UNIVERSITY OF RAJASTHAN

Programme Name : UG0803-Four Year B.Sc. (Maths Group)

Name of University	**University of Rajasthan, Jaipur**
Name of Faculty	**Science**
Name of Programme	**UG0803-B. Sc. (Maths Group)**
Name of Discipline	**Major Discipline -Chemistry, Mathematics, Physics** **Major/Minor Discipline – Economics, Geography, Geology, Psychology**

PROGRAMME PREREQUISITES
Physics and Mathematics courses of Central Board of Secondary Education or equivalent.
PROGRAMME OUTCOMES (POs)

Program Outcome in B.Sc.(Physics) with Minor in Chemistry or Mathematics:

1. Strong foundational knowledge: Students will develop a strong foundational knowledge in physics, including core concepts, principles, theories, and mathematical techniques. They will also gain an understanding of the fundamental principles of chemistry or mathematics, depending on their chosen minor.
2. Problem-solving skills: Students will develop excellent problem-solving skills, both qualitative and quantitative, by applying scientific principles and mathematical techniques to analyze and solve complex problems in physics, chemistry, or mathematics.
3. Experimental skills: Students will acquire practical skills in designing, conducting, and analyzing experiments in physics and chemistry. They will learn to use various laboratory instruments and techniques, collect and interpret experimental data, and draw meaningful conclusions.
4. Computational skills: Students will develop proficiency in computational methods and numerical analysis, using appropriate software tools to model and simulate physical systems, solve mathematical problems, and analyze experimental data.
5. Critical thinking and analytical reasoning: Students will develop the ability to think critically, analyze information, and apply logical reasoning to evaluate scientific phenomena and experimental results. They will also learn to assess the validity of scientific arguments and draw evidence-based conclusions.
6. Communication skills: Students will enhance their oral and written communication skills by effectively presenting scientific concepts, experimental results, and research findings. They will learn to communicate complex scientific ideas to both technical and non-technical audiences.
7. Research and inquiry skills: Students will be able to conduct independent research, formulate scientific questions, design experiments, gather and analyse data, and draw

conclusions. They will also develop skills in literature review, data interpretation, and scientific writing.

8. Interdisciplinary perspective: Students with a minor in chemistry or mathematics will gain interdisciplinary knowledge and perspectives, allowing them to explore the connections between physics and other scientific disciplines. They will be able to apply their understanding of chemistry or mathematics concepts to enhance their problem-solving abilities.
9. Ethical and professional conduct: Students will develop an understanding of the ethical responsibilities and professional conduct expected in scientific research and practice. They will be aware of the importance of integrity, safety, and ethical considerations in their work.
10. Lifelong learning: Students will develop a passion for learning and an appreciation for the dynamic nature of scientific knowledge. They will be equipped with the skills and motivation to engage in lifelong learning, keeping up with advancements in physics, chemistry, or mathematics and adapting to new challenges and opportunities in their careers.

These program outcomes will prepare students for diverse career paths in research, academia, industry, government, and other sectors where strong analytical and problem-solving skills, as well as a deep understanding of physics and its interdisciplinary connections, are valued.

Examination Scheme

1. 1 credit = 25 marks for examination/evaluation
2. For Regular Students there will be Continuous assessment, in which sessional work and the terminal examination will contribute to the final grade. Each course in Semester Grade Point Average (SGPA) has two components- Continuous assessment (20% weightage) and (End of end-semester examination) EoSE (80% weightage).
3. For Regular Students,75% Attendance is mandatory for appearing in the EoSE.
4. To appear in the EoSE examination of a course/subject a regular student must appear in the mid-semester examination and obtain at least a C grade in the course/subject.
5. Credit points in a Course/Subject will be assigned only if, the regular student obtains at least a C grade in the CA and EoSE examination of a Course/Subject.
6. In the case of Non-Collegiate Students there will be no Continuous assessment and credit points in a course/subject will be assigned only if, the non-collegiate student obtains at least a C grade in the EoSE examination of a Course/Subject.

Contact Hours –

15 Weeks per Semester

L – Lecture	(1 Credit = 1 Hour/Week)
T – Tutorial	(1 Credit = 1 Hour/Week)

S – Seminar (1 Credit = 2 Hours/Week)
P – Practical/Practicum (1 Credit = 2 Hours/Week)
F – Field Practice/Projects (1 Credit = 2 Hours/Week)
SA – Studio Activities (1 Credit = 2 Hours/Week)
I – Internship (1 Credit = 2 Hours/Week)
C – Community Engagement and Service (1 Credit = 2 Hours/Week)

DISTRIBUTION OF CONTINUOUS ASSESSMENT (CA) MARKS

S. No.	CATEGORY	Weightage (out of total internal marks)		THEORY					PRACTICAL		
				CORE (Only Theory)	CORE (Theory + Practical)	AEC	SEC	VAC	CORE (Theory +Practical)	SEC	VAC
	Max Internal Marks			**30**	**20**	**20**	**10**	**10**	**10**	**10**	**10**
1	**Mid-term Exam**	***50%***		**15**	**10**	**10**	**5**	**5**	**5**	**5**	**5**
2	**Assignment**	***25%***		**7.5**	**5**	**5**	**2.5**	**2.5**	**2.5**	**2.5**	**2.5**
3	**Attendance**	***25%***		**7.5**	**5**	**5**	**2.5**	**2.5**	**2.5**	**2.5**	**2.5**
		Regular Class Attendance	= 75%	3	2	2	1	1	1	1	1
			75-80%	4	3	3	1.5	1.5	1.5	1.5	1.5
			80-85%	5	4	4	2	2	2	2	2
			> 85%	7.5	5	5	2.5	2.5	2.5	2.5	2.5

Note:

1. Continuous assessment will be the sole responsibility of the teacher concerned.
2. For continuous assessment no remuneration will be paid for paper setting, Evaluation, Invigilation etc.

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3. For continuous assessment Paper setting and Evaluation responsibility will be of teacher concern.
4. For continuous assessment no Answer sheets/question papers etc. will be provided by the University.
5. Colleges are advised to keep records of continuous assessment, attendance etc.

[courses which have Practical Examination]

The question paper will consist of **two** parts **A** & **B**.

PART-A: 20 Marks

Part A will be compulsory having 10 very short answer-type questions (with a limit of 20 words) of two marks each.

PART-B: 60 Marks

Part B of the question paper shall be divided into four units comprising question numbers 2-5. There will be one question from each unit with internal choice. Each question will carry 15 marks.

Type	Paper code and Nomenclature	Duration of Examination	Maximum Marks (Midterm + EoSE)	Minimum Marks (Midterm + EoSE)
Theory	**UG0803**	**1 Hrs-MT** **3 Hrs-EoSE**	**20 Marks-MT** **60 Marks-EoSE**	**8 Marks-MT** **24 Marks-EoSE**
Practical	**UG0803**	**2 Hrs-MT** **4 Hrs-EoSE**	**10 Marks-MT** **40 Marks-EoSE**	**4 Marks-MT** **16 Marks-EoSE**

[For Practical Examination Please specify Examination Scheme with Course Detail]

Non-Collegiate Students –

Type	Paper code and Nomenclature	Duration of Examination	Maximum Marks (Midterm + EoSE)	Minimum Marks (Midterm + EoSE)

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Theory	**UG0803**	**3 Hrs-EoSE**	**100 Marks-EoSE**	**40 Marks-EoSE**
Practical	**UG0803**	**4 Hrs-EoSE**	**50 Marks-EoSE**	**20 Marks-EoSE**

Exit and Entrance Policy

1. Students who opt to exit after completion of the first year and have secured 48 credits will be awarded a **UG Certificate** if, in addition, they complete one internship of 4 credits during the summer vacation of the first year. These students are allowed to re-enter the degree programme within three years and complete the degree programme within the stipulated maximum period of seven years.
2. Students who opt to exit after completion of the second year and have secured 96 credits will be awarded the UG diploma if, in addition, they complete one internship of 4 credits during the summer vacation of the second year. These students are allowed to re-enter within a period of three years and complete the degree programme within the maximum period of seven years.
3. Students who wish to undergo a 3-year UG programme will be awarded UG Degree in the Major discipline after successful completion of three years, securing 150 credits and satisfying the minimum credit requirement.
4. A four-year UG Honours degree in the major discipline will be awarded to those who complete a four-year degree programme with 200 credits and have satisfied the minimum credit requirements.
5. Students who secure 75% marks and above in the first six semesters and wish to undertake research at the undergraduate level can choose a research stream in the fourth year. They should do a research project or dissertation under the guidance of a faculty member of the University/College. The research project/dissertation will be in the major discipline. The students who secure 200 credits, including 12 credits from a research project/dissertation, are awarded UG Degree (Honours with Research).

