

Category II

Physical Science Courses with Physics discipline as one of the Core Disciplines

DISCIPLINE SPECIFIC CORE COURSE – PHYSICS DSC 3: HEAT AND THERMODYNAMICS

Course Title & Code	Credits	Credit distribution of the course			Pre-requisite of the course
		Lecture	Tutorial	Practical	
HEAT AND THERMODYNAMICS PHYSICS DSC – 3	4	2	0	2	--

LEARNING OBJECTIVES

This course will review the basic concepts of Thermodynamics, Kinetic Theory of gases with a brief introduction to Statistical Mechanics. The primary goal is to make the student understand the applications of fundamental laws of thermodynamics to various systems and processes. This coursework will enable the students to understand the connection between the macroscopic observations of physical systems and microscopic behaviour of atoms and molecule through a brief knowledge of statistical mechanics. The lab course deals with providing the knowledge of the concepts of Thermodynamics along with Planck's Law and Stefan Boltzmann laws related to black body radiation.

LEARNING OUTCOMES

At the end of this course, students will be able to

- gain an essence of the basic concepts of thermodynamics, the first and the second law of thermodynamics, the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations along with Maxwell's thermodynamic relations.
- Know the fundamentals of the kinetic theory of gases, Maxwell-Boltzmann distribution law, mean free path of molecular collisions, viscosity, thermal conductivity and diffusion.
- Learn about the black body radiations, Stefan- Boltzmann's law, Rayleigh-Jean's law and Planck's law and their significances.
- gain the basic knowledge about quantum statistics: the Bose-Einstein statistics and the Fermi-Dirac statistics.
- In the laboratory course, the students are expected to: Measure of Planck's constant using black body radiation, determine Stefan's Constant, coefficient of thermal conductivity of a bad conductor and a good conductor, determine the temperature coefficient of resistance, study variation of thermo-emf across two junctions of a thermocouple with temperature etc.

SYLLABUS OF PHYSICS DSC – 3

THEORY COMPONENT

Unit – I - Laws of Thermodynamics (10 Hours)

Fundamental basics of Thermodynamic system and variables, Zeroth Law of Thermodynamics and temperature, First law and internal energy, various thermodynamical processes, Applications of First Law: general relation between C_p and C_v , work done during various processes, Compressibility and Expansion Coefficient, reversible and irreversible processes, Second law: Kelvin-Planck and Clausius statements, Carnot engine, Carnot cycle and theorem, basic concept of Entropy, Entropy changes in reversible and irreversible processes, Clausius inequality, Entropy-temperature diagrams.

Unit – II - Thermodynamic Potentials and Maxwell's Relations (5 Hours)

Basic concept of Thermodynamic Potentials, Internal Energy, Enthalpy, Helmholtz Free Energy, Gibbs's Free Energy, derivation of Maxwell's Thermodynamic Relations and their applications in Clausius Clapeyron Equation, value of $C_p - C_v$, TdS Equations, Energy equations for ideal gases, evaluation of C_p/C_v

Unit – III - Kinetic Theory of Gases and Molecular Collisions (6 Hours)

Maxwell-Boltzmann Law of Distribution of Velocities in an ideal gas and its experimental verification, Mean, Root Mean Square and Most Probable Speeds, Mean Free Path (Zeroth order), Transport Phenomena in ideal gases: Viscosity, Thermal Conductivity and Diffusion (for vertical case)

Unit – IV - Theory of Radiation (5 Hours)

Blackbody radiation, Spectral distribution, Derivation of Planck's law, Deduction of Wien's law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law

Unit – V - Statistical Mechanics (4 Hours)

Macrostate and Microstate, phase space, Entropy and thermodynamic probability, Maxwell-Boltzmann law, qualitative description of Quantum statistics – Bose Einstein and Fermi Dirac, comparison of three statistics.

References:

Essential Readings:

- 1) Heat and Thermodynamics: M. W. Zemansky and R. Dittman, 1981, Tata McGraw-Hill.
- 2) Thermal Physics: S. C. Garg, R. M. Bansal and C. K. Ghosh, 2nd Edition, Tata McGraw-Hill.
- 3) Thermodynamics, Kinetic Theory and Statistical Thermodynamics: Sears and Salinger, 1988, Narosa.
- 4) Concepts in Thermal Physics: Blundell and Blundell, 2nd Edition, 2009, Oxford University Press.
- 5) Thermal Physics, A. Kumar and S. P. Taneja, 2014, R. Chand Publications.
- 6) A Text Book of Heat and Thermodynamics for Degree Students, J. B. Rajam, 1981, S. Chand.

