ST. ALOYSIUS COLLEGE(AUTONOMOUS), JABALPUR

Reaccredited 'A++ 'Grade by NAAC(CGPA:3.58/4.00)
College with Potential for Excellence by UGC
DST-FIST Supported & STAR College Scheme by DBT

Faculty of Science

Bachelor of Science (B.Sc.)

SUBJECT: PHYSICS

B.Sc. II

Semester

Paper-Major 3

Thermal Physics (Theory)

Course Outcomes

	Course Outcomes	Cognitive Level
CO-I	Learner will be able to understand the historical development of thermal physics, with a focus on Indian knowledge systems, contributions from Satyendra Nath Bose and Meghnad Saha.	U, R
CO-II	Learner will be able to make use of Basic concepts of thermodynamics & compare working of different engines	R, U, An, E
CO-III	Learner will be able to apply Maxwell's thermodynamics equations to solve real world problems.	Ap, E,C
CO-IV	The learner will be able to determine the requirements for thermodynamic equilibrium and discover how low temperature is produced	Ap, An, E
CO-V	Learner will be able to understand concept of Thermometry, Calorimetry and Radiation	U,R,Ap

Credit and Marking Scheme

	Credits	Marks		Total Marks
		Internal	External	
Theory	4	30	70	100
Practical	2	30	70	100
Total	6	200		

Evaluation Scheme

	Marks	
	Internal	**External**
Theory	3 Internal Exams of 15 Marks (During the Semester, Best 2 will be taken)	1 External Exam (At the End of Semester)
Practical	Question Answer /any given task during class (Oral): 10 Marks Attendance: 10 Marks Assignment/Presentation/Sessionalviva:10Marks	1 External Exam (At the End of Semester)

Content of the Course

Theory

No. of Lectures (in hours per week): 4.5 Hrs. per week

Total No. of Lectures: 60 Hrs. **Maximum Marks:** 70

Units	Topics	No. of Lectures
I	**Historical background & Kinetic theory** *[iii]* 1. Historical context of thermal physics in Indian knowledge systems, contributions of Satyendra Nath Bose to Statistical Physics, Biography and Significant contributions of Meghnad saha. 2. Thermal Power Plants Located in Madhya Pradesh and their key characteristics. 3. Kinetic theory of gases, Maxwell's speed distribution, Mean free path, Treatment of transport phenomena. 4. Viscous flow and thermal conduction in gases. Real gases, Andrew's curve and equation of state. 5. Viral coefficients, Van der Waals equation of state, critical constants. **Activities:** 1. Visit thermal power plant (if possible)/ make model of thermal power plant / make chart of thermal power plant 2. To compare the viscosity of different of different fluids by observing how they flow down in inclined surface ***Keywords:*** Thermodynamics, thermal power pants viral coefficients, critical constants.	12
II	**Laws of Thermodynamics** *[vii]* 1. Thermodynamics system, Thermodynamics equilibrium, zeroth law of Thermodynamics, the concept of path function and point function, First law of thermodynamics, reversible and irreversible processes. 2. Heat engine and its efficiency, Carnot's cycle, Carnot's & it's efficiency,Carnot's theorem, Otto engine. Diesel engine, Introductory idea about Jet, Turbo Jet engine (Basic Principle	12

	and comparison with Diesel Engine). 3. Second law of thermodynamics, statement of kelvin Planck and Clapeyron, third law of thermodynamics. **Activities:** 1. Compare Otto & Diesel engines via model and chart. 2. Illustrate the second law of thermodynamics with a chart on entropy, heat flow and applications. ***Keywords:*** Thermodynamics equilibrium, Reversible and irreversible processes, Heat engine	
III	**Entropy and thermodynamic potentials** *[ii], [vii]* **1.** Concept of entropy, change in entropy of universe in reversible and irreversible processes, Principle of increase of entropy, entropy and unavailable energy, Heat death of Universe, Entropy of ideal gases, Entropy as a thermodynamics variable, T-S diagram. 2. Thermodynamic functions, internal energy, Enthalpy, Helmholtz function and Gibbs's free energy, Maxwell's thermodynamic equations and their applications. 3. TdS equations, Derivation of expressions of C_P-C_V for ideal and real gases, derivation of the expression $E_S/E_T = C_P/C_V$, Energy and heat capacity equations, Clapeyron equations (Latent Heat) and its applications (sublimation, vaporization) **Activities:** **1.** Ask students to observe the example of reversible and irreversible process in daily life. **2.** Ask students to present the T-S Diagram using graph. ***Keywords:*** Entropy, Thermodynamics potentials, internal energy, Helmholtz free energy.	**12**
IV	**Thermodynamics of Vapours, Phases and Systems** *[vii]* 1. Heat capacity of saturated vapour, Thermodynamics of liquid surfaces and paramagnetic solids, cooling by adiabatic demagnetization (no derivation) 2. Criterion of equilibrium of a system, isolated systems, Systems in contact with constant temperature and pressure reservoir, phase transition, coexistence of phases, Triple	12

