GOVERNMENT DEGREE COLLEGE (BOYS), BARAMULLA

Semester 3rd Major / Minor

Physics

Title: Thermal and Statistical Physics Code: BPH22C301
CREDITS: 06 (04 Th, 02 Pr.) Contact Hours: 64 Hr + 64 Hr

Course Objectives

To develop comprehension of fundamental thermodynamic concepts and principles including behaviour of real and ideal gases, and to apply them to different thermodynamics processes and systems.

Course Outcomes

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

1. Apply the First law of Thermodynamics and calculate Heat, Internal Energy, and Work in various thermodynamical processes and systems.
2. explain the concepts of Reversibility, Irreversibility, Carnot cycle, Entropy, Clausius theorem, Realise Second law as one of the fundamental law of nature
3. Estimate the entropy changes in reversible and irreversible processes.
4. Calculate the different measures of speeds in the Maxwell Boltzmann Distribution of velocities and derive the transport coefficients of Thermal conductivity, Viscosity and Diffusion in ideal gases.
5. Describe the behaviour of real gases and obtain the critical constants of the gas.

Unit I: First law of Thermodynamics and its applications

Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, Indicator Diagram, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_p and C_v, Work Done during thermodynamic processes (Isothermal, Adiabatic, Isochoric, Isobaric)

Unit II: Second law of Thermodynamics and Entropy

Second Law and Entropy, Carnot's cycle and theorem, Entropy changes in Reversible and Irreversible Process, Entropy –Temperature diagram, Thermodynamic Scale of Temperature. Third law of thermodynamics. Thermodynamic potentials: Enthalpy, Gibbs, Helmholtz and Internal energy functions, Compressibility and Expansion Co-efficient. Derivation of Maxwell's relations from thermodynamic potentials and their applications:- Joule--Thomson Effect, Clausius-Claperon Equation, Expression for C_p-C_v, C_P/C_V, TdS equations.

Unit III: Kinetic Theory of Gases

Kinetic Theory of Gases: Basic assumptions of kinetic theory, distinction between mean; rms and most probable speed values.. Mean free path and transport phenomena:- viscosity, diffusion and thermal conductivity. Imperfect gases and van der Wall's equation: Derivation

of perfect gas behaviour, Onnes equation of state, van der Wall's equation of state, reduced equation of state. Critical constants and relation between them.

Unit IV: Statistical Mechanics & Theory of Radation

Statistical Mechanics: Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Sterling's approximation, Maxwell-Boltzmann law - distribution of velocity. Quantum statistics - Fermi-Dirac distribution law - electron gas – Bose-Einstein distribution law - photon gas – comparison of three statistics.

Theory of Radiation: Blackbody radiation, Spectral distribution, Concept of Energy. Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh- Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law. Concept of radiation Pressure

Reference Books:

1. Thermal Physics by S C Garg, R M Bansal and C K Ghosh
2. Concepts of Modern Physics by Arthur Beiser.
3. Heat and Thermodynamics, M.W.Zemasky and R. Dittman Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears & G. L. Salinger.
4. B. B. laud; "Introduction to Statistical Mechanics" (Macmillan 1981)
5. F. Reif; "Statistical Physics" (Mcgraw-Hill; 1989)
6. K. Huang; "Statistical Physics" (Wiley Eastern; 1988)
7. C. Kittle "Thermal Physics" 5. Berkeley Physics Course Vol 5 "Statistical Physics"

e-Resources

https://archive.nptel.ac.in/courses/127/106/127106135/

https://oyc.yale.edu/physics/phys-200

https://ocw.mit.edu/courses/5-60-thermodynamics-kinetics-spring-2008/pages/lecture-notes/

https://www.coursera.org/courses?query=thermodynamics

Laboratory Work:

1. To study Newton's law of Cooling
2. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
3. Measurement of Planck's constant using black body radiation.
4. To determine Stefan's Constant.
5. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
6. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
7. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
8. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.

9. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
10. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system
11. To calibrate Resistance Temperature Device (RTD) using Null Method/Off- Balance Bridge
12. To study probability distributions using dices/coins.
13. Study of Heating Efficiency of Electric kettle.

3rd SEMESTER

SKILL EHHANCEMENT COURSE

PH318S: RENEWABLE ENERGY AND ENERGY HARVESTING

(Credits: Theory: 02)

The aim of this course is not just to impart theoretical knowledge to the students but to provide them with exposure and hands-on learning wherever possible

UNIT-I

Fossil fuels and Alternate Sources of energy: Fossil fuels and Nuclear Energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean, Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy, tidal energy, Hydroelectricity.

Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

UNIT-II

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.

Geothermal Energy: Geothermal Resources, Geothermal Technologies.

Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, piezoelectric parameters and modeling piezoelectric generators, piezoelectric energy harvesting applications.

Human power Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications, Carbon captured technologies, cell, batteries, power consumption. Environmental issues and Renewable sources of energy, sustainability.

PRACTICALS (CREDITS: 2)

Demonstrations and Experiments

1. Demonstration of Training modules on solar energy, wind energy, etc.
2. Conversion of vibration to voltage using piezoelectric materials
3. Conversion of thermal energy into voltage using thermoelectric modules.

Reference Books:

1. Non-conventional energy sources - G.D Rai - Kh^nna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
4. Godfrey Boyle, “Renewable Energy, Power for a feustainable future”, 2004, Oxford University Press, in association with The Open University.
5. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009
6. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).

Semester 1st Multidisciplinary

Subject: Physics

Course title: Energy Sources Course Code: **PHY022I**
Credits: 2+1

Unit I

Physics as a fundamental science, physics and society, relation of physics with other sciences, Energy crisis as a major challenge of the century; Energy concept and sources in general, its significance & necessity, Classification of energy sources: Primary and Secondary energy sources. Commercial and Non-commercial energy sources, Renewable and Non-renewable energy, Conventional and Non-conventional energy. Importance of Non-commercial energy resources Conventional energy sources: Fossil fuels & Nuclear energy- production