Letter Grades and Grade Points

Letter Grade	Grade Point	Marks Range (%)

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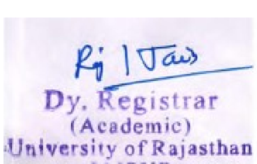
O (outstanding)	10	91 – 100
A+ (Excellent)	9	81 – 90
A (Very good)	8	71 – 80
B+ (Good)	7	61 – 70
B (Above average)	6	51 – 60
C (Average)	5	40 – 50
P (Pass)	4	
F (Fail)	0	
Ab (Absent)	0	

When students take audit courses, they may be given a pass (P) or fail (F) grade without any credits.

Name of University	**University of Rajasthan, Jaipur**
Name of Faculty	**UG0803-B. Sc. (Maths Group)**
Name of Discipline	**Physics**

SEMESTER-WISE PAPER TITLES WITH DETAILS

UG0803-B. Sc. (Maths Group)								
				PHYSICS	**Credits**			
#	**Level**	**Semester**	**Type**	**Title**	**L**	**T**	**P**	**Total**
1.	5	I	MJR	**UG0803-PHY-51T-101-Mechanics& Oscillations**	4	0	0	4
2.	5	I	MJR	**UG0803-PHY-51P-102-Physics Lab-I**	0	0	2	2
3.	5	II	MJR	**UG0803-PHY-52T-103-Electromagnetism**	4	0	0	4



4.	5	II	MJR	**UG0803-PHY-52P-104-Physics Lab-II**	0	0	2	2
5.	6	III	MJR	**UG0803-PHY-63T-201-Optics**	4	0	0	4
6.	6	III	MJR	**UG0803-PHY-63P-202-Physics Lab-III**	0	0	2	2
7.	6	IV	MJR	**UG0803-PHY-64T-203-Thermodynamics & Statistical Physics**	4	0	0	4
8.	6	IV	MJR	**UG0803-PHY-64P-204-Physics Lab-IV**	0	0	2	2
9.	7	V	MJR	**UG0803-PHY-75T-301-Electronics and Solid-State Devices**	4	0	0	4
10.	7	V	MJR	**UG0803-PHY-75P-302-Physics Lab-V**	0	0	2	2
11.	7	VI	MJR	**UG0803-PHY-76T-303-Quantum Mechanics and Spectroscopy**	4	0	0	4
12.	7	VI	MJR	**UG0803-PHY-76P-304-Physics Lab-VI**	0	0	2	2

Syllabus

Semester I

***UG 0803-PHY*-51T-101- Mechanics & Oscillation**

Type	Paper code and Nomenclature	Duration of Examination	Maximum Marks (Midterm + EoSE)	Minimum Marks (Midterm + EoSE)
Theory	UG 0803-PHY-51T-101-Mechanics & Oscillation	1 Hrs-MT 3 Hrs- EoSE	20 Marks-MT 60 Marks-EoSE	8 Marks-MT 32 Marks-EoSE
Practical	UG 0803-PHY-51P-102-Physics Lab-I	2 Hrs-MT 4 Hrs- EoSE	10 Marks-MT 40 Marks-EoSE	4 Marks-MT 16 Marks-EoSE

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Semester	Code of the Course	Title of the Course / Paper	NHEQF Level	Credits
I	**UG 0803-PHY-51T-101**	**Mechanics & Oscillation**	**5**	**4**
Level of Course	Type of Course	Delivery of the Course		
Introductory	Major/Minor	Lecture, Sixty Lectures (4 hrs in a week) including diagnostic and formative assessment during lecture hours.		
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			
Objectives of the Course	Objectives of the Course in Mechanics: The objective of the course is to provide students with a comprehensive understanding of classical mechanics, including the laws of motion, frames of reference, forces, motion of particles and rigid bodies, oscillations, and central forces. The course aims to develop their knowledge and skills in analyzing and solving problems related to these topics, using appropriate mathematical formalism and physical concepts.			

Unit - I

Physical Law and frame of Reference:

(a) Inertial and non-inertial frames, **C**oordinate transformation**:** transformation of displacement, velocity, acceleration between different frames of reference involving translation motion, Galilean transformation and invariance of Newton's laws.

(b) The Special theory of relativity: Postulates of STR (Special theory of relativity), the Lorentz transformation, transformation of velocity, acceleration, Length contraction, time dilation and its experimental evidence.

(c) Coriolis Force: Transformation of displacement, velocity and acceleration between rotating frame, Pseudo forces, Coriolis force, motion relative to earth, Foucault's pendulum.

(d) Conservative Forces: Introduction about conservative and non-conservative forces, rectilinear motion under conservative forces, discussion of potential energy curve and motion of a particle. **(15 Lectures)**

Unit -II:

Centre of Mass: Introduction about Centre of Mass, Centre of Mass Frame: Collision of two particles in one and two dimensions (elastic and inelastic), Slowing down of neutrons in a moderator, Motion of a system with varying mass, Angular momentum concept, conservation and charge particle scattering by a nucleus.

Rigid body: Equation of a motion of a rigid body, Inertial coefficient, Case of J not parallel to ω, the kinetic energy of rotation and the idea of principal axes, the processional motion of the spinning top. **(15 Lectures)**

Unit -III

Motion under Central Forces: Introduction about Central Forces, Motion under central forces,
gravitational interaction, inertia and gravitational mass, General solution under gravitational interaction, Kepler's laws, Discussion of trajectories: Cases of elliptical and circular orbits, Rutherford scattering.

Damped Harmonic Oscillations: Oscillations in a potential well, Damped force and motion under damping, Damped Harmonic Oscillator, Power dissipation, Anharmonic oscillator and simple pendulum as an example. **(15 Lectures)**

Unit-IV

Driven Harmonic Oscillations: Driven harmonic oscillator with damping, Frequency response, Phase relation, Quality factor, Series and parallel of LCR circuit, Electromechanical system: (Ballistic galvanometer).

Coupled Oscillations: Equation of motion of two coupled Harmonic Oscillators, Normal modes, motion in mixed modes and transient behaviour, Dynamics of many number of oscillators. **(15 Lectures)**

Suggested Books and References –

1. Mechanics, Berkeley Physics, Vol.1, Kittel, Knight, et.al. 2007, Tata McGraw-Hill
2. An introduction to Mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill
3. Feynman Lectures, Vol. I, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education.
4. Course of Theoretical Physics, Vol-I Mechanics, L.D. Landau, E.M. Lifshitz, Butterworth-Heinemann
5. Mechanics, D.S. Mathur, S. Chand and Company Limited,
6. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.
7. Introduction to Classical Mechanics: With Problems and Solutions, David Morin
8. Classical Mechanics, Herbert Goldstein, Charles P. Poole, and John L. Safko
9. Classical Mechanics, John R. Taylor
10. Mechanics, Keith R. Symon
11. The Physics of Waves & Oscillations, Bajaj
12. Waves, A. P. French

Suggested E-resources:

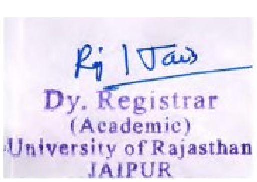
Online Lecture Notes and Course Materials:

1. MIT Open Course Ware: Classical Mechanics - This resource provides lecture notes, problem sets, and solutions for a complete course on classical mechanics: https://ocw.mit.edu/courses/physics/8-01sc-classical-mechanics-fall-2016/
2. Hyper Physics - This online resource provides concise explanations and interactive simulations for various topics in mechanics: http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

Syllabus

UG0803-PHY-51P-102: Physics Lab-I

Semester	Code of the Course	Title of the Course / Paper	NHEQF Level	Credits
I	**UG 0803-PHY-51P-102**	**Physics Lab-I**	**5**	**2**



Level of Course	Type of Course	Delivery of the Course
Introductory	Major/Minor	Lecture, Sixty Lectures (4 hrs in a week) including diagnostic and formative assessment during lecture hours.
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.	
Objectives of the Course	The objective of the physics Lab-I, with the mentioned experiments, is to provide students with hands-on experience in conducting experiments related to oscillations, damping, coupled oscillators, and properties of materials. The lab aims to reinforce theoretical concepts learned in the classroom, develop practical skills, and enhance the understanding of physics principles through experimentation.	

