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-Minor 2

Thermodynamics

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 compare how various engines operate and use fundamental thermodynamic ideas.	U, An, E
CO-III	Learner will be able to examine how entropy changes during both reversible and irreversible processes.	An. E
CO-IV	Learner will be able to apply Maxwell's thermodynamics relations to solve real world problems.	Ap, An, E, C
CO-V	Learner will be able to comprehend the concepts of radiation, thermometry, and calorimetry.	R, U

Credit and Marking Scheme

	Credits	Marks		Total Marks
		Internal	External	
Theory	3	30	70	**100**
Practical	1	30	70	**100**
Total	**4**	**200**		

Evaluation Scheme

	Marks	
	Internal	**External**
Theory	3 Internal Exams of 15 Marks (During the Semester Best 2 will be taken)	1 External Exams (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 Exams (At the End of Semester)

Content of the Course

Theory

No. of Lectures (in hours per week): 3 Hrs. per week

Total No. of Lectures: 45 Hrs. **Maximum Marks:** 70

Units	Topics	No. of Lectures
I	**Historical background & Kinetic theory** *[iii]* 1. Historical context of thermodynamics 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, elementary treatment of transport phenomena. 4. Viscous flow and thermal conduction in gases. Real gases, Andrew's curve and equation of state. 5. Virial coefficients, Van der Waals equation, 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 fluids by observing how they flow down in inclined surface ***Keywords:*** Thermodynamics, Thermal Power Plants, Virial coefficients, Critical constants.	9
II	**Laws of Thermodynamics** 1. Thermodynamical system, Thermodynamic 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 engine and its efficiency, Carnot's theorem, Otto engine. diesel engine, Introductory idea about Jet, Turbo Jet engine (Basic Principle and comparison with Diesel Engine). 3. 4. Second law of thermodynamics, statement of Kelvin-Planck and	9

	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** **1.** Concept of entropy, Clausius theorem, Entropy change in adiabatic reversible process, Entropy as point function, Change in entropy of universe in reversible and irreversible processes. **2.** 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. **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, T-S diagram	**9**
IV	**Thermodynamic Potentials** 1. Thermodynamic functions: Internal energy, Enthalpy, Helmholtz and Gibbs's free energy. Maxwell's thermodynamical equations(relations) and their applications. 2. 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 (Latent heat) equations and its applications (sublimation, vaporization) **Activities:** 1. Assign students to create a flowchart or diagram showing the relationships between internal energy, enthalpy, Helmholtz free energy and Gibb's free energy. 2. Provide numerical problems where students calculate C_P-C_V for ideal gases and compare results with real gases. **Keywords/Tags:** Thermodynamic potentials, Internal energy, Enthalpy, Helmholtz free energy and Gibb's free energy.	9

V	**Thermometry, Calorimetry and Radiation** **1.** Types of thermometers, Platinum Resistance Thermometer, Seebeck effect, Peltier effect, Absolute scale of temperature. 2. Calorimetry, Newton's Law of cooling, calorific value of fuel, Coefficient of thermal conductivity, Determination of coefficient of thermal conductivity of a conductor by Searl's Method and Determination of coefficient of thermal conductivity of bad conductors by Lee's method. 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 public buildings, stepwells, and havelis. **2.** Study Scientific significance of Rituals and Yajnas. ***Keywords:*** Seeback effect, Peltier effect, Radiations.	**9**

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 Practical

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. Determination of Inversion temperature of Fe-Cu / Fe-Constantan Thermocouple.
17. Determination of Relaxation (Thermal) Time of a Serial Light Bulb.

Other experiments of the same difficulty level may be added.
Student needs to perform at least 7 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)