DEPARTMENT OF PHYSICS				CLASS: I B.Sc. Physics				
Sem	**Course**	**Subject Code**	**Course title**	**Credits**	**Contact hours/week**	**CIA**	**Ext**	**Total**
II	Major Core – 3	20U2PMC3	HEAT AND THERMODYNAMICS	3	3	25	75	100

Course Objectives:

1. To understand the phenomena connected with measurement of temperature.
2. To know the concept of specific heat capacities of matter, transmission of heat, concept of lowering the temperature, liquefying gases and process of making heat to do mechanical work.
3. To understand the application of thermodynamics in real life situations.

Unit-I: Thermometry and Calorimetry

Concept of heat and temperature — Calendar and Griffith's bridge - Specific heat capacity of solids – Regnault's method of mixtures(solid) – Newton's law of cooling – Specific heat capacity of liquids – Determination of specific heat capacity of liquid– Calendar and Barnes method – Specific heat capacity of gases — $C_v$by Joly's differential steam calorimeter method – C_p by Regnault's method.

Self study: C_p and C_v, Meyer's relation.

Audit : International temperature scale – Thermistor

Unit-II: Transmission of Heat

Conduction – Coefficient of thermal conductivity – Rectilinear flow of heat along a bar – Lee's disc method - Convection – Radiation – black body – Kirchhoff's law – Stefan – Boltzmann law – Energy distribution in black body spectrum – Wien's law – Rayleigh Jean's law – Planck's law – Solar constant – Temperature of the sun — Angstrom's pyroheliometer - Water flow pyroheliometer. **Self study:** Mechanism of heat transfer, Application of convection.

Audit : Lapse rate – Stability of the atmosphere

Unit-III: Kinetic Theory of Gases

Concept of Ideal or Perfect gas – Kinetic model – Brownian motion – Degree of freedom, Maxwell's law of equipartition of energy – Molecular collisions – Mean free path – Expression for mean free path – Transport phenomena – Expression for viscosity – Diffusion and thermal conductivity of gas – Van der Waals equation of state – Estimation of critical constants – Joule Thomson effect – porous plug experiment - Theory – Principle of Regenerative cooling – Production of low temperatures – Adiabatic demagnetization .

Self study: Properties of matter near critical point, Different methods of liquefaction of gases, Practical Applications of low temperature and refrigerators.

Audit: Super fluidity – Application of super fluidity

Unit-IV: Thermodynamics

Zeroth law of thermodynamics – Concept of heat – thermodynamic equilibrium – Work, Internal energy - first law of thermodynamics – Applications of first law of thermodynamics – Adiabatic equation of perfect gas – Isothermal process – Work done during isothermal & adiabatic process – Reversible and irreversible processes – Heat engine – Definition of efficiency – Carnot's ideal heat engine – Carnot's cycle – Effective way to increase efficiency – Carnot's engine – Second law of thermodynamics – Carnot's theorem.

Self study: Isothermal process, adiabatic process, Refrigerator

Audit: Steam engine, Internal combustion engine.

Unit-V: Entropy

Entropy – Change of entropy – Change of entropy in adiabatic process, Change of entropy in reversible and irreversible processes – Temperature – entropy diagrams – Physical significance of entropy – Entropy of a perfect gas – third law of thermodynamics – Zero point energy – Negative temperature – Maxwell thermo dynamical relations – Derivation and application – Clausius – Clapeyron equation.

Self study: Change of entropy when ice converted into steam - Heat death of universe

Audit: First order phase transistions,Second order phase transition – Ehrenfest's equations

Books for Study

1. Heat, Thermodynamics and Statistical Physics– Brijlal, Dr.N.Subrahmanyam and P.S.Hemne, S.Chand& Co, New Delhi, Reprint 2016.

Unit I: 13.1, 13.16, 14.1, 14.2, 14.5, 14.7, 14.11, 14.12.

Unit II: 15.1, 15.2, 15.10, 15.11, 15.22, 8.6, 8.9, 8.10, 8.12, 8.13, 8.14, 8.15, 8.17, 8.26, 8.27, 8.28, 8.29.

Unit III: 1.2,1.3,1.13,1.18,1.19, 3.1, 3.2, 3.5, 3.7, 3.8, 3.9, 3.11, 3.16, 2.4,2.8,2.10,2.13,2.20, 2.21,2.23,2.26,7.7,7.15,7.16

Unit IV: 4.2,4.3, 4..4, 4.5, 4.6, 4.7, 4.10.1,4.10.4, 4.10.6,4.10.7,4.12,4.13,4.20,4.21,4.22,4.23, 4.24,4.25,4.26, 4.27, 4.28, 4.29, 4.30,4.32

Unit V: 5.1, 5.2, 5.3,5.4, 5.6, 5.7, 5.8,5.9,5.15,5.16,5.17, 6.3, 6.4.7.