The colleges are free to set new experiments of equivalent standards. This should be intimated and approved by the Convener, Board of Studies before the start of the academic session. It is binding on the college to have an experimental set-up of at least ten experiments listed below. In case the number of experiments performed by the student is less than eight, his marks shall be scaled down in the final examination on a pro-rata basis. Laboratory examination paper will be set by the external examiner out of eight or more experiments available at the centre

Exam Scheme-

Students will have to perform one practical in the exam. The duration of practical exam will be 4 hours.

Marks distribution

Student category	Experiments	Viva-voice	Record	Maximum marks
Regular Student	**20**	**10**	**10**	**40**
Non-collegiate	**30**	**20**	**N\A**	**50**

Marking distribution in practical

Student category	Theory/formula	Figure/circuit	Observation	Calculation	Results/Error	Precautions
Regular	**3**	**2**	**6**	**5**	**3**	**1**

Non-collegiate	**5**	**3**	**8**	**7**	**5**	**2**

Physics Lab - I

List of Experiments:

1. Study the variation of the time period with amplitude in large-angle oscillations using a compound pendulum.
2. To study the damping using a coupled pendulum.
3. To study the excitation of normal modes and measure frequency splitting into two coupled oscillators.
4. To study the frequency of energy transfer as a function of coupling with mass using coupled oscillators.
5. To study the viscous fluid damping of a compound pendulum and determiner the damping coefficient and quality factor of the oscillator.
6. To study the electromagnetic damping of a compound pendulum and to find the variation of damping coefficients with the assistance of a conducting lamina.
7. Study of normal modes of a coupled pendulum system. Study of oscillations in mixed modes and find the period of energy exchange between the two oscillators.
8. To determine Young's modulus by bending of the beam method.
9. To determine Y, σ and η by Searle's method
10. To determine the modulus of rigidity of a wire using Maxwell's needle.
11. To determine the moment of Inertia of a fly-wheel.
12. To find the motion of a spring and calculate (a) Spring constant (b) Acceleration due to gravity (g) (c) Modulus of Rigidity.

Suggested Books and References -

Suggested E-resources:

Course Learning Outcomes:

Through these experiments, students will develop practical skills in experimental techniques, data collection, analysis, and interpretation. They will also enhance their understanding of fundamental concepts and principles in oscillations, damping, coupled oscillators, and material properties. The lab experiences will foster critical thinking, problem- solving abilities, and the application of theoretical knowledge to real-world scenarios.

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Syllabus

Semester II

UG 0803-PHY-52T-103- Electromagnetism

Semester	Code of the Course	Title of the Course / Paper	NHEQF Level	Credits
II	**UG 0803-PHY-52T-103**	**Electromagnetism**	**5**	**4**
Level of Course	Type of Course	Delivery of the Course		
Introductory	Major/Minor	Lecture, Sixty Lectures (4 hrs in a week) including diagnostic and formative assessment during lecture hours.		
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			
Objectives of the Course	Objectives of the Course in Electromagnetism: Objectives of the Course: The objective of the course is to provide students with a comprehensive understanding of the fundamental concepts and principles of electromagnetism. It aims to develop their knowledge and skills in analyzing scalar and vector fields, electric and magnetic fields, and their interactions, as described by Maxwell's equations. The course will also cover important topics such as electric potential, polarization, magnetostatics and electromagnetic waves.			

Unit I

Scaler and Vector Fields: Concept of Field, Scalar and Vector Fields, Gradient of scalar field, Physical significance of Gradient, Divergence and Curl of a vector field, Cartesian co-ordinates system, Problems based on Gradient, Divergence and curl operators.

Concept of Solid angle, Gauss divergence and Stoke's theorem. Gauss law from inverse square law. Differential form of Gauss law.

Electric Field and Potential Energy: Invariance of Charge, Potential energy of system of (i) Discrete N-charges (ii) Continuous charge distribution, Energy required to built a uniformly charged sphere, classical radius of electron, Electric field due to a short electric dipole, Interaction of electric dipole with external uniform and non-uniform electric field, potential due to a uniformly charged spherical shell.

Poisson's and Laplace equations in Cartesian co-ordinates and their applications to solve the problems of electrostatics, Electric field measured in moving frames, Electric field of a point charge moving with constant velocity. **(15 Lectures)**

Unit II

Electric field in matter: Multipole expansion, definition of moments of charge distribution, Dielectrics, Induced dipole moments, polar and non-polar molecules, Free and bound charges, Polarization, Atomic polarizability, electric displacement vector, electric susceptibility, dielectric constant, relation between them.

Electric potential and electric field due to a uniformly polarized sphere (i) outside the sphere (ii) at the surface of the sphere (iii) inside the sphere, Electric field due to a dielectric sphere placed in a uniform electric field (a) outside the sphere (b) inside the sphere, Electric field-due to a charge placed in dielectric medium and Gauss law, Clausius-Mossotti relation in dielectrics. **(15 Lectures)**

Unit III

Magnetostatics and Magnetic field in matter: Lorentz force, properties of magnetic field, Ampere's law, field due to a current carrying solid conducting cylinder (a) outside (b) at the surface and (ii) inside the cylinder, Ampere's law in differential form, Introduction of Magnetic Vector potential, Poisson's equation for vector potential, Deduction of Biot-Savart law using Magnetic Vector potentials, Atomic magnet, Gyromagnetic ratio, Bohr-magneton, Larmor frequency, induced magnetic moment and dia-magnetism, spin magnetic moment, para and ferro magnetism, Intensity of Magnetization, Magnetic permeability and Susceptibility, free and bound current densities, Magnetic field due to a uniformly magnetized material and Non-uniformly magnetized material. (15 Lectures)

Unit IV

Maxwell's Equations and Electromagnetic waves: Displacement current, Maxwell's Equations, Electromagnetic waves, Electromagnetic waves in an Isotropic medium, Properties of electromagnetic waves, Energy density of Electromagnetic waves, Pointing vector, Radiation pressure of free space, Electromagnetic waves in Dispersive medium, Spectrum of Electromagnetic waves. **(15 Lectures)**

Suggested Books and References -

1. Berkeley Physics Course, Vol II
2. Feynman in Physics Vol. II
3. An Introduction to Electrodynamics by Griffiths
4. Fundamental University Physics Vol. II: Fields and Waves; M. Alonso and E.J. Finn: Addison-Wesley Publishing Company

Suggested
E-resources-

1. MIT OpenCourseWare: Electricity and Magnetism - This resource offers lecture notes, assignments, and exams for a complete course on electricity and magnetism: https://ocw.mit.edu/courses/physics/8-02sc-physics-ii-electricity-and-magnetism-spring- 2011/
2. HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in electrostatics and electric fields: http://hyperphysics.phy- astr.gsu.edu/hbase/hframe.html

Course Learning Outcomes:

By the end of the course, students should be able to:

1. Understand the concept of scalar and vector fields and their physical significance.
2. Demonstrate knowledge of gradient, divergence, and curl operators and their applications in electromagnetism.
3. Apply Gauss divergence and Stoke's theorems to analyze electric and magnetic fields.

