.

Additional References:

1. A text book of electrical technology, vol 1, B. L. Theraja, A. K. Theraja and S. G. Tarnekar.
2. Introduction to Electrodynamics: A. Z. Capria and P. V. Panat. Narosa Publishing House.
3. Mechanics and Electrodynamics, Brij Lal, Subramanyam, Jivan Sesan, (S. Chand) (Revised & Enlarged ED. 2005)

Course/ Paper Title	Thermodynamics
Course offered as	Major
Course Code	RUSPHMJ303
Semester	III
No. of Credits	2
No. of lecture Hours/week	2

Sr. No.	Course Learning Objectives
1	To learn about thermodynamics laws and calibrate absolute scale of temperature
2	To understand about different types of combustion heat engines
3	To understand the concept of entropy and its importance in thermodynamics
4	To learn about third law of thermodynamics and its application on system
5	To familiarize about the methods to achieve low temperature

Course Outcome :

	On completing the course, the student will be able to :
CO1	Apply thermodynamics laws to solve problems
CO2	Discuss and distinguish between different types of combustion heat engines
CO3	Describe the concept of entropy and its application in various systems
CO4	Apply all the four laws of thermodynamics to solve thermodynamics problems
CO5	Create low temperature which can be used for various purpose

CO-PO mapping (RUSPHMJ303)

	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓			✓
CO2		✓	✓		✓
CO3		✓	✓		✓
CO4		✓	✓		✓
CO5	✓	✓			✓

CO-PSO mapping (RUSPHMJ303)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	✓		✓	✓	
CO2		✓			✓		✓
CO3		✓	✓				✓
CO4		✓		✓	✓		

CO5	✓	✓	✓		✓		✓

Detailed Syllabus:

Module	Title with content	No. of lectures	CO Mapping
I	(Review of zeroth, first and second law of thermodynamics) Carnot's theorem, Application of Carnot cycle - Otto engine, Efficiency of Otto cycle, (Self-study - Diesel cycle, Efficiency of Diesel cycle), comparison of Otto, and diesel cycle. Concept of Entropy, Change in Entropy, Change in Entropy in Adiabatic Process, Change in Entropy in Reversible cycle, Principle of increase of Entropy, Change in Entropy in Irreversible, Physical significance of entropy, Entropy of a perfect gas, Kelvin's thermodynamic scale of temperature, The size of a degree, zero of absolute scale. **BSH: 4.29, 4.31,4.33,5.1,5.2,5.3,5.4,5.5,5.6,5.8,5.9,5.10,5.11, 5.12,5.13**	**15**	
II	Third law of thermodynamics, Consequences of the third law, Maxwell's thermodynamic relations, Clausius-Clapeyron equation. Low temperature physics: Different methods of liquefaction of gases, Method of freezing, Cooling by Evaporation under reduced Pressure, Cooling by Adiabatic Expansion, Joule-Thomson Expansion, Liquefaction of gases, Principle of Regenerative Cooling and Liquefaction of Helium. **BSH: 5.15,5.16, 5.17,5.18,6.3,6.4,6.4.7, 7.1, 7.2, 7.3, 7.4,7.5,7.6, 7.7,7.11**	**15**	

References :

1. **BSH:** Brijlal, Subramanyam and Hemne, Heat Thermodynamics and Statistical Physics, S Chand, Revised, Multi-coloured,2007 Ed.

Additional References:

1. Thermal Physics, AB Gupta and H. Roy, Book and Allied (P) Ltd, Reprint 2008, 2009.
2. Thermodynamics and an introduction to thermostatics – Herbert B Callen, 2nd Edition, John, Wiley, and Sons.

Theory Examination Pattern for

(Major)

I	Internal Assessment	
a	One class test (Short answers/Objectives/ Multiple Choice)	**10**
b	Assignment/ Project/ Presentation/Book or research paper Review	**10**
	Total	**20 Marks**
II	Semester End Examination	**30 Marks**

Question Paper Pattern (Major)

Total Marks: 30

Duration: 1 hour

Module I **(15 Marks)**	**Q1 A Attempt any one (7 marks)** i Theory a. (7 M) b. (7 M) **Q1 B Attempt any one (3 marks)** ii Problem a. (3 M) b. (3 M) **Q1 C Multiple choice (3 marks)** i ii iii **Q1 D Fill in the blanks (2 marks)** i ii
Module II **(15 Marks)**	**Q2 A Attempt any one (7 marks)** i Theory c. (7 M) d. (7 M) **Q2 B Attempt any one (3 marks)** ii Problem c. (3 M) d. (3 M) **Q2 C Multiple choice (3 marks)** i ii iii **Q2 D Fill in the blanks (2 marks)** i ii

Course/ Paper Title	**Physics Practical**
Course offered as	**Major Practical**
Course Code	**RUSPHMJP3**
Semester	**III**
No. of Credits	**2**
No. of lecture Hours/week	**4**

Sr. No.	Course Learning Objectives
1	To provide students with hands-on experience in fundamental physics concepts by performing experiments across subjects like optics, electromagnetism, and mechanics.
2	To help students develop analytical skills, enhance their understanding of theoretical principles, and learn experimental techniques essential for scientific inquiry.