Books for References

1. Heat & Thermodynamics – J.B. Rajan, SC Publisher, New Delhi, 1985.
2. Concepts of Physics Volume I and II – H.C. Varma, BharatiBhawan Publishers, New Delhi, 2015
3. M. Narayanamoorthy and N. Nagarathinam, Heat, National publishing Co,Chennai, Eight edition, 1987.
4. Sears and Zemensky 's "University Physics with Modern Physics", 14th edition by Hugh D. Young , Roger A.Freedman.Copyright 2017 Pearson India Education Services Pvt.Ltd
5. Lecture notes on thermodynamics–Joseph M. Powers, Department of Aerospace and MechanicalEngineering–University of Notre Dame, Notre Dame, Indiana 46556–5637–USA updated 20 March 2019
6. Heat and Thermodynamics – D.S. Mathur, Sultan Chand & Sons, 5th Edition, New Delhi, 2014.
7. Thermal Physics – R. Murughesan and KiruthigaSivaprasath, S.Chand& Co, II Edition, New Delhi, 2008

Web Resources

Fundamentals of thermodynamics:

1. https://www.khanacademy.org/science/physics/thermodynamics
2. https://www.britannica.com/science/thermodynamics
3. https://www3.nd.edu/~powers/ame.20231/notes.pdf

Course Designers:

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2. Mr.S.SivaramKrishnan
3. Mrs.S.Angayarkanni

Lecture Schedule

Unit	Topics	Hours	Mode
Unit I	Concept of heat and temperature	1	Chalk and talk, Quiz and assignment
	Calendar and Griffith's bridge	1	
	Specific heat capacity of solids – Regnault's method of mixtures(solid)	2	
	Newton's law of cooling – Specific heat capacity of liquids	2	
	Determination of specific heat capacity of liquid– Callendar and Barnes method.	1	
	Specific heat capacity of gases – $C_v$by Joly's differential steam calorimeter method – C_p by Regnault's method	2	
Unit II	Conduction – Coefficient of thermal conductivity	1	PPT, Chalk and talk, and Group discussion
	Rectilinear flow of heat along a bar	1	
	Lee's disc method - Convection – Radiation – black body – Kirchhoff's law	2	
	Stefan – Boltzmann law – Energy distribution in black body spectrum – Wien's law – Rayleigh Jean's law – Planck's law – Solar constant	3	
	Temperature of the sun — Angstrom'spyroheliometer - Water flow pyroheliometer	2	
Unit III	Conduction – Coefficient of thermal conductivity – Rectilinear flow of heat along a bar	1	PPT, Chalk and talk, Quiz and Group discussion
	Concept of Ideal or Perfect gas – Kinetic model - Brownian motion – Degree of freedom	1	
	Maxwell's law of equipartition of energy – Molecular collisions – Mean free path – Expression for mean free path	2	
	Transport phenomena – Expression for viscosity – Diffusion and thermal conductivity of gas	2	
	Van der Waals equation of state – Estimation of critical constants – Joule Thomson effect – porous plug experiment - Theory – Principle of Regenerative cooling	2	
	Production of low temperatures – Adiabatic demagnetization	1	
Unit IV	Zeroth law of thermodynamics – Concept of heat – thermodynamic equilibrium	2	PPT, Chalk and talk, Assignment
	Work, Internal energy - first law of thermodynamics – Applications of first law of thermodynamics – Adiabatic equation of perfect gas	2	
	Isothermal process – Work done during isothermal & adiabatic process – Reversible and irreversible processes – Heat engine – Definition of efficiency – Carnot's ideal heat engine – Carnot's cycle	3	
	Effective way to increase efficiency – Carnot's engine – Second law of thermodynamics – Carnot's theorem	2	
Unit V	Entropy – Change of entropy – Change of entropy in adiabatic process	2	Chalk and talk, Quiz and Interaction
	Change of entropy in reversible and irreversible processes – Temperature – entropy diagrams – Physical significance of entropy	2	
	Entropy of a perfect gas — third law of thermodynamics – zero point energy – Negative temperature – Maxwell thermo dynamical relations –	3	
	Derivation and application – Clausius – Clapeyron equation.	2	

Pedagogy

Chalk and Talk , PPT, group discussion, seminar, interaction , problem solving , quiz

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLOs	Course Learning Outcomes	Knowledge level
CLO1	Calculate and interpret heat and related properties using typical calorimetry/thermometry data.	K3
CLO2	Apply concepts of blackbody radiation and associated radiation laws to estimate the temperature of stars and other objects where thermometry and calorimetric estimates are not feasible.	K3
CLO3	Apply the principles of kinetic theory of gases to determine the macroscopic variables of real gases (including free electron gases)	K3
CLO4	Analyze real world thermodynamical system and apply the principles of thermodynamics to them and determine whether a process is reversible, irreversible or impossible.	K4
CLO5	Understand entropy as the law of nature & apply the same to thermodynamic systems.	K2

Mapping of CLOs with PSOs

	PSO–1	PSO–2	PSO–3	PSO–4	PSO–5	PSO–6	PSO–7
CLO–1	3		2	1			
CLO–2	3		2	1			
CLO–3	3		2	1			
CLO–4	3		2	1			
CLO–5	3		2	1			

Mapping of CLOs with POs

#	PO1	PO2	PO3	PO4	PO5
CLO1	3	2	1		
CLO2	3	2	1		
CLO3	3	2	1		2
CLO4	3	2	1		2
CLO5	3	2	1		1

Advance application –3; Intermediate level –2; Basic level–1