Additional Readings:

- 1) An Introduction to Thermal Physics: D. Schroeder, 2021, Oxford University Press (earlier published by Pearsons)
- 2) Thermal Physics: C. Kittel and H. Kroemer, 1980, 2nd Edition, W.H. Freeman
- 3) Heat, Thermodynamics and Statistical Physics, Brij Lal, N. Subrahmanyam and P. S. Hemne, S. Chand and Company

PRACTICAL COMPONENT**(15 Weeks with 4 hours of laboratory session per week)**

At least six experiments to be done from the following:

- 1) To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
- 2) To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
- 3) To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method using steam or electrical heating.
- 4) Measurement of Planck's constant using black body radiation.
- 5) To determine the temperature coefficient of resistance by Platinum Resistance Thermometer using Carey Foster's bridge.
- 6) To study the variation of thermos-emf across two junctions of a thermocouple with temperature.
- 7) To determine Stefan's Constant.
- 8) To determine the Temperature Coefficient of Resistance using Platinum Resistance Thermometer (PRT) by Callender-Griffith Bridge

References for laboratory work:

- 1) Advanced Practical Physics for students: B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
- 2) A Text Book of Practical Physics: Indu Prakash and Ramakrishna, 11th Edition, Kitab Mahal
- 3) Advanced level Practical Physics: Nelkon and Ogborn, 4th Ed, reprinted 1985, Heinemann Educational Publishers.
- 4) An Advanced Course in Practical Physics: D. Chattopadhyay and P. C. Rakshit, 1990, New Central Book Agency.
- 5) Practical Physics: G.L. Squires, 1985, Cambridge University Press.
- 6) B.Sc. Practical Physics: Harnam Singh, Dr P. S. Hemne, revised edition 2011, S. Chand and Co.
- 7) B. Sc. Practical Physics: C. L. Arora, 2001, S. Chand and Co.
- 8) B. Sc. Practical Physics: Geeta Sanon, R. Chand and Co.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – PHYSICS DSC 6: COMMUNICATION ELECTRONICS

Course Title & Code	Credits	Credit distribution of the course			Pre-requisite of the course
		Lecture	Tutorial	Practical	
COMMUNICATION ELECTRONICS PHYSICS DSC – 6	4	2	0	2	--

LEARNING OBJECTIVES

This paper aims to describe the concepts of electronics in communication. Communication techniques based on analog modulation, analog and digital pulse modulation including PAM, PWM, PPM, ASK, PSK, FSK are described in detail. Communication and Navigation systems such as GPS, satellite and mobile telephony systems are introduced.

LEARNING OUTCOMES

At the end of this course, students will be able to develop following learning outcomes:

- This paper aims to describe the concepts of electronics in communication. In this course, students will receive an introduction to the principle, performance and applications of communication systems.
- Students will learn the various means and modes of communication. They will gain an understanding of fundamentals of electronic communication system and electromagnetic communication spectrum with an idea of frequency allocation for radio communication system in India.
- They will gain an insight on the use of different modulation and demodulation techniques used in analog communication
- Students will be able to analyse different parameters of analog communication techniques.
- They will learn the need of sampling and different sampling techniques where they can sample analog signal.
- Students will learn the generation and detection of a signal through pulse and digital modulation techniques and multiplexing.
- They will gain an in-depth understanding of different concepts used in a satellite communication system.
- This paper will essentially connect the text book knowledge with the most popular communication technology in real world.

SYLLABUS OF PHYSICS DSC 6

THEORY COMPONENT

Unit – I (10 Hours)

Electronic communication: Introduction to communication – means and modes. Power measurements (units of power). Need for modulation. Block diagram of an electronic communication system. Brief idea of frequency allocation for radio communication system in India (TRAI). Electromagnetic communication spectrum, band designations and usage. Channels and base-band signals.

Analog Modulation: Amplitude Modulation: Frequency spectrum of AM waves, average power, average voltage, modulation index, AM-modulator circuits (collector modulation), AM-demodulator (diode detector), single side band generation and detection.

Angle Modulation: Frequency and phase modulation, frequency spectrum of FM waves, intersystem comparisons (FM and AM), FM generation using VCO, FM detector (slope detector)

Unit – II (5 Hours)

Analog Pulse Modulation: Channel capacity, Sampling Theorem and Nyquist Criterion, Basic Principles – Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM), modulation and detection technique for PAM only, Multiplexing – Time Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM).

Unit – III (6 Hours)

Digital Pulse Modulation: Need for digital transmission, Pulse Code Modulation (PCM), Digital Carrier Modulation Techniques, Sampling, Quantization and Encoding. Concept of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK) and Phase Shift Keying (PSK)

Unit – IV (6 Hours)

Satellite Communication: Introduction, Geosynchronous satellite orbits, geostationary satellite advantages of geostationary satellites. Transponders (C - Band), Uplink and downlink, path loss, Satellite visibility, Ground and earth stations. Simplified block diagram of the earth station.

Unit – V (3 Hours)

Mobile Telephony System: Basic concept of mobile communication, frequency bands used in mobile communication, the concept of cell sectoring and cell splitting, SIM number, IMEI number, GPS navigation system (qualitative idea only).