Course Outcome:

	On completing the course, the student will be able to :
CO1	Use experimental apparatus and techniques for conducting measurements and observations related to mechanics and optics.
CO2	Understand the connection between theoretical concepts with experiments.
CO3	Apply the theories they've learned to solve real-time problems.

CO-PO mapping (RUSPHMJP3)

	PO1	PO2	PO3	PO4	PO5
CO1			✓	✓	
CO2	✓	✓		✓	✓
CO3	✓	✓			✓

CO-PSO mapping (RUSPHMJP3)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1		✓	✓	✓			✓
CO2	✓	✓	✓	✓		✓	
CO3	✓	✓	✓		✓	✓	

Regular experiments:

Sr. No.	Skills Experiments
1	Drawing of graph on semi logarithmic / logarithmic scale.
2	Simple PCB making.
3	Use of electronic balance: Find the density of a solid cylinder
4	Dual trace CRO: Phase shift measurement
5	Use of DMM- for component testing- diode and transistor
	Experiments
1	Helmholtz resonator- determination of unknown frequency
2	Y by Koenig's method
3	Verification of Thevenin's Theorem
4	Verification of Norton's Theorem
5	Verification of Maximum Power Transfer Theorem
6	Double refraction
7	Brewster's law
8	Optical lever
9	Cylindrical obstacle.
10	Resolving power of grating.
11	Gauss Meter: Determination of Magnetic Field
12	Bar pendulum

Reference Books:

1. Advanced Practical Physics, B. L. Worsnop and H.T. Flint (Asia Publishing)
2. Practical Physics, M. Nelkon and J. Ogborn (Heinemann)
3. A Laboratory Manual of Physics for Undergraduate Classes, D. P. Khandelwal (Vani)
4. BSc Practical Physics: Harnam Singh. S. Chand & Co. Ltd. – 2001.
5. A Text book of Practical Physics: Samir Kumar Ghosh New Central Book
6. Agency (4th edition).
7. B Sc. Practical Physics: C. L. Arora (1st Edition) – 2001 S. Chand & Co.
8. Ltd.
9. Practical Physics: C. L. Squires – (3rd Edition) Cambridge University Press.

Rules of Practical:

- All skill experiments must be reported in the journal
- A Minimum of 10 experiments must be reported in journal.

Practical examination :

	External Assessment for Practical	50 Marks
	Experiment I	**30**
	Viva	**10**
	Journal	**10**

- A learner will be allowed to appear for the semester end practical examination only after the learner submits a certified journal of Physics.
- The duration of the practical exam will be of three hours.

Course/ Paper Title	**Crystal Physics, Renewable Energy**
Course offered as	**Minor**
Course Code	**RUSPHMN301**
Semester	**III**
No. of Credits	**2**
No. of lecture Hours/week	**2**

Sr. No.	Course Learning Objectives
1	To understand the basics of crystallography
2	To learn about different types of crystals and their representation
3	To understand the importance of renewable energy
4	To learn about the solar energy and its application

Course Outcome:

	On completing the course, the student will be able to :
CO1	Describe the crystallographic structure of solid
CO2	Distinguish between different types of crystal structure
CO3	Describe the environmental aspects of renewable energy resources
CO4	Explain the use of solar energy and the various components used in the energy production

CO-PO mapping (RUSPHMN301)

	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓			✓
CO2	✓	✓			✓
CO3	✓	✓			✓
CO4	✓	✓			✓

CO-PSO mapping (RUSPHMN301)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓					
CO2	✓	✓	✓			✓	
CO3	✓	✓	✓				✓
CO4	✓	✓	✓		✓	✓	✓

Detailed Syllabus:

Module	Title with content	No. of lectures	CO Mapping
I	**Crystal Physics**: 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, examples of simple crystal structures, problems. **SOP: Chapter 4**: I,II,III,IV,V,VI,VII,VIII,XIII,XIV,XV,XVI, XVIII,XX,XXII	**15**	**CO1, CO2**
II	**Renewable Energy:** Introduction: Principles of renewable energy, energy and sustainable development, fundamentals and social implications. worldwide renewable energy availability, renewable energy availability in India, brief descriptions on solar energy, wind energy, tidal energy, wave energy, ocean thermal energy, biomass energy, geothermal energy. **Solar Energy:** Fundamentals, Solar Radiation, Estimation of solar radiation on horizontal and inclined surfaces, Solar radiation Measurements: Pyrheliometers, Pyrometer, Sunshine Recorder. **NES:** 1.1,1.2.1.3.1.4,2.1,2.2,2.3,2.4,2.5	**15** **15**	**CO3, CO4**

References:

1. SOP: Solid State Physics: S. O. Pillai, New Age International. 6th Ed.
2. NES: Nonconventional Energy sources, G D Rai, Khanna Publication, Fourth Edition

Theory Examination Pattern for

(Minor)

I	Internal Assessment	
a	One class test (Short answers/Objectives/ Multiple Choice)	**10**
b	Assignment/ Project/ Presentation/Book or research paper Review	**10**
	Total	**20 Marks**
II	Semester End Examination	**30 Marks**

Question Paper Pattern (Minor)