4. Explain the behaviour of electric fields and potential energy in different charge distributions.
5. Analyze the interaction of electric dipoles with external electric fields and calculate the resulting potentials.
6. Solve problems related to Poisson's and Laplace's equations in electrostatics.
7. Describe the behaviour of electric fields in different types of matter, including dielectrics and polarized spheres.
8. Understand the concept of electric displacement, susceptibility, and dielectric constant.
9. Analyze the behaviour of magnetic fields in various materials and the effects of currents on magnetic fields.
10. Apply Ampere's law and the magnetic vector potential to calculate magnetic fields in different scenarios.
11. Explain the properties of electromagnetic waves and their behavior in isotropic and dispersive media.
12. Calculate the energy density and radiation pressure of electromagnetic waves

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Syllabus

UG 0803-PHY-52P-104-Physics Lab-II

Semester	Code of the Course	Title of the Course / Paper	NHEQF Level	Credits
II	**UG 0803-PHY-52P-104**	**Physics Lab-II**	**5**	**2**
Level of Course	Type of Course	Delivery of the Course		
Introductory	Major/Minor	Lecture, Sixty Lectures (4 hrs in a week) including diagnostic and formative assessment during lecture hours.		
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			

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Objectives of the Course	1. To provide hands-on experience in conducting experiments related to electricity and magnetism. 2. To develop practical skills in using various electrical components and instruments. 3. To reinforce theoretical concepts learned in the corresponding lecture course through practical applications. 4. To enhance problem-solving and analytical skills by analyzing experimental data and interpreting results. 5. To promote scientific inquiry, critical thinking, and the ability to design and execute experiments. 6. To foster teamwork and collaboration in conducting experiments and analyzing results. 7. To develop skills in accurately measuring and recording experimental data.

The colleges are free to set new experiments of equivalent standards. This should be intimated and approved by the Convener, Board of Studies before the start of the academic session. It is binding on the college to have an experimental set-up of at least ten experiments listed below. In case the number of experiments performed by the student is less than eight, his marks shall be scaled down in the final examination on a pro-rata basis. Laboratory examination paper will be set by the external examiner out of eight or more experiments available at the centre.

Exam Scheme-

Students will have to perform one practical in the exam. The duration of practical exam will be 4 hours.

Marks distribution

Student category	**Experiments**	**Viva-voice**	**Record**	**Maximum marks**
Regular Student	**20**	**10**	**10**	**40**
Non-collegiate	**30**	**20**	**N\A**	**50**

Marking distribution in practical

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Student category	Theory/formula	Figure/circuit	Observation	Calculation	Results/Error	Precautions
Regular	3	2	6	5	3	1
Non-collegiate	5	3	8	7	5	2

List of Experiments -

1. To study the Faradays Law of electromagnetic induction.
2. To study the variation of power transfer by two different loads by a D.C. source and to verify the maximum power transfer theorem.
3. To study the variation of charge and current in an RC circuit with a different time constant (using a DC source).
4. To study the behaviour of an RC circuit with varying resistance and capacitance using AC mains as a power source and also to determine the impedance and phase relations.
5. To study the rise and decay of current in an LR circuit with a source of constant emf.
6. To study the voltage and current behaviour of an LR circuit with an AC power source. Also determine power factor, impedance and phase relations.
7. To study the magnetic field along the axis of a current-carrying circular coil. Plot the necessary graph and hence find the radius of the circular coil.
8. To study the frequency response of a series LCR series circuit and to estimate the resonant frequency and find out Q-factor and band width.
9. To study the frequency response and to find resonant frequencies of L-C-R parallel circuits. And find out Q-factor and band width.
10. To determine the specific resistance of a material and determine the difference between two small resistance using Carey Fosters Bridge.
11. To convert a galvanometer into an ammeter of a given range.
12. To convert a galvanometer into a voltmeter of a given range.

Suggested E-resources:

Course Learning Outcomes:

By the end of the course, students should be able to:

1. Demonstrate proficiency in using various electrical components and instruments required for conducting experiments.
2. Apply theoretical concepts of electricity and magnetism to design and execute experiments.
3. Analyze experimental data using appropriate mathematical and statistical techniques.
4. Interpret experimental results and draw conclusions based on data analysis.
5. Develop skills in accurately measuring physical quantities and recording experimental observations.
6. Communicate experimental procedures, results, and conclusions effectively in written reports.

Syllabus

III-Semester

UG0803-PHY-63T-201-Optics

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
III	**UG0803-PHY-63T-201**	**Optics**	**6**	**4**
Level of Course	**Type of the Course**	**Delivery Type of the Course**		
Introductory	**Major/Minor**	**Lecture, Sixty Lectures (4 hours in week) including diagnostic and formative assessments during lecture hours.**		
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			
Objectives of the Course:	The student will get an introduction to the discipline of optics and its role in daily life. They will learn basic knowledge of interference, diffraction, polarization, LASER, HOLOGRAPHY, and FIBRE OPTICS for future research purposes.			

Unit I

Interference: Concept of Spatial and temporal coherence, coherence length, coherence time, Definition and propagation of wavefront, Huygens principle of secondary wavelets, Young's Double Slit Experiment, Types of fringes, Interference by division of wavefront: Fresnel's Bi-Prism, Measurement of wavelength and thickness of a thin transparent sheet. Interference by division of amplitude– Thin films (parallel and wedge-shaped films), Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index. Michelson's Interferometer, the shape of fringes, the Measurement of wavelength, the difference between two spectral lines, and the thickness of a thin transparent sheet. **(15 Lectures)**

Unit II

Diffraction: Fraunhofer diffraction: Single slit; Double slit. Multiple slits, missing order, Diffraction grating, Resolving power of grating, Rayleigh's criterion of resolution.

Fresnel Diffraction: Half-period zones. Zone plate. Multiple Foci of zone plate, comparison between zone plate and convex lens, Fresnel Diffraction pattern at a circular aperture, straight edge, and a rectangular slit using half-period zone analysis. **(15 Lectures)**

Unit III

Polarization: Polarisation (i) Plane polarized light (ii) Circularly polarized light (iii) Elliptically polarized light, Production of plane-polarized light (i) by reflection (ii) by refraction (iii) by double refraction, and (iv) by dichroism (Polaroid), Brewster's law, Law of Malus, Huygens' wave theory of double refraction, Analysis of Polarized light: Nicol prism, Quarter wave plate, and half-wave plate, Optical activity, Laws of optical activity, and Fresnel's explanation of optical activity; Specific rotation, Polarimeters: Laurent's half shade Polarimeter and Biquartz Polarimeter. **(15 Lectures)**

Unit IV

Quantum Optics and photonics

(i) **Laser:** Spontaneous and stimulated emission, Einstein's A & B coefficients, population inversion, methods of optical pumping. Ruby, He-Ne, and Semiconductor laser (Principle and working).

(ii) **Holography:** Principle of holography, Theory of construction and reconstruction of image, applications of holography.

(iii) **Fiber Optics:** Introduction to optical fiber, types of optical fiber, Total internal reflection, Explanation of propagation of light through an optical fiber

(15 Lectures)

REFERENCES:

1. F.A. Jenkins and H.E. White, Fundamentals of Optics, Tata McGraw Hill.
2. Brij Lal and N. Subrahmaniyam, Optics, S. Chand.
3. E.Hecht, Optics, Pearson.
4. A.K.Ghatak, Optics, Tata Mc Graw Hill.

Course outcomes:

1. The student will get an introduction to the discipline of optics and its role in daily life.
2. The optics course will give the student a basic knowledge of interference, diffraction, and polarization.
3. The student will be able to analyze and calculate interference between light waves and application of the theory to various interferometers along with their practical applications.
4. The student would know the conditions for near and far-field diffraction and be able to calculate the far-field diffraction from gratings and simple aperture functions.
5. The student would understand how the polarization of light changes at reflection and transmission at interfaces.
6. The students are able to understand theory of LASER,HOLOGRAPHY and FIBRE OPTICS for future research purpose.