	point. 3. Joule –Thomson effect: Thermodynamics analysis, inversion temperature. **Activities:** 1. Plot the phase diagram of water with temperature. 2. Obtain minimum temperature by adding salt in ice. ***Keywords:*** Isolated system, phase transition, Joule –Thomson effect.	
V	**Thermometry, Calorimetry and Radiation** *[vii]* **1.** Types of thermometer, platinum resistance thermometer, Thermodynamic scale of temperature, Ideal gas thermometer, Seebeck effect, Peltier effect, Elementary idea about thermal Sensors (Ex.-J Type,K Type) 2. Calorimetry, Newton's Law of cooling, calorific value of method, Lee's method for bad conductors. 3. Blackbody radiation, Wien displacement law, Rayleigh – Jean's law, Planck's quantum theory of radiation. **Activities:** **1.** Study temperature management techniques used in ancient Indian architecture such as cooling in temples, stepwells, and havelis. **2.** Study Scientific significance of Rituals and Yajnas. ***Keywords:*** Seeback effect, Peltier effect, Thermal management techniques, Radiations.	**12**

Code Details: *Gender – [i], Environment & Sustainability – [ii], Human Values – [iii], Professional Ethics – [iv], Employability – [v], Entrepreneurship - [vi], Skill Development -[vii]*

References

Suggested Readings:

1. Pandey R. C. "Suryasiddhanta", Chaukhamba Surabharati Prakashan, Varanasi.
2. History of Science in Sanskrit Literature, NCERT, 2018.
3. Bhaskara II, "Siddhanta Shiromani", (1150 CE).
4. Dongre N. G., Nene S. G., "Physics in Ancient India", National Book Trust, India. Treatise on Heat. Indian Press.
5. Saha, M. N., & Srivastava, B. N. (1958).
6. Zemansky M. W. & Dittman R., "Heat and Thermodynamics", Tata McGraw-Hill.
7. Sears and Salinger, "Thermodynamics, Kinetic Theory & Statistical Thermodynamics", Narosa.
8. Garg S. C. & Ghosh C. K., "Thermal Physics", Tata McGraw-Hill.
9. Subrahmanyam N., Brij Lal, Hemne P.S., "Heat Thermodynamics and statistical", S. Chand, 2012.
10. Gambhir & Loknathan, "Statistical and Thermal Physics: An Introduction",PHI, 1991
11. Books published by Madhya Pradesh Hindi Granth Academy, Bhopal.

Web Links:

Suggested equivalent online courses:

1. https://www.eshiksha.mp.gov.in/mpdhe/ Learning Management System, Department of higher education, Government of Madhya Pradesh (M.P.).
2. https://www.edx.org/course/thermodynamics Thermodynamics course.

List of Experiments *[iv,] [vii]*

1. Determination of the mechanical equivalent of heat by Callendar & Barne's method.
2. Determination of efficiency of electrical Kettle with variable voltages.
3. Determination of temperature coefficient of a resistance using platinum resistance thermometer.
4. Determination of electromotive force of a thermocouple.
5. Determination of thermal conductivity of a bad conductor by Lee's disc method.
6. Verification of Newton's law of cooling.
7. Determination of the ratio of specific heat of air by Clement-Desorme's method.
8. Determination of specific heat of a liquid with the help of Newton's law of cooling**.**
9. Determination of the coefficient of thermal conductivity of a metal by Searle's method.
10. Determination of thermal conductivity of the rubber using calorimeter.
11. Determination of mechanical equivalent of heat (J) using Joule calorimeter.
12. Determination of Stefan's constant using thermocouple.
13. Study of statistical distribution and determination of standard deviation with the help of black and white dice.
14. Determination of the temperature coefficient of a resistance with the help of Carey-Foster bridge.
15. Determination of the critical constant of a gas/ vapour.
16. Thermo–EMF Analyser : Inversion temperature of Fe-Cu Thermocouple**. (SPONSARED BY DBT STAR)**
17. Relaxation (Thermal) Time of a Serial Light Bulb**. (SPONSARED BY DBT STAR)**

Other experiments of the same difficulty level may be added.
Student needs to perform at least 10 experiments.

REFERENCES

1. Arora C.L., "B.Sc. Practical Physics", S.Chand, New Delhi (2021).
2. Ghosh & Majumdar., "Advanced Practical Physics,Vol.1&Vol.2", Shridhar Publishers, Kolkata (2019)
3. Indu Prakash, "Textbook of Practical Physics, Vol.1&Vol.2, Kitab Mahal, New Delhi (2012)
4. B.L. Worsnop & H. T. Flint, "Advanced Practical Physics" Khosla Publishing House
5. Squires G.L., "Practical Physics", Cambridge University Press, (2001)