Maharaja Surajmal Brij University
Bharatpur (Rajasthan)

Syllabus (Physics)

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

(III & IV Semester)

Academic Session 2024-25

डॉ. अरूण कुमार पाण्डेय
उपकुलसचिव
प्रभारी अकादमिक प्रथम

Syllabus
III-Semester
PHY-20T-301-Optics

Type	Paper code and Nomenclature	Duration of Examination	Maximum Marks (Midterm+ EoSE)	Minimum Marks (Midterm + EoSE)
Theory	PHY-20T-301 Optics	1 Hrs-MT/IA 3 Hrs-EoSE	20 Marks-MT/IA 80 Marks-EoSE	8 Marks-MT/IA 32 Marks-EoSE
Practical	PHY-20P-302 Physics Lab-III	2 Hrs-MT/IA 4 Hrs-EoSE	10 Marks-MT/IA 40 Marks-EoSE	4 Marks-MT/IA 16 Marks-EoSE

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
III	PHY-20T-301	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 earn basic knowledge of interference, diffraction, polarization, LASER, HOLOGRAPHY and FIBRE OPTICS for future research purposes.			

MT- Mid Term
IA- Internal Assesment
EoSE- End of Session Exam

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Detailed Syllabus
PHY-20T-301-Optics
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: Polarization (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)**

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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

(15Lectures)

REFERENCES:

1. F.A.Jenkins and H.E.White,Fundamentals of Optics,Tata Mc Graw 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.

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Syllabus
III-Semester

PHY-20P-302-Physics Lab-III

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
III	PHY-20P-302	Physics Lab-III	6	2
Level of Course	Type of the Course	Delivery Type of the Course		
Introductory	Major/Minor	Practical, Sixty hours of practical including diagnostic And formative assessment during practical hours.		
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Educationor equivalent			
Objectives of the Course:	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			

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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.
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 Rydberg constant by using grating.

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Suggested Books and References–

1. Practical Optics, by S.Naftali Men. First Edition (ISBN 13:978-0124909519)
Suggested E – Resources:
http://msbahae.um.edu,UniversityofNewMexico.

Course Learning Outcomes

1. Ability to find the formation of Newton ring and calculate the wavelength of monochromatic source.
2. 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 wave front 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

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Syllabus
IV-Semester
PHY-20T-401-Thermodynamics & Statistical physics

Type	Paper code and Nomenclature	Duration of Examination	Maximum Marks (Midterm+ EoSE)	Minimum Marks (Midterm + EoSE)
Theory	PHY-20T-401 Thermodynamics & Statistical Physics	1 Hrs-MT/IA 3 Hrs-EoSE	20 Marks-MT/IA 80 Marks-EoSE	8 Marks-MT/IA 32 Marks-EoSE
Practical	PHY-20P-402 Physics Lab-IV	2 Hrs-MT 4 Hrs-EoSE	10 Marks-MT 40 Marks-EoSE	4 Marks-MT 16 Marks-EoSE

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
IV	PHY-20T-401	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.			

MT- Mid Term
IA- Internal Assesment
EoSE- End of Session Exam

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Detailed Syllabus
PHY-20T-401-Thermodynamics & Statistical physics
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 law 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.

(15Lectures)

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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 I: 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.

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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 I and He II, including super-fluidity.
10. Study phase space, microstates, macrostates, thermodynamic probability, and entropy. Learn about quantum 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

PHY-20P-402 -Physics Lab-IV

Semester	Code of the Course	Title of the Course / Paper	NHEQF Level	Credits
IV	PHY-20P-402	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.		

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Prerequisites	Practical, sixty hours (4hours 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 team work 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

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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 determine the Specific Heat of a Liquid using a Calorimeter.
2. To Study the Variation of Thermo- emf with Temperature.
3. Determination of the Coefficient of Thermal Conductivity of a Bad Conductor by Lee and Charlton's Disc Method.
4. Determination of Stefan's Constant using Black Body Radiation.
5. Determination of Planck's Constant.
6. To study the black body spectrum of light intensity for a light bulb.
7. Experimental Determination of γ using Clement and Desormes Method
8. Study of variation of total thermal radiation with temperature.
9. Determine specific rotation of sugar solution by Polarimeter.
10. To study the resolving power of prism.
11. To study the resolving power of grating.
12. Plot thermo emf versus temperature graph and find the neutral temperature (Use sand bath)

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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.

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