Syllabus

UG0803-PHY-63P-202-Physics Lab-III

<table>
<tr><th>Semester</th><th>Code of the Course</th><th>Title of the Course/Paper</th><th>NHEQF Level</th><th>Credits</th></tr>
<tr><td>III</td><td>UG0803-PHY-63P-202</td><td>Physics Lab-III</td><td>6</td><td>2</td></tr>
<tr><th>Level of Course</th><th>Type of the Course</th><th colspan="3">Delivery Type of the Course</th></tr>
<tr><td>Introductory</td><td>Major/Minor</td><td colspan="3">Practical, Sixty hours of practical including diagnostic and formative assessment during practical hours.</td></tr>
<tr><td>Prerequisites</td><td colspan="4">Physics and Mathematics courses of Central Board of Secondary Education or equivalent.</td></tr>
<tr><td>Objectives of the Course:</td><td colspan="4">1.Ability to find the formation of Newton ring and calculate the wavelength of monochromatic source.
2. Develop an understanding of light dispersion through prisms
3. Proficiency in analyzing and calculating the wavelength of light by grating.
4. Learn to determine the thermal conductivity of band teeth.
5. Develop skills in designing and analyzing the value of inductance by Anderson Bridge.
6. Understand the principle of wavefront division and also learn how to determine the wavelength of sodium light by biprism.
7. Students learn about the sensitivity ballistic galvanometer and determine the value of ballistic constant</td></tr>
</table>

Exam Scheme-

Students will have to perform one practical in the exam. The duration of practical exam will be 4 hours.

Marks distribution

Student category	Experiments	Viva-voice	Record	Maximum marks
Regular Student	20	10	10	40
Non-collegiate	30	20	N\A	50

Marking distribution in practical

Student category	Theory/formula	Figure/circuit	Observation	Calculation	Results/Error	Precautions
Regular	3	2	6	5	3	1
Non-collegiate	5	3	8	7	5	2

Practical lists-

1. Find the wavelength of the monochromatic source using the Newton ring method and find the refractive index of the liquid.
2. Determine the dispersive power of prism.
3. Determine the wavelength of sodium light using grating.
4. Study the light properties using a fiber optics trainer kit.
5. Measure the induction by the Anderson bridge coil.
6. Determine the wavelength of sodium light using bi-prism.
7. Calculate the ballistic constant of the ballistic galvanometer.
8. Find high resistance by the leakage method.
9. Study the coherent source and coherent time using a diode laser.
10. To study the preparation of air film using the air wedge method.
11. To study the resolving power of prism.
12. To study the resolving power of grating.
13. To study the Rydberg constant by using grating.

Suggested Books and References –

1. Practical Optics, by S. Naftali Men. First Edition (ISBN 13:978-0124909519)

Suggested e-Resources: http://msbahae.um.edu, University of New Mexico.

Course Learning Outcomes

1. Ability to find the formation of Newton ring and calculate the wavelength of monochromatic source. 2. Develop an understanding of light dispersion through prisms

3. Proficiency in analyzing and calculating the wavelength of light by grating.

4. Learn to determine the thermal conductivity of band teeth.

5. Develop skills in designing and analyzing the value of inductance by Anderson Bridge.

6. Understand the principle of wavefront division and also learn how to determine the wavelength of sodium light by biprism.

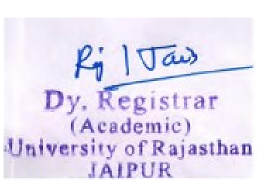
7. Students learn about the sensitivity ballistic galvanometer and determine the value of a ballistic constant.

Syllabus

IV-Semester

UG0803-PHY-64T-203-Thermodynamics & Statistical physics

Semester	**Code of the Course**	**Title of the Course/Paper**	**NHEQF Level**	**Credits**
IV	**UG0803-PHY-64T-203**	**Thermodynamics & Statistical Physics**	**6**	**4**
Level of Course	**Type of the Course**	**Delivery Type of the Course**		
Introductory	**Major/Minor**	**Lecture, Sixty Lectures including diagnostic and formative assessments during lecture hours.**		
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			
Objectives of the Course:	By this course, students will have developed a strong understanding of thermal and statistical physics. They will be able to apply the principles and concepts learned to analyze and solve problems related to thermodynamic systems, phase transitions, transport phenomena, low-temperature production, and quantum statistics. Additionally, they will be able to interpret and explain various phenomena and			



	behaviors of macroscopic and microscopic systems using the principles of thermodynamics and statistical mechanics.

Unit I

Thermal and adiabatic interactions: Thermal interaction, Zeroth law of thermodynamics, systems in thermal contact with a heat reservoir (canonical distribution), Energy Fluctuations, Entropy of a system, Helmholtz free energy, Adiabatic interaction and enthalpy, General interaction and first of thermodynamics, Infinitesimal general interaction, Gibb's free energy, Phase transitions, Triple point, First and second-order phase transition, Clausius-Clapeyron equation, Vapour-pressure curve, transformation of disorder into order, Heat engine and efficiency of engine, carnot's Cycle; Thermodynamic scale as an absolute scale, Maxwell relations and their applications. **(15 Lectures)**

Unit II

Kinetic Theory: Derivation of Maxwell's law of distribution of velocities and its experimental verification, most probable, average and RMS velocities, Diffusion, Equipartition Theorem, Classical theory of Specific heat capacity, the specific heat of solid (Explanation on the basis of Einstein and Debye Theory.

Transport Phenomenon: Mean free path, Distribution of free path, Coefficients of viscosity, thermal conductivity and diffusion, Brownian motion, Langevin's and Einstein's theories, Experimental determination of Avogadro number. **(15 Lectures)**

Unit III

Production of low temperatures: Cooling by Adiabatic expansion, Coefficient of performance, Joule Thomson effect, J-T coefficient for ideal as well as-Vander Waal's gases, porous plug experiment, Temperature of inversion, Regenerative cooling, Air Liquefiers. Adiabatic demagnetization of paramagnetic substances: Nuclear Para-magnetism, Liquid He I and He II, Superfluidity, Quest for absolute zero, Third law of thermodynamics and Nernst Heat Theorem. **(15 Lectures)**

Unit IV

Quantum Statistics: Introduction to Phase space, Micro and Macro states, Thermodynamic probability, Entropy and probability, Bose-Einstein and Fermi-Dirac distribution laws, Calculation of the thermodynamic functions of weak degenerate gas, Strong degeneration, Calculation of the thermodynamic functions of an ideal Bose gas, Derivation of Plank law, Flux of radiation energy, radiation pressure, thermodynamic functions of an ideal Fermi electron gas, Free electron model for metals, Spectra of metals, Richardson's equation of thermionic emission, Relativistic fermi gas, White dwarf stars, Chandrasekhar mass limit.

(15 Lectures)

Suggested Books and References -

1. Kittle-Thermal Physics.
2. Berkeley Series, Vol. V, Statistical Physics
3. Reif-Thermodynamics and Statistical Physics.
4. Lokanathan and Khandelwal Thermodynamics and Statistical Physics.
5. Sears Thermodynamics, Kinetic Theory of Gases and Statistical Physics.

Suggested E-sources:

1. MIT OpenCourseWare: Statistical Mechanics 1: Statistical Mechanics of Particles- This resource offers lecture notes, assignments, and exams for a complete course on Statistical Mechanics I, https://ocw.mit.edu/courses/8-333-statistical-mechanics-i-statistical-mechanics-of-particles-fall-2013/pages/syllabus/

Course Learning Outcomes:

By the end of the course, students should be able to:

1. Understand the concepts of thermal interactions and the law of thermodynamics.
2. Calculation of the entropy of a system and analyze the Helmholtz free energy.
3. Study infinitesimal general interactions and Gibb's free energy.
4. Explore phase transitions, including first and second-order phase transitions. Understand the Clausius-Clapeyron equation and the vapour pressure curve.

