Government PG College, Ambala Cantt

Course File (Session 2023-24)

Name of Professor: Dr. Harneet Kaur

Class: BSc-II/3rd Semester/ SECTION: NM, CS

Subject code and Name: Physics PH-301 / Computer Programming and Thermodynamics

SYLLABUS

Maximum Marks: 40 **Internal: 10**

Time: 3 hours

Note: The syllabus is divided into 4 units. 9 questions will be set. Question no 1 will be compulsory, it contains 6 parts (form all the four units) and answer should be brief but not in yes / no. Four more questions are to be attempted, selecting one question from each unit. Questions 2-9 may contain two or more parts. All questions carry equal marks. 20% numerical problems are to be set. Use of scientific (non-programmable) calculator is allowed

UNIT-1: Computer Programming

Computer organization, Binary representation, Algorithm development, Flow charts and their interpretation. FORTRAN Preliminaries: Integer and floating point arithmetic expression, built in functions, executable and non-executable statements, input and output statements, Formats, IF, DO and GO TO statements, Dimension arrays, statement function and function subprogram.

UNIT –2: Applications of FORTRAN programming

Algorithm, Flow Chart and Programming for Print out of natural numbers, Range of the set of given numbers, Ascending and descending order, Mean and standard deviation, Least square fitting of curve, Roots of quadratic equation, Product of two matrices, Numerical integration (Trapezoidal rule and Simpson 1/3 rule).

UNIT-3: Thermodynamics-I

Thermodynamic system and Zeroth law of thermodynamics. First law of thermodynamics and its limitations, reversible and irreversible process. Second law of thermodynamics and its significance, Carnot theorem, Absolute scale of temperature, Absolute Zero and magnitude of each division on work scale and perfect gas scale, Joule's free expansion, Joule Thomson effect, Joule-Thomson (Porous plug) experiment, conclusions and explanation, analytical

treatment of Joule Thomson effect. Entropy, calculations of entropy of reversible and irreversible process , T-S diagram, entropy of a perfect gas, Nernst heat law(third law of thermodynamics), Liquefaction of gases, (oxygen, air, hydrogen and helium), Solidification of He below 4K, Cooling by adiabatic demagnetization.

UNIT-4: Thermodynamics-II

Derivation of Clausius-Clapeyron and Clausius latent heat equation and their significance,specific heat of saturated vapours,phase diagrame and triple point of a substance, development of Maxwell thermodynamical relations. Thermodynamical functions: Internal energy (U), Helmholtz function (F), Enthalpy (H), Gibbs function (G) and the relations between them, derivation of Maxwell thermodynamical relations from thermodynamical functions,Application of Maxwell relations: relations between two specific heats of gas, Derivation of Clausius-Clapeyron and Clausius equation,variation of intrinsic energy with volume for (i) perfect gas (ii)Vanderwall gas (iii)solids and liquids , derivation of Stefans law, adiabatic compression and expention of gas & deduction of theory of Joule Thomson effect.

References

1. Roy S K, Thermal Physics and Statistical Mechanics, New Age International Publishers, New Delhi
2. Rajaraman V, Computer Programming in FORTRAN 77, Prentice-Hall of India Pvt Ltd, New Delhi.
3. Ian C and Malcon C, Interactive FORTRAN 77, Affiliated East West Press Pvt Ltd, New Delhi.
4. Sharma J K and Sarkar K K, Thermodynamics and Statistical Physics, Himalaya Publishing House, Bambay
5. Stowe Keith, Introduction to Thermodynamics and its Applications, University press (India) Pvt Ltd, Hyderabad
6. Infelta Pierre P. Introductory Thermodynamics Publisher: BrownWalker Press
7. Johnson J. K, Fundamentals of Thermodynamics University of Pittsburgh 2009
8. Jefferson Tester, Michael Modell, Thermodynamics and Its Applications 3rd Edition

COURSE OBJECTIVES

The course objectives outlined are as follows:

- **Understanding Computer Programming Fundamentals**: Gain a comprehensive understanding of computer organization, binary representation, algorithm development, and flow chart interpretation. Students will be able to analyze and develop algorithms using flow charts, comprehend binary representations, and interpret various aspects of computer organization.

- **Proficiency in FORTRAN Programming:** Acquire proficiency in FORTRAN programming language, covering preliminaries such as integer and floating-point arithmetic expressions, built-in functions, control flow statements (IF, DO, GO TO), arrays, input/output operations, and formatting. Students will be equipped to write efficient and structured FORTRAN code for various applications.

- **Application of FORTRAN in Problem Solving:** Apply FORTRAN programming skills to solve a range of mathematical and scientific problems. This includes tasks such as printing natural numbers, determining the range of given numbers, sorting data, calculating mean and standard deviation, solving quadratic equations, matrix operations, and numerical integration using methods like the Trapezoidal rule and Simpson's 1/3 rule.

- **Understanding Thermodynamics Principles**: Develop a deep understanding of the fundamental principles of thermodynamics. Topics covered include the zeroth, first, and second laws of thermodynamics, reversible and irreversible processes, Carnot theorem, absolute temperature scales, Joule-Thomson effect, entropy, Nernst heat law, and liquefaction of gases.

- **Application of Thermodynamics Concepts:** Apply thermodynamic principles to analyze and solve problems related to energy, heat, and work. This includes understanding thermodynamic processes, calculating entropy changes, interpreting T-S diagrams, studying phase diagrams, deriving thermodynamic relations (such as Maxwell's relations), and applying thermodynamic functions (internal energy, enthalpy, entropy, Gibbs function) to various systems.

By the end of the course, students will be equipped with a solid foundation in computer programming using FORTRAN and a comprehensive understanding of thermodynamics principles, enabling them to tackle real-world engineering and scientific problems effectively.

COURSE OUTCOMES:

After the successful completion of the course, students will be able to:

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- Understand the principles and basic constructions of computer.
- Learn the basic aspects of FORTRAN and various statements, in built functions and loops.
- Application of FORTRAN in various programmes.
- Understand the basic concepts of thermodynamics.
- The first and the second law of thermodynamics
- Joule Thomson effect, Joule-Thomson (Porous plug) experiment
- The concept of entropy and the associated theorems
- Calculations of entropy of reversible & irreversible process
- T-S diagram and Nernst heat law (third law of thermodynamics).
- Derive the Clausius - Clapeyron and Clausius latent heat equations and understand their significance.
- The students will also be able to learn about Maxwell's thermodynamic relations their physical interpretations.

Lesson Plan

Week No.	Scheduled Dates	Topics to be covered
1.	26th July 2023 – 29 July 2023	Computer organization, Binary representation, Algorithm development, Flow chart and their interpretation
2.	31st July 2023 – 5th August 2023	Integer and floating point arithmetic expressions, Built in functions, Executable and non-executable statements
3.	7th August 2023-12 August 2023	Input and output statements, Formats, IF, DO and GO TO statements
4.	14th August 2023-19 August 2023	Dimension arrays, statement function and function subprogram, **Revision and doubts of Unit-1**
5.	21st August 2023 – 26th August 2023	Algorithm, Flow chart and programming for print out of natural numbers, range of set of given numbers, ascending and descending order, mean and standard deviation,
6.	28th August 2023-2nd September 2023	least square fitting of curve, roots of quadratic equation, product of two matrices, numerical integration (Trapezoidal rule and Simpson's 1/3 rule)
7.	4th September 2023 – 9th September 2023	**Revision and doubts of unit-2** Thermodynamic system and Zeroth law of thermodynamics. First law of thermodynamics and its limitations
8.	11th September 2023 – 16th September 2023	Reversible and irreversible process. Second law of thermodynamics and its significance, Carnot theorem, Absolute scale of temperature
9.	18th September 2023 – 23th September 2023	Absolute Zero and magnitude of each division on work scale and perfect gas scale, Joule's free expansion, Joule Thomson effect, Joule-Thomson (Porous plug) experiment
10.	25th September 2023 – 30th September 2023	Conclusions and explanation, analytical treatment of Joule Thomson effect, Entropy, calculations of entropy of reversible and irreversible process
11.	2nd October 2023-7th October 2023	T-S diagram, entropy of a perfect gas, Nernst heat law(third law of thermodynamics), Liquefaction of gases, (oxygen, air, hydrogen and helium),
12.	9th October 2023-14th October 2023	Solidification of He below 4K, Cooling by adiabatic demagnetization. **Numericals, Revision and doubts of unit-2** Derivation of Clausius-Clapeyron and Clausius latent heat equation and theirSignificance, Specific heat of saturated vapours,
13.	16th October 2023-21st October 2023	Phase diagram and triple point of a substance, development of Maxwell thermodynamical relations. Derivation of Clausius-Clapeyron and Clausius latent heat equation and theirSignificance
14.	23rd October 2023-28th October 2023	Thermodynamical functions: Internal energy (U), Helmholtz function (F), Enthalpy (H), Gibbs function (G)
15.	30th October 2023-4th November 2023	Relation between thermodynamical potentials, Derivation of Stefans law
16.	6th November 23 to 9th November 23	adiabatic compression and expansion of gas & deduction of theory of Joule Thomson effect. **Numericals, revision and doubts of unit-4**
17.	10th -16th November 23	Diwali Break
18.	17th November – 24th November 23	**Revision & Tests and previous Year Question paper discussion**