Total Marks: 30

Duration: 1 hour

Module I (15 Marks)	**Q1 A Attempt any one (7 marks)** i Theory e. (7 M) f. (7 M) **Q1 B Attempt any one (3 marks)** ii Problem e. (3 M) f. (3 M) **Q1 C Multiple choice (3 marks)** i ii iii **Q1 D Fill in the blanks (2 marks)** i ii	
Module II (15 Marks)	**Q2 A Attempt any one (7 marks)** i Theory g. (7 M) h. (7 M) **Q2 B Attempt any one (3 marks)** ii Problem g. (3 M) h. (3 M) **Q2 C Multiple choice (3 marks)** i ii iii **Q2 D Fill in the blanks (2 marks)** i ii	

Course/ Paper Title	**Physics Practical (Minor)**
Course offered as	**Practical**
Course Code	**RUSPHMNP3**
Semester	**III**
No. of Credits	**2**
No. of lecture Hours/week	**4**

Sr. No.	Course Learning Objectives
1	To provide students with hands-on experience in fundamental physics concepts by performing experiments across subjects like optics, thermodynamics, electromagnetism, and mechanics.
2	To help students develop analytical skills, enhance their understanding of theoretical principles, and learn experimental techniques essential for scientific inquiry.

Course Outcome :

	On completing the course, the student will be able to :
CO1	Use experimental apparatus and techniques for conducting measurements and observations.
CO2	Understand the connection between theoretical concepts with experiments.
CO3	Apply the theories learned to solve real-time problems.

CO-PO mapping (RUSPHMNP3)

	PO1	PO2	PO3	PO4	PO5
CO1			✓	✓	
CO2	✓	✓		✓	✓
CO3	✓	✓			✓

CO-PSO mapping (RUSPHMNP3)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1		✓	✓	✓			✓
CO2	✓	✓	✓	✓		✓	
CO3	✓	✓	✓		✓	✓	

Regular experiments:

Sr. No.	Experiments
1	Helmholtz resonator
2	Y by bending
3	Thermal conductivity by Lee’s method
4	Determination of wavelength of laser using grating and demonstration of 2D grating.
5	Passive low pass & High Pass filter
6	Passive band pass filter
7	Verification of Inverse square law using LUX meter
8	Resolving power of telescope
9	Double refraction
10	Figure of merit of a mirror galvanometer
11	Solar cell characteristics

Reference Books:

1. Advanced Practical Physics, B. L. Worsnop and H.T. Flint (Asia Publishing)
2. Practical Physics, M. Nelkon and J. Ogborn (Heinemann)
3. A Laboratory Manual of Physics for Undergraduate Classes, D. P. Khandelwal (Vani)
4. BSc Practical Physics: Harnam Singh. S. Chand & Co. Ltd. – 2001.
5. A Text book of Practical Physics: Samir Kumar Ghosh New Central Book
6. Agency (4th edition).

Rules of Practical:

- A Minimum of 9 experiments must be reported in journal.

Practical examination:

	External Assessment for Practical	50 Marks
	Experiment I	**30**
	Viva	**10**
	Journal	**10**

- A learner will be allowed to appear for the semester end practical examination only after the learner submits a certified journal of Physics.
- The duration of the practical exam will be of three hours.

Course/ Paper Title	**Computational Techniques in Physics using Python**
Course offered as	**Skill Enhancement Course**
Course Code	**RUSPHSEC301**
Semester	**III**
No. of Credits	**2**
No. of lecture Hours/week	**4**

Sr. No.	Course Learning Objectives
1	To help students develop skills to solve complex physical problems.
2	To help students develop computational skills to analyze physical systems, perform numerical calculations, and visualize data effectively.

Course Outcome:

	On completing the course, the student will be able to :
CO1	Write and execute Python programs for scientific computing.
CO2	Utilize libraries such as NumPy, SciPy, Matplotlib, and SymPy for numerical analysis and visualization.
CO3	Simulate, analyze, and visualize physical systems, equipping them with valuable problem-solving skills for research and industry applications.

CO-PO mapping (RUSPHSEC301)

	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓		✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓

CO-PSO mapping (RUSPHSEC301)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	✓	✓	✓		
CO2	✓	✓	✓	✓	✓	✓	
CO3	✓	✓	✓	✓	✓	✓	

Regular experiments:

Sr. No.	Experiments
1	Basic Python syntax: variables, operators, and simple calculations. **Activity:** Write a program to calculate velocity, force, or energy..
2	Using loops (for, while) and conditionals (if). Introduction to lists and arrays (NumPy basics). Simple input/output operations. Activity: Calculate the position of an object in free fall using a loop.
3	Introduction to data visualization using Matplotlib. Plotting physics data: Position vs. time. Velocity vs. time. Activity: Plot the trajectory of a projectile.
4	Introduction to SymPy
5	Solving simple algebraic equations (using SymPy). Numerical root-finding (bisection method). Activity: Find the root of a quadratic equation related to motion.
6	Concept of integration as the area under a curve. Numerical integration using the trapezoidal rule. Activity: Calculate the work done by a force using numerical integration.
7	Introduction to simulations. Simulating simple motion: Free fall. Motion under constant acceleration. Simulate and visualize the motion of a ball dropped from a height.
8	Basics of harmonic motion. Numerical solution of simple harmonic motion (Euler's method). Activity: Simulate and plot the motion of a mass on a spring.

Reference:

Doing Math with Python - Amit Saha

A Beginner's Guide to Python for Physical Modeling *by Jesse M. Kinder and Philip Nelson.*

Rules of Practicals :
Minimum 6 Experiment must be written in the journal.