5. Learn about the thermodynamic scale as an absolute scale and apply Maxwell relations.
6. Explore the classical theory of specific heat capacity and analyze the specific heat of solids.
7. Study the production of low temperatures and cooling by adiabatic expansion.
8. Explore regenerative cooling and air liquefiers.
9. Understand adiabatic demagnetization of paramagnetic substances and the properties of liquid He 1 and He II, including super-fluidity.
10. Study phase space, microstates, macrostates, thermodynamic probability, and entropy. Learn about quanturn statistics, including Bose-Einstein and Fermi-Dirac distribution laws.
11. Analyze the behavior of an ideal Bose gas.
12. Understand the free electron model for metals, the spectrum of metals, relativistic Fermi gas, and the Chandrasekhar mass limit for white dwarf stars.

By the end of this course, students will have developed a strong understanding of thermal and statistical physics. They will be able to apply the principles and concepts learned to analyze and solve problems related to thermodynamic systems, phase transitions, transport phenomena, low- temperature production, and quantum statistics. Additionally, they will be able to interpret and explain various phenomena and behaviours of macroscopic and microscopic systems using the principles of thermodynamics and statistical mechanics.

Syllabus

UG 0803-PHY-64P-204-Physics Lab-IV

Semester	Code of the Course	Title of the Course / Paper	NHEQF Level	Credits
IV	**UG 0803-PHY-64P-204**	**Physics Lab – IV**	**6**	**2**
Level of Course	Type of Course	Delivery of the Course		
Introductory	Major	Lecture, Sixty Lectures(4 hour in a week) including diagnostic and formative assessment during lecture hours.		

Prerequisites	Practical, sixty hours (4 hours in a week) of practical including diagnostic and formative assessment during practical hours
Objectives of the Course	To provide hands-on experience in conducting experiments related to Thermal and statistical Physics. To develop practical skills in using various experimental components and instruments. To reinforce theoretical concepts learned in the corresponding lecture course through practical applications. To enhance problem-solving and analytical skills by analyzing experimental data and interpreting results. To promote scientific inquiry, critical thinking, and the ability to design and execute experiments. To foster teamwork and collaboration in conducting experiments and analyzing results. To develop skills in accurately measuring and recording experimental data.

The colleges are free to set new experiments of equivalent standards. This should be intimated and approved by the Convener, Board of Studies before the start of the academic session. It is binding on the college to have an experimental set-up of at least ten experiments listed below. In case the number of experiments performed by the student is less than eight, his marks shall be scaled down in the final examination on a pro-rata basis. Laboratory examination paper will be set by the external examiner out of eight or more experiments available at the centre

Exam Scheme-

Students will have to perform one practical in the exam. The duration of practical exam will be 4 hours.

Marks distribution

Student category	**Experiments**	**Viva-voice**	**Record**	**Maximum marks**
Regular Student	**20**	**10**	**10**	**40**

Non-collegiate	**30**	**20**	**N\A**	**50**

Marking distribution in practical

Student category	Theory/formula	Figure/circuit	Observation	Calculation	Results/Error	Precautions
Regular	**3**	**2**	**6**	**5**	**3**	**1**
Non-collegiate	**5**	**3**	**8**	**7**	**5**	**2**

List of Experiments -

1. To find out the melting-point of a given substance using platinum resistance thermometer.
2. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer
3. To determine the Specific Heat of a Liquid using a Calorimeter.
4. Determination of Specific Heat Capacity of a Liquid using the Method of Cooling.
5. To Study the Variation of Thermo-emf with Temperature.
6. Determination of the Coefficient of Thermal Conductivity of a Bad Conductor by Lee and Charlton's Disc Method.
7. Determination of the Coefficient of Thermal Conductivity of Copper by Searle's Apparatus.
8. Determination of Stefan's Constant using Black Body Radiation.
9. Determination of Planck's Constant.
10. To Study the Linear expansion of different solid samples.
11. Determination of Thermal conductivity by Armstrong method.
12. Study of Phase Transitions and Interpretation of Cooling Curves.
13. To study the blackbody spectrum of light intensity for a light bulb.
14. Experimental Determination of γ using Clement and Desormes Method
15. Study of variation of total thermal radiation with temperature.
16. To investigate the rate of thermal conduction through some common materials.
17. Determine the specific heat capacity of the given solid by Ice Calorimetry

18. Plot thermo emf versus temperature graph and find the neutral temperature (Use sand bath).

Suggested Books and Reference-

Suggested E-resources:

http://egyankosh.ac.in//handle/123456789/67451

Course Learning Outcomes:

By the end of the course, students should be able to:

1. Demonstrate proficiency in using various thermodynamically components and instruments required for conducting experiments.
2. Apply theoretical concepts of thermodynamics and statistical dynamics to design and execute experiments.
3. Analyze experimental data using appropriate mathematical and statistical techniques.
4. Interpret experimental results and draw conclusions based on data analysis.
5. Develop skills in accurately measuring physical quantities and recording experimental observations.
6. Communicate experimental procedures, results, and conclusions effectively in written reports.

Syllabus

V-Semester

UG0803-PHY-75T-301 –Electronics and Solid State Devices

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
V	UG0803-PHY-75T-301	Electronics and Solid State Devices	7	4
Level of Course	**Type of the Course**	**Delivery Type of the Course**		
Introductory	**Major/Minor**	**Lecture, Sixty Lectures including diagnostic and formative assessments during lecture hours.**		
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			
Objectives of the Course:	The syllabus for Electronics and Solid-State Devices aims to equip undergraduate students with a comprehensive understanding of circuit analysis, semiconductor device operation, and digital logic. It covers DC and AC circuits, semiconductor characteristics, BJTs and FETs configurations, and biasing techniques essential for amplifier and oscillator design. Students will also explore operational amplifiers and the foundational principles of Boolean algebra and logic gates. The course prepares students for practical applications and theoretical analysis in modern electronics.			

Unit 1

Circuit Analysis:

- **Electric Networks:** Definitions, loop and nodal equations for D.C. and A.C. circuits (Kirchhoff's Laws).
- **Four-Terminal Electric Network:** Ampere-volt conventions, open, closed, and hybrid parameters of four-terminal networks; input, output, and mutual impedance for active four-terminal networks.
- **Circuit Theorems:** Superposition, Thevenin, Norton, reciprocity, compensation, maximum power transfer, and Miller theorems.

P-N Junction: Charge densities in N and P Semiconductors; conduction by drift and diffusion of charge carriers; P-N diode equation; capacitance effects.

Rectifiers: Half-wave, full-wave, and bridge rectifiers; Ripple factor, efficiency, Peak Inverse Voltage and regulation; Series inductor, shunt capacitor, L-section, and π-section filters.

Voltage Regulation: Zener diode**,** Voltage regulation using Zener diodes; voltage multipliers.

Unit 2

Transistor Fundamentals: Notations, Configurations: CB, CE, CC. operation and characteristic curves for bipolar junction transistors (BJTs); Concept of load line and operating point, hybrid parameters.

Transistor Biasing: Need for biasing and stability of Q point, stability factors; Types of bias circuits for thermal bias stability: fixed bias, collector-to-base feedback bias, and four-resistor bias.

Field Effect Transistors (FETs): Introduction and merits demerits over BJT, biasing, and volt-ampere characteristics; Source follower, operation of FET as a variable voltage resistor.

Unit 3

Amplifiers: Analysis of transistor amplifiers using hybrid parameters, gain-frequency response; Cascade amplifiers, basic ideas of direct-coupled and R-C coupled amplifiers and analysis, differential amplifiers.

Amplifiers with feedback: Concept of feedback, positive and negative feedback, voltage and current feedback circuits, Advantages of negative feedback

Operational Amplifier: Definition and history of operational amplifiers, Ideal Op-Amps, Input offset voltage and current, Common-mode rejection ratio (CMRR), Power supply rejection ratio (PSRR), Input and output impedance, Open-loop gain and frequency response, Slew rate; Inverting Amplifier, Non-Inverting Amplifier, Voltage Follower (Buffer)

Unit 4

Oscillators: Criteria for self-excited and self-sustained oscillation, Circuit conditions for self-excited oscillations; Basic transistor oscillator circuit and its analysis; Colpitts's and Hartley oscillators, R.C. oscillators, crystal oscillators and their advantages.

Logic Operations: Fundamentals of Boolean Algebra, Boolean variables and functions, De Morgan's Theorems, basic logic gates (AND, OR, NOT, NAND, NOR, XOR, XNOR), symbols, truth tables, Boolean expressions, Diode-Transistor Logic (DTL) concept and configuration, Transistor-Transistor Logic (TTL) concept and evolution from DTL.

Textbooks:

1. Basic Electronics and Linear Circuits by N.N. Bhargava, D.C. Kulshreshtha; S.C. Gupta.
2. Solid State Electronic Devices" by Ben G. Streetman and Sanjay Kumar Banerjee
3. Introduction to Semiconductor Devices" by M.S. Tyagi

Reference books:

1. Electronic Principles" by Albert Malvino and David Bates
2. Semiconductor Physics and Devices" by Donald A. Neamen
3. Integrated Electronics: Analog and Digital Circuits and Systems" by Jacob Millman and Christos C. Halkias
4. "Electronic Devices" by Thomas L. Floyd
5. Electronic Devices and Circuit Theory" by Robert L. Boylestad and Louis Nashelsky

E-Resources:

1. **NPTEL (National Programme on Technology Enhanced Learning)**:
   Website: https://nptel.ac.in/courses
2. **MIT Open Course Ware**:
   Website:https://ocw.mit.edu/courses/6-002-circuits-and-electronics-spring-2007/; https://ocw.mit.edu/courses/6-002-circuits-and-electronics-spring-2007/video_galleries/video-lectures/
3. **Coursera**:
   Website: Coursera - Electronics Courses

4. **edX**: Electronics Courses
   Website: https://www.edx.org/learn/electronics
5. **IEEE Xplore Digital Library**:
   Website: IEEE Xplore Digital Library

Learning Outcomes:

1. Understand and apply Kirchhoff's laws for analyzing DC and AC circuits.
2. Analyze four-terminal networks and calculate open, short-circuited, and hybrid parameters.
3. Apply circuit theorems like Superposition, Thevenin, and Norton to simplify circuits.
4. Comprehend the behavior of P-N junctions and their application in rectifiers and voltage regulation.
5. Explain the operation and characteristics of BJTs and FETs, including biasing techniques.
6. Design and analyze transistor amplifiers and understand feedback in amplifiers.
7. Utilize operational amplifiers in various configurations and understand practical limitations.
8. Design oscillators and understand the conditions for sustained oscillations.
9. Understand Boolean algebra and logic gates, and apply them in digital logic circuits.

Syllabus

UG0803-PHY-75P-302-PHYSICS LAB-V

Semester	**Code of the Course**	**Title of the Course/Paper**	**NHEQF Level**	**Credits**
V	**UG0803-PHY-75P-302**	**Physics Lab-V**	**7**	**2**
Level of Course	**Type of the Course**	**Delivery Type of the Course**		
Introductory	**Major/Minor**	**Practical, Sixty hours(4 hours per week) of practical including diagnostic and formative assessment during practical hours.**		
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			
Objectives of the Course:	The objectives of the practical in the Electronics and Solid-State Devices syllabus aim to provide hands-on experience and deepen understanding of key electronics concepts. Students will verify Kirchhoff's laws and the maximum power transfer theorem, explore the characteristics of semiconductor devices such as transistors, junction diodes, Zener diodes, and FETs, and determine the band gap in semiconductors. Practical exercises will include the analysis of temperature dependence of resistance, designing single-stage transistor audio amplifiers, amplifiers with negative feedback, and studying power supply circuits, rectifiers with various filters, and Zener regulated power supplies. Advanced experiments will cover designing oscillators like Hartley and Colpitts oscillators, investigating			

	clipping and clamping circuits, and studying logic gates using discrete components compared with TTL integrated circuits. These practical prepare students to design, analyze, and troubleshoot various electronic circuits for further studies and professional work in electronics.

Exam Scheme-

Students will have to perform one practical in the exam. The duration of practical exam will be 4 hours.

Marks distribution

Student category	Experiments	Viva-voice	Record	Maximum marks
Regular Student	20	10	10	40
Non-collegiate	30	20	N\A	50

Marking distribution in practical

Student category	Theory/formula	Figure/circuit	Observation	Calculation	Results/Error	Precautions
Regular	3	2	6	5	3	1
Non-collegiate	5	3	8	7	5	2

List of Practical:

1. Verify Kirchhoff's laws using breadboard circuits with resistors and voltage sources.
2. Verify the maximum power transfer theorem.
3. Study the characteristics of a given transistor (PNP/NPN) in common emitter, common base, and common collector configurations.
4. Determine the band gap of a semiconductor using a junction diode.
5. Study the variation of gain with frequency in a single-stage transistor audio amplifier.
6. Study the temperature dependence of resistance in a semiconductor using the four-probe method.

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7. Study the characteristics of a junction diode and a Zener diode.
8. Study the characteristics of a field effect transistor (FET) and design an amplifier with finite gain.
9. Study a power supply using full wave rectifier or a bridge wave rectifier with various filter circuits.
10. Study a half wave rectifier with L and π section filters.
11. Design a Zener regulated power supply and study the regulation with various loads.
12. Study the frequency response of a transistor amplifier and obtain the input and output impedance.
13. Design and study an R-C phase shift oscillator and measure the output impedance (frequency response with change of R and C components).
14. Study a voltage multiplier circuit to generate high voltage D.C. from A.C.
15. Study OR, AND, and NOT logic gates using discrete components and compare them with TTL integrated circuits (ICs).
16. Design a Hartley oscillator and study its frequency stability and waveform.
17. Design a Colpitts oscillator and study its frequency stability and waveform.
18. Investigate the effect of negative feedback on amplifier performance.

Reference books:

1. "Electronic Devices and Circuit Theory" by Robert L. Boylestad and Louis Nashelsky
2. "Microelectronic Circuits" by Adel S. Sedra and Kenneth C. Smith
3. "Solid State Electronic Devices" by Ben G. Streetman and Sanjay Kumar Banerjee
4. "The Art of Electronics" by Paul Horowitz and Winfield Hill
5. "Electronic Principles" by Albert Malvino and David Bates
6. "Electronic Devices and Circuits" by David A. Bell
7. "Basic Electronics for Scientists and Engineers" by Dennis L. Eggleston
8. "Foundations of Analog and Digital Electronic Circuits" by Anant Agarwal and Jeffrey H. Lang
9. "Electronic Instrumentation and Measurements" by David A. Bell
10. "Operational Amplifiers and Linear Integrated Circuits" by Robert F. Coughlin and Frederick F. Driscoll

Learning Outcomes:

Upon completion, students will be able to verify Kirchhoff's laws and the maximum power transfer theorem. They will analyze transistor characteristics in various configurations, determine semiconductor band gaps, and study the variation of amplifier gain with frequency. Students will measure temperature-dependent resistance, understand diode and FET characteristics, design power supplies and rectifiers, explore oscillator designs and voltage multipliers, and investigate the impact of negative feedback on amplifiers, effectively bridging theoretical concepts with practical skills.

Syllabus

VI-Semester

UG0803-PHY-76T-303 –Quantum Mechanics and Spectroscopy

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
VI	**UG0803-PHY-76T-303**	**Quantum Mechanics and Spectroscopy**	**7**	**4**
Level of Course	**Type of the Course**	**Delivery Type of the Course**		
Introductory	**Major/Minor**	**Lecture, Sixty Lectures(4 hour per week) including diagnostic and formative assessments during lecture hours.**		
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			

Objectives of the Course:	This course aims to introduce the basic features of quantum mechanics and its applications in various physical phenomena. It will help students explore the core concepts, experiments, and the mathematical framework of quantum mechanics. • A central theme of the course is the Schrödinger wave equation, which explains the behavior of quantum systems. • Students will learn how to solve the Schrödinger wave equation for various types of potential, as well as for the hydrogen atom. • They will also learn about the concept of orbital angular momentum and its quantization. • The final section introduces students to rotational and vibrational energy levels and spectra.

Unit - I: Evolution of quantum physics

1. Difficulties of classical mechanics to explain: the black-body emission spectrum, specific heat of solids. Plank quanta concept and radiation law, Photo electric effect and Einstein's explanations. Compton Effect, de-Broglie hypothesis, diffraction experiments for wave particles (Davisson-Germer experiment).
2. Uncertainty principle: position and momentum, angle and angular moment, energy, and time. Application of uncertainty principle: (i) Ground state energy of hydrogen atom, (ii) ground state energy of simple harmonic oscillator. (iii) Natural width of spectral lines, (iv) Non-existence of electron in nucleus.
3. Operators: linear operators, product of two operators, commuting and non-commuting operators. Simultaneous eigenfunction and eigenvalues, orthogonal wave functions, Hermitian operators, their eigenvalues. Hermitian adjoint operators. eigenvalues and eigenfunction; expectation values of operators: position, momentum, energy; Ehrenfest theorem and complementarity, Concept of group and phase velocity, wave packet, Gaussian wave packet, bra-ket notation.

(15 Lectures)

Unit - II: Schrödinger wave equation and its solutions

1. Schrödinger wave equation: general equation of wave propagation, propagation of matter waves, time dependent and time-independent Schrödinger equation, wavefunction representation (ψ), physical meaning of ψ. properties and conditions on ψ, postulates of wave mechanics, operators, observable and measurements; probability current density.
2. Time independent Schrödinger equation, stationary state solution, one dimensional problem: particle in one dimensional box, eigenfunctions and eigenvalues, discrete levels, generalization into three dimension and degeneracy of energy levels, concept of a potential well and barrier, step potential, penetration through rectangular barrier, reflection and transmission coefficients, barriers with special shapes (graphical representation), quantum mechanical tunneling effect. (alpha decay). **(15 Lectures)**

Unit - III: Schrödinger equation solutions in special cases

1. Symmetric square well potential, reflection and transmission coefficients, resonant scattering, bound state problems: particle in one dimensional infinite potential well and finite depth potential well, energy eigenvalues and eigenfunctions, transcendental equation and its solution; Simple harmonic oscillator. Schrödinger equation for simple harmonic oscillator and its solution, eigenfunction, eigenvalues, zero-point energy, quantum and classical probability density, parity, symmetric and antisymmetric wave functions with graphical representation.
2. Schrödinger equation in spherical coordinates, Schrödinger equation for one electron atom in spherical coordinates, separation into radial and angular variables, solution of radial equation and angular equation, qualitative discussion of spherical harmonics, series solution and energy eigenvalues, stationary state wave function. Wave-functions of H-atom for ground and first excited states, average radius of H-atom, Bohr correspondence principle, orbital angular momentum and its quantization, commutation relation, eigenvalues and eigenfunctions **(15 Lectures)**

UNIT IV: H-atom, Atomic and Molecular spectroscopy

1 Energy level derivation for H-atom, quantum features of hydrogen spectra and hydrogen like spectra, Stern-Gerlach experiment, electron spin, spin magnetic moment. Spin-orbit coupling. Qualitative explanation of fine structure, Franck-Hertz experiment. Zeeman effect, normal Zeeman splitting, Qualitative explanation of Stark effect.

2. Molecular spectroscopy: concept of rigid rotator, rotational energy levels, rotational spectra, selection rules, intensity of spectral lines, isotopic effect; Vibrational energy levels, vibrational spectra, selection rules, isotopic effect, effect of anharmonicity in vibrational spectra, vibrational-rotational spectra of CO and HCl molecules. **(15 Lectures)**

Suggested Books and Reference-

1. Griffiths, Introduction to Quantum Mechanics, 2nd edition.
2. R. Shankar, Principles of Quantum Mechanics, 2nd edition.
3. Arthur Beiser, Perspective of modern Physics, 6th edition.
4. AK Ghatak and S Lokanathan, Quantum Mechanics: Theory and application.
5. HS Mani, GK Mehta, Introduction to modern Physics.
6. C.N. Banwell and E.M. McCash, Fundamental of Molecular Spectroscopy, 4th edition.
7. H.E. White, Introduction to atomic physics,

Suggested E-sources:

Video Lectures:

MIT OpenCourseware - 8.04 Quantum Physics I https://ocw.mit.edu/courses/8-04-quantum-physics-i-spring-2016/

Lecture Series on Quantum Physics by Prof.V.Balakrishnan, Department of Physics, IIT Madras.

Learning Outcomes for Quantum Physics Course

Upon successful completion, this course students will gain a comprehensive understanding of the fundamental principles of quantum mechanics and be able to apply them to various problems in Solid state physics, Nuclear and particle physics, and atomic and molecular physics.

Syllabus

UG 0803-PHY-76P-304-Physics Lab-VI

Semester	Code of the Course	Title of the Course/Paper	NHEQFE Level	Credits

VI	**UG 0803-PHY-76P-304**	**Physics Lab-VI**	**7**	**02**
Level of Course	Type of Course	Delivery of the Course		
Introductory	Major	**Practical, Sixty hours(4 hours per week) of practical including diagnostic and formative assessment during practical hours.**		
Introductory	B.Sc. Semester I and II Practical			
Objectives of the Course	The Objective of this course is to make the students gain practical knowledge to co-relate with the theoretical studies. To achieve perfectness in experimental skills and Measure fundamental constants and probe material properties in the lab.			

Exam Scheme-

Students will have to perform one practical in the exam. The duration of practical exam will be 4 hours.

Marks distribution

Student category	Experiments	Viva-voice	Record	Maximum marks
Regular Student	**20**	**10**	**10**	**40**
Non-collegiate	**30**	**20**	**N\A**	**50**

Marking distribution in practical

Student category	Theory/formula	Figure/circuit	Observation	Calculation	Results/Error	Precautions
Regular	**3**	**2**	**6**	**5**	**3**	**1**
Non-collegiate	**5**	**3**	**8**	**7**	**5**	**2**

List of experiments

[1] Determination of Planck's constant by photo cell (retarding potential method using optical filters, preferably five wavelengths).

[2] Determination of Planck's constant using solar cell.

[3] Determination of Stefan's constant (Black body method).

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[4] Study of the temperature dependence of resistivity of a semiconductor using four probe-methods.

[5] Study of Iodine spectrum with the help of grating and spectrometer and ordinary bulb light.

[6] Study of characteristics of a GM counter and verification of inverse square law for the same strength of a radioactive source.

[7] Study of β-absorption in Al foil using GM Counter to find endpoint energy.

[8] To find the magnetic susceptibility of a paramagnetic solution using Quincke's method.

[9] Determination of coefficient of rigidity as a function of temperature using torsional oscillator (resonance method).

[10] Study of polarization by reflection from a glass plate with the help of Nicol's prism and photocell and verification of Brewster's Law and Malus's Law.

[11] e/m measurement by helical method.

[12] Measurement of magnetic field using ballistic galvanometers and search coil (using earth inductor for calibration of galvanometer). Study of variation of magnetic field of an electromagnet with current.

[13] Measurement of electric charge by Millikan's oil drop method.

Learning outcomes -

This course covers a wide range of topics in physics. Upon completion, students will be able to: i. Quantify fundamental physical constants ii. Characterize material properties iii. Analyze radiation and its interactions iv. Investigate light polarization v. Develop proficiency in handling laboratory instrumentation.