References:

Essential Readings:

- 1) Communication Electronics, Principles and Applications, L. E. Frenzel, Tata McGraw-Hill.
- 2) Communication Systems: Analog and Digital, R. P. Singh and S. D Sapre, Tata McGraw-Hill.
- 3) Analog and Digital Communications, H. Hsu, Schaum's Outline Series, Tata McGraw-Hill.
- 4) Electronic Communications Systems: Fundamentals Through Advanced, Wayne Tomasi, Fifth Edition, Pearson.
- 5) Communication Systems, S. Haykin, Wiley India

Additional Readings:

- 1) Electronic Communication, L. Temes and M. Schultz, Schaum's Outline Series, Tata McGraw- Hill.
- 2) Electronic Communication Systems, G. Kennedy and B. Davis, Tata McGraw-Hill
- 3) Analog and Digital Communication Systems, M.J. Roden, Prentice Hall of India.

PRACTICAL COMPONENT**(15 Weeks with 4 hours of laboratory session per week)**

Every student must perform at least 06 experiments.

- 1) To study AM – Generation and Detection circuit
- 2) To study FM – Generation and Detection circuit
- 3) To study Time Division Multiplexing (TDM)
- 4) To study Pulse Amplitude Modulation (PAM)
- 5) To study Pulse Width Modulation (PWM)
- 6) To study Pulse Position Modulation (PPM)
- 7) To study Amplitude Shift Keying (ASK)
- 8) To study Frequency Shift Keying (FSK)
- 9) To study Phase Shift Keying (PSK)

References (for Laboratory Work):

- 1) Introduction to Analog and Digital Communication – by M. A. Bhagyaveni, R. Kalidoss and K. S. Vishvakshenan, River Publishers Series in Communications
- 2) Communication Systems – by Michael Moher Simon Haykin, Wiley
- 3) Wireless Communication – by Goldsmith Andrea, Cambridge University Press
- 4) Digital Communications: Fundamentals & Applications – Bernard Sklar and Pabitra Kumar Ray, Pearson Education India

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

B.Sc. (Physical Sciences/Mathematical Sciences) with Mathematics as one of the Core Discipline

Category-III

**DISCIPLINE SPECIFIC CORE COURSE – A-3:
DIFFERENTIAL EQUATIONS**

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Differential Equations	4	3	1	0	Class XII pass with Mathematics	Nil

Learning Objectives

The primary objective of this course is to introduce:

- Ordinary and partial differential equations.
- Basic theory of higher order linear differential equations, Wronskian and its properties.
- Various techniques to find the solutions of above differential equations which provide a basis to model complex real-world situations.

Learning Outcomes

This course will enable the students to:

- Solve the exact, linear, Bernoulli equations, find orthogonal trajectories and solve rate problems.
- Apply the method of undetermined coefficients and variation of parameters to solve linear differential equations.
- Solve Cauchy-Euler equations and System of linear differential equations.
- Formulate and solve various types of first and second order partial differential equations.

SYLLABUS of Discipline A-3

Unit – 1

(15 hours)

Ordinary Differential Equations

First order ordinary differential equations: Basic concepts and ideas, First order Exact differential equations, Integrating factors and rules to find integrating factors, Linear equations and Bernoulli equations, Initial value problems, Applications of first order differential equations: Orthogonal trajectories and Rate problems; Basic theory of higher order linear differential equations, Wronskian and its properties.

Unit – 2

(12 hours)

Explicit Methods of Solving Higher-Order Linear Differential Equations

Linear homogeneous equations with constant coefficients, Linear non-homogeneous equations, Method of undetermined coefficients, Method of variation of parameters, Two-point boundary value problems, Cauchy-Euler equations, System of linear differential equations.

Unit – 3

(18 hours)

First and Second Order Partial Differential Equations

Classification and Construction of first-order partial differential equations, Method of characteristics and general solutions of first-order partial differential equations, Canonical forms and method of separation of variables for first order partial differential equations; Classification and reduction to canonical forms of second-order linear partial differential equations and their general solutions.

Essential Readings

1. Myint-U, Tyn and Debnath, Lokenath (2007). Linear Partial Differential Equations for Scientist and Engineers (4th ed.). Birkhäuser. Indian Reprint.
2. Ross, Shepley L. (1984). Differential Equations (3rd ed.). John Wiley & Sons.

Suggestive Readings

- Edwards, C. Henry, Penney, David E., & Calvis, David T. (2015). Differential Equations and Boundary Value Problems: Computing and Modeling (5th ed.). Pearson Education.
- Kreyszig, Erwin. (2011). Advanced Engineering Mathematics (10th ed.). Wiley India.
- Sneddon I. N. (2006). Elements of Partial Differential Equations. Dover Publications.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.