Practical examination:

	External Assessment for Practical	**50 Marks**
	Experiment –I	20
	Experiment –II	10
	Viva	10
	Journal	10

- A learner will be allowed to appear for the semester end practical examination only after the learner submits a certified journal of Physics.
- The practical exam will be of two hours duration.

SEMESTER IV

Course/ Paper Title	**Quantum Mechanics**
Course offered as	**Major**
Course Code	**RUSPHMJ401**
Semester	**IV**
No. of Credits	**2**
No. of lecture Hours/week	**2**

Sr. No.	Course Learning Objectives
1	Understand the fundamental concepts of quantum mechanics.
2	To learn the concept of wave function and its physical interpretation.
3	Understand the application of Schrodinger equation to various quantum systems.
4	Explore quantum tunneling and its applications.
5	Understand how band structure emerges in one-dimensional periodic potentials.
6	Develop analytical and problem-solving skills in quantum mechanics.

Course Outcome :

	On completing the course, the student will be able to :
CO1	Understand and interpret the wave function, calculate probabilities and expectation values using wave functions.
CO2	Apply the quantum mechanical operators (position, momentum, and energy).
CO3	Solve the Schrodinger equation for simple systems.
CO4	Analyze energy quantization and degeneracy.
CO5	Explain and apply quantum tunneling
CO6	Demonstrate problem-solving skills in quantum mechanics

CO-PO mapping (RUSPHMJ401)

	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓			✓
CO2					✓
CO3					✓
CO4					
CO5	✓				✓
CO6			✓	✓	✓

CO-PSO mapping (RUSPHMJ401)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓				✓	
CO2			✓		✓	✓	
CO3		✓		✓	✓	✓	
CO4	✓					✓	
CO5		✓					
CO6	✓		✓	✓	✓	✓	

Detailed Syllabus :

Module	Title with content	No. of lectures	CO Mapping
I	**The Schrodinger wave equation:** Review : Blackbody Radiation, Particle duality, Heisenberg uncertainty principle. Concept of wave function, Born interpretation of wave function. Concepts of operator in quantum mechanics examples – position, momentum and energy operators, expectation values of operators. Class. Harmonic oscillator (classical & quantum). **AB : 5.1, 5.2, 5.6, 5.11**	**7**	**CO1**
	Eigenvalue equations, Schrodinger equation, Postulates of Quantum Mechanics, Analogy between Wave equation and Schrodinger equation, Time dependent and time independent (Steady State) Schrodinger equation, Stationary State, Superposition principle, Probability current density, Equation of continuity and its physical significance. **AB : 5.3, 5.4, 5.5**	**8**	**CO2**
II	**Applications of Schrodinger steady state equation-I** Free particle, step potential, particle in infinitely deep potential well (one - dimension), Particle in three-dimension rigid box, degeneracy of energy state. **AB : 5.8**	**7**	**CO3** **CO4**
	Applications of Schrodinger steady state equation-II Potential barrier (Finite height and width) penetration and tunneling effect (derivation of approximate transmission probability), Theory of alpha particle decay from radioactive nucleus. **AB : 5.10, Appendix to chapter 5**	**8**	**CO5** **CO6**

References:

1. Concepts of Modern Physics – A. Beiser (6th Ed.) Tata McGraw Hill.

Additional Reference:

1. Quantum Mechanics – S P Singh, M K Bagade, Kamal Singh, - S. Chand : 2004 Ed. 3.
2. Quantum Mechanics by H. C. Verma 2nd edition.
3. Introduction to Quantum Mechanics. - By D. Griffiths Published by Prentice Hall.

Course/ Paper Title	**Mathematical Physics**
Course offered as	**Major**
Course Code	**RUSPHMJ402**
Semester	**IV**
No. of Credits	**2**
No. of lecture Hours/week	**2**

Sr. No.	Course Learning Objectives
1	To make student develop a thorough understanding of line, surface, and volume integrals.
2	To help student analyze and apply the Fundamental Theorems of Gradient, Divergence, and Curl.
3	To make student understand the transformation between Cartesian and curvilinear coordinates.
4	To make student understand the Fundamentals of Complex Numbers and apply Complex Number theory to solve Physics problems.
5	To help student understand Second-Order Ordinary Differential Equations and Partial Differential Equations
6	To help student apply Second-Order Ordinary Differential Equations and Partial Differential Equations to solve Physics problems

Course Outcome:

	On completing the course, the student will be able to :
CO1	Solve problems using different integral like line, surface, and volume integrals in vector calculus.
CO2	Apply Stokes', and Gauss' divergence theorems for solving vector field problems.
CO3	Solve mathematical and physical problems using coordinate transformations.
CO4	Solve problems related to complex numbers and functions, including exponential, trigonometric, and hyperbolic functions and apply complex numbers to real-world problems in physics.
CO5	Solve second-order homogeneous differential equations with constant coefficients.
CO6	Solve Partial Differential Equations using the separation of variables technique and apply it to solve and analyze fundamental equations such as the heat equation, wave equation, and Laplace's equation.

CO-PO mapping (RUSPHMJ402)

	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓			✓
CO2	✓	✓			✓
CO3	✓	✓			✓
CO4	✓	✓			✓
CO5	✓	✓			✓
CO6	✓	✓			✓

CO-PSO mapping (RUSPHMJ402)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	✓		✓		
CO2	✓	✓	✓		✓		
CO3	✓	✓	✓		✓		
CO4	✓	✓	✓		✓		
CO5	✓	✓	✓		✓		
CO6	✓	✓	✓		✓		

Detailed Syllabus:

Module	Title with content	No. of lectures	CO Mapping
I	**Integral Calculus:** Line, surface, volume integrals, Problems related to Fundamental theorems of Gradient, Divergence and Curl. **Curvilinear Coordinates:** Curvilinear co-ordinates System. Relation between Cartesian and Curvilinear Coordinate System and vice versa, line area and volume element. **DG: 1.2.6 to 1.2.7, 1.3.1 to 1.3.4, 1.4.1 to 1.4.2,**	**15**	
II	**Complex Numbers**: Introduction, Real and imaginary parts of the complex numbers, the complex plane, the terminology and notation, the complex algebra: (i) simplifying to $x + iy$ form, (ii) complex conjugate of a complex expression, (iii) Finding the absolute value of z, (iv) Complex equations, (v) Graphs, (vi) Physical Applications; Functions of complex variables: The exponential and trigonometric functions, hyperbolic functions, some applications. **MB: Chapter 2: Topic no: 1 – 5, 11, 12, 16**	**15**	
	Differential Equations: Review of first order differential equations, Second-order homogeneous equations with constant coefficients, Second-order nonhomogeneous equations with constant coefficients, partial differential equations, some important partial differential equations in physics, method of separation of variables. **CH- 5.2.3, 5.2.4, 5.3.1 to 5.3.4**		

References :

1. DG: Introduction to Electrodynamics, David J. Griffiths (4th Ed) Prentice Hall of India.
2. CH: Introduction to Mathematical Methods: Charlie Harper (PHI Learning).
3. MB: Mathematical Methods in the Physical sciences: Mary L. Boas Wiley India, 3rd ed.

Additional Refrences :

1. H. K. Dass, Mathematical Physics, S. Chand & Co.
2. Mathematical Physics, B.D. Gupta-Vikas Publishing House, 4th Edition (2006).
3. Mathematical Physics, Sathya Prakash, Sultan Chand, 6th edition (2014).
4. Mathematical Physics Rajput, Pragathi Prakasan Pub., (2017).

Course/ Paper Title	**Electronics**
Course offered as	**Major**
Course Code	**RUSPHMJ403**
Semester	**IV**
No. of Credits	**2**
No. of lecture Hours/week	**2**

Sr. No.	Course Learning Objectives
1	Understand transistor biasing and stabilization.
2	Analyze power amplifiers and their performance.
3	Explore power electronics and silicon controlled rectifiers (SCR).
4	Understand the fundamentals of amplifiers.
5	Analyze different types of oscillators.
6	Gain knowledge of operational amplifiers (OP-AMPs) and its applications.

Course Outcome:

	On completing the course, the student will be able to :
CO1	Explain the need for faithful amplification and how biasing ensures stable transistor operation.
CO2	Compare different transistor biasing methods (base resistor, voltage divider, etc.) and calculate their stability factors.
CO3	Classify power amplifiers into Class A, B, AB, and C, and derive the collector efficiency of each type.
CO4	Explain the structure, working principle, and V-I characteristics of Silicon Controlled Rectifiers (SCRs) and its applications.
CO5	Analyze the general theory of feedback and explain the importance of negative feedback in amplifiers.
CO6	Explain the effect of positive feedback and its role in oscillator circuits and its applications
CO7	Explain working of Op-Amp and its various parameters.
CO8	Design and analyze various Op-Amp circuits.

CO-PO mapping (RUSPHMJ403)

	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓			✓
CO2	✓	✓	✓	✓	
CO3	✓	✓			
CO4	✓	✓	✓	✓	
CO5	✓	✓		✓	✓
CO6	✓	✓			✓
CO7	✓	✓	✓	✓	
CO8	✓	✓	✓	✓	✓

CO-PSO mapping (RUSPHMJ403)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓					
CO2	✓	✓	✓	✓	✓		
CO3	✓	✓	✓				
CO4	✓	✓	✓	✓	✓		
CO5	✓	✓	✓		✓		
CO6	✓	✓	✓				
CO7	✓	✓		✓			
CO8	✓	✓	✓	✓	✓	✓	

Detailed Syllabus:

<table>
<tr><th>Module</th><th>Title with content</th><th>No. of lectures</th><th>CO Mapping</th></tr>
<tr><td rowspan="3">I</td><td>1. Transistor Biasing
Faithful amplification, Transistor biasing, Inherent variation of transistor parameter, Stabilization, Stability factor, Methods of transistor biasing, base resistor method, voltage divider method. Stability factor for voltage divider bias.
VK : 9.1-9.8 , 9.12, 9.13</td><td>7</td><td>CO1
CO2</td></tr>
<tr><td>2. Power Amplifiers :
Transistor Audio Power Amplifier, output power of amplifier, Difference Between Voltage and Power Amplifiers, Performance Quantities of Power Amplifiers, Classification of Power Amplifiers, Expression for Collector Efficiency.
VK : 12.1, 12.3, 12.4, 12.5, 12.6, 12.7</td><td>5</td><td>CO3</td></tr>
<tr><td>3. Power electronics :
Silicon Controlled Rectifier (SCR), Working of SCR, Equivalent Circuit of SCR, Important Terms, V-I Characteristics of SCR, SCR in Normal Operation, SCR as a Switch, SCR Switching.
VK : 20.1-20.8</td><td>3</td><td>CO4</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">II</td><td>1. General Amplifier :
Concept of amplification, amplifier notations, current gain, Voltage gain, power gain, input resistance, output resistance, General theory of feedback, reasons for negative feedback.
AM : 7.1, 7.2 , 7.3 , 7.4, 7.5, 7.6, 7.7. , 8.1, 8.7, 8.8 , 17.1 , 17.2, 17.3</td><td>4</td><td>CO5</td></tr>
<tr><td>2. Oscillators
Introduction, effect of positive feedback. Requirements for oscillations, phase shift oscillator, Wien Bridge Oscillator, Colpitt's oscillator.
AM : 18.1 , 18.2 , 18.3 , 18.5 , 18.6</td><td>4</td><td>CO6</td></tr>
<tr><td>3. Operational Amplifier :
Introduction, Schematic symbol of OPAMP, Output voltage from OPAMP, Bandwidth of an OPAMP, Slew rate, Frequency Response of an OPAMP, Virtual ground concept, gain, offset voltage and current, OPAMP with Negative feedback, Inverting Amplifier, Non-Inverting Amplifier, Voltage Follower, Summing Amplifier, Applications of Summing amplifier, OPAMP Integrator and Differentiator, Critical frequency of Integrator, Comparator.
VK : 25.1 , 25.16 , 25.17 , 25.19, 25.20, 25.21, 25.22 , 25.24 , 25.26, 25.27, 25.32, 25.33 , 25.35 , 25.36, 25.37, 25.38 , 25.39</td><td>7</td><td>CO7
CO8</td></tr>
</table>

References:

Module I :

1. Principles of Electronics – V. K. Mehta and Rohit Mehta. (S. Chand –Multicolour revised edition)

Module II :

1. Electronic devices and circuits – An introduction Allan Mottershead (PHI Pvt. Ltd.– EEE – 1986)

2. Principles of Electronics – V. K. Mehta and Rohit Mehta. (S. Chand –Multicolour revised edition)

Additional Reference :

Electronic Principles, Malvino & Bates -7th Ed TMH Publication.

Functional Electronics, K.V. Ramanan-TMH Publication.

Theory Examination Pattern for
(Major)

I	Internal Assessment	
a	One class test (Short answers/Objectives/ Multiple Choice)	**10**
b	Assignment/ Project/ Presentation/Book or research paper Review	**10**
	Total	**20 Marks**
II	Semester End Examination	**30 Marks**

Question Paper Pattern (Major)

Total Marks: 30
Duration: 1 hour

Module I (15 Marks)	**Q1 A Attempt any one (7 marks)** i Theory i. (7 M) j. (7 M) **Q1 B Attempt any one (3 marks)** ii Problem i. (3 M) j. (3 M) **Q1 C Multiple choice (3 marks)** i ii iii **Q1 D Fill in the blanks (2 marks)** i ii
Module II (15 Marks)	**Q2 A Attempt any one (7 marks)** i Theory k. (7 M) l. (7 M) **Q2 B Attempt any one (3 marks)** ii Problem k. (3 M) l. (3 M) **Q2 C Multiple choice (3 marks)** i ii iii **Q2 D Fill in the blanks (2 marks)** i ii

Course/ Paper Title	**Physics Practical**
Course offered as	**Major Practical**
Course Code	**RUSPHMJP4**
Semester	**IV**
No. of Credits	**2**
No. of lecture Hours/week	**4**

Course Outcome :

	On completing the course, the student will be able to :
CO1	Use experimental apparatus and techniques for conducting measurements and observations related to mechanics and thermodynamics.
CO2	Understand the connection between theoretical concepts with experiments.
CO3	Apply the theories they've learned to solve real-time problems.

CO-PO mapping (RUSPHMJP4)

	PO1	PO2	PO3	PO4	PO5
CO1			✓	✓	
CO2	✓	✓		✓	✓
CO3	✓	✓			✓

CO-PSO mapping (RUSPHMJP4)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1		✓	✓	✓			✓
CO2	✓	✓	✓	✓		✓	
CO3	✓	✓	✓		✓	✓	

Regular experiments:

Sr. No.	Demonstration Experiments
1	Transformer (theory, construction and working), types of transformers and energy losses associated with them.
2	Use of LCR meter
3	Determination of Op-Amp parameters (offset voltage, slew rate)
4	Lissajous figures using mechanical methods.
	Experiments
1	Thermal conductivity by Lee's method
2	LCR parallel resonance
3	LCR transients
4	CE amplifier: determination of bandwidth
5	Wien bridge oscillator
6	Operational Amplifier as a Inverting amplifier.
7	Operational Amplifier as a non-Inverting amplifier and voltage follower
8	Operational Amplifier as Integrator.
9	Operational Amplifier as Differentiator.
10	Determination of wavelength of laser using grating
11	C_1/ C_2 by De Sauty's Bridge
12	Figure of merit of a mirror galvanometer
13	Study/Industrial visit

Reference Books:

1. Advanced Practical Physics, B. L. Worsnop and H.T. Flint (Asia Publishing)
2. Practical Physics, M. Nelkon and J. Ogborn (Heinemann)
3. A Laboratory Manual of Physics for Undergraduate Classes, D. P. Khandelwal (Vani)

Rules of Practical:

- All skill experiments must be reported in the journal
- A Minimum of 11 experiments must be reported in journal.
- Report of Study/Industrial visit must be entered in the journal.

Practical examination:

	External Assessment for Practical	50 Marks
	Experiment I	**30**
	Viva	**10**
	Journal	**10**

- A learner will be allowed to appear for the semester end practical examination only after the learner submits a certified journal of Physics.
- The duration of the practical exam will be of three hours.

Course/ Paper Title	**Quantum Mechanics and Radiation Detectors**
Course offered as	**Minor**
Course Code	**RUSPHMN401**
Semester	**IV**
No. of Credits	**2**
No. of lecture Hours/week	**2**

Sr. No.	Course Learning Objectives
1	Understand the historical background and need for quantum mechanics
2	Explore the Schrodinger equation and its applications:
3	Understand the physical interpretation of the wave function.
4	Learn about eigen functions, eigenvalues, and operators in quantum mechanics.
5	Solve the Schrodinger equation for a free particle and analyze its wave function for different quantum mechanical situations.
6	Understand the basic principles of radiation detectors.

Course Outcome :

	On completing the course, the student will be able to :
CO1	Explain the limitations of classical physics and the need for quantum mechanics
CO2	Solve the Schrodinger equation for basic quantum systems.
CO3	Analyze eigen functions and eigenvalues of quantum mechanical operators.
CO4	Solve the Schrodinger equation for simple systems.
CO5	Explain the basic principles of radiation detectors
CO6	Explain the concepts of radiation dose, dose equivalent, and effective dose.

CO-PO mapping (RUSPHMN401)

	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓			✓
CO2				✓	✓
CO3		✓			✓
CO4				✓	✓
CO5	✓	✓			✓
CO6	✓	✓	✓		✓

CO-PSO mapping (RUSPHMN401)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓					
CO2			✓		✓	✓	
CO3			✓			✓	
CO4			✓		✓		
CO5	✓	✓				✓	✓
CO6	✓	✓				✓	✓

Detailed Syllabus:

Module	Title with content	No. of lectures	CO Mapping
I	**1. Review & Origin of quantum Mechanics :** Blackbody radiation, particle duality, diffraction by double slit, atomic spectra. **TE : 1.3, 1.5, 1.6, 1.7**	**4**	**CO1**
	2. The Schrodinger equation : Introduction, classical waves and non-dispersive wave equation, Max born interpretation of wave function, Wave representation by complex function, quantum mechanical waves and Schrodinger equation, Solving the Schrodinger equation, Eigen function of quantum mechanical operator. **TE : 2-1-2.6**	**7**	**CO2**
	3. The quantum mechanical postulates : Physical interpretation of wave function, Eigen operator, Expectation value. **TE : 3.1, 3.2, 3.4**	**4**	**CO3**
II	**Applications of Schrodinger steady state equation-I** Free particle, Particle in infinitely deep potential well (one - dimension), Particle in two and three-dimension rigid box. **TE : 4.1-4.4**	**8**	**CO4**
	Radiation Detector : Radiation units, Sources of radiation: natural and man-made, Radiation protection. Types of Radiation detectors, Ionization Detectors, Scintillation detectors, Particle detectors, TLD, Thin film detectors, Radiation field analyzer, Basic principles of beam profile measurements **DRP**	**7**	**CO5** **CO6**

References:

1. Quantum Chemistry and Spectroscopy – Thomas Engle, Philip Reid (Pearson)
2. Course in DRP by Department of Atomic Energy

Additional References :

1. Quantum Mechanics – S P Singh, M K Bagade, Kamal Singh, - S. Chand : 2004 Ed. 3.
2. Quantum Mechanics by H. C. Verma 2nd edition.
3. Introduction to Quantum Mechanics. - By D. Griffiths Published by Prentice Hall.

Theory Examination Pattern for

(Minor)

I	Internal Assessment	
a	One class test (Short answers/Objectives/ Multiple Choice)	**10**
b	Assignment/ Project/ Presentation/Book or research paper Review	**10**
	Total	**20 Marks**
II	Semester End Examination	**30 Marks**

Question Paper Pattern (Minor)

Total Marks: 30
Duration: 1 hour

Module I (15 Marks)	**Q1 A Attempt any one (7 marks)** i Theory m. (7 M) n. (7 M) **Q1 B Attempt any one (3 marks)** ii Problem m. (3 M) n. (3 M) **Q1 C Multiple choice (3 marks)** i ii iii **Q1 D Fill in the blanks (2 marks)** i ii
Module II (15 Marks)	**Q2 A Attempt any one (7 marks)** i Theory o. (7 M) p. (7 M) **Q2 B Attempt any one (3 marks)** ii Problem o. (3 M) p. (3 M) **Q2 C Multiple choice (3 marks)** i ii iii **Q2 D Fill in the blanks (2 marks)** i ii

Course/ Paper Title	**Physics Practical**
Course offered as	**Minor Practical**
Course Code	**RUSPHMNP4**
Semester	**IV**
No. of Credits	**2**
No. of lecture Hours/week	**4**

Course Outcome:

	On completing the course, the student will be able to :
CO1	Determine resolving power, refractive indices, and Brewster's angle experimentally
CO2	Use capacitors, rectifiers, and voltage regulators for practical applications
CO3	Develop experimental and analytical skills in physics.

CO-PO mapping (RUSPHMNP4)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1		✓	✓	✓	
CO2	✓	✓	✓	✓	
CO3	✓	✓	✓	✓	✓

CO-PSO mapping (RUSPHMNP4)

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CO1		✓	✓	✓			✓
CO2	✓	✓	✓	✓	✓		
CO3	✓	✓	✓	✓	✓	✓	

Regular experiments:

Sr. No.	Experiments
1	Determination of wavelength of sodium source using grating
2	Cauchy’s constant
3	Brewsters laws
4	Maximum Power Transfer theorem.
5	Determination of magnetic field using Gauss meter.
6	Flat spiral spring (Y)
7	Viscosity using Poiseuille’s method.
8	To study load regulation of a Bridge Rectifier
9	To study Zener Diode as Regulator
10	I-V Characteristics of LED
11	Comparison of capacitances by De Sauty Bridge
12	Study of charging and discharging of a capacitor through a resistor

Reference Books:

Advanced Practical Physics, B. L. Worsnop and H.T. Flint (Asia Publishing)
Practical Physics, M. Nelkon and J. Ogborn (Heinemann)
A Laboratory Manual of Physics for Undergraduate Classes, D. P. Khandelwal (Vani)

Rules of Practical:

- All skill experiments must be reported in the journal
- A Minimum of 10 experiments must be reported in journal.

Practical examination :

	External Assessment for Practical	50 Marks
	Experiment I	**30**
	Viva	**10**
	Journal	**10**

- A learner will be allowed to appear for the semester end practical examination only after the learner submits a certified journal of Physics.
- The duration of the practical exam will be of three hours.

Course/ Paper Title	**Arduino Programming**
Course offered as	**Skill Enhancement Course**
Course Code	**RUSPHSEC401**
Semester	**IV**
No. of Credits	**2**
No. of lecture Hours/week	**4**

Course Outcome :

	On completing the course, the student will be able to :
CO1	Understand the basic concepts of microcontrollers and Arduino development environment.
CO2	Design and implement simple electronic circuits using Arduino.
CO3	Interface various sensors and actuators with Arduino for practical applications.

CO-PO mapping (RUSPHSEC401)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓	✓			
CO2	✓	✓	✓	✓	
CO3	✓	✓	✓	✓	✓

CO-PSO mapping (RUSPHSEC401)

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CO1	✓	✓	✓				
CO2			✓	✓	✓	✓	
CO3		✓	✓	✓	✓		

Regular experiments:

Sr. No.	Experiments
1	Familiarize with Arduino Uno board and understand the analog and digital pins
2	Setting up Arduino board and installation of IDE and basics of Arduino programming
3	Basic LED blinking program and other related programs
4	Introduction to Sensors and temperature and humidity sensor (DHT11/DHT22)
5	Ultrasonic Distance Sensor (HC-SR04)
6	Servo Motor Control
7	Interfacing LCD Display and Seven-Segment Display Control
8	Bluetooth Communication using HC-05
9	Wi-Fi Communication with ESP32

Rules of Practicals:
Minimum 7 Experiment must be written in the journal.

Practical examination :

	External Assessment for Practical	**50 Marks**
	Experiment –I	15
	Experiment –II	15
	Viva	10
	Journal	10

- A learner will be allowed to appear for the semester end practical examination only after the learner submits a certified journal of Physics.
- The practical exam will be of two hours duration.

Dr. Nandini Kachhap
Chairperson,
BOS, Physics.

Prof. (Dr) Kalpana Patankar Jain,
Principal

Board of studies in Physics

	Category	Name and Designation	Affiliation
1	Chairperson (Head of Department)	Dr. Nandini Kachhap, Associate Professor	Royal College of Arts, Science and Commerce.
2	Internal BOS Members	Dr. Vinod Panchal Assistant Professor	Royal College of Arts, Science and Commerce.
		Mr. Abdul Kayum Chaudhary Assistant Professor	Royal College of Arts, Science and Commerce.
3	External Subject Expert	Dr. Shirish Pathare, Scientific Officer – E	Homi Bhabha Centre for Science Education
		Prof. Mohan Narayan, Professor, Department of Physics	Institute of Chemical Technology
4	Vice-Chancellor Nominee	Ms. Vidya Hiren Patil, Associate Professor & Head, Department of Physics	Ruparel College of Arts, Science & Commerce,
5	Industry Representative	Krishan Kumar Pandey, Scientific Officer G	High Pressure & Synchrotron Radiation Physics Division, BARC, Mumbai
6	Postgraduate meritorious alumnus	Shailendra Singh, Assistant Professor	Department of Physics, Thakur College
7	Nomination by Management	Dr. Anil Raghav, Assistant Professor	Department of Physics, University of Mumbai

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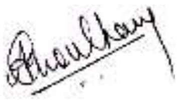
		Mr. Abdul Kayum Chaudhary Assistant Professor	Royal College of Arts, Science and Commerce.	
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		Dr. Mohan Narayan, Professor, Department of Physics	Institute of Chemical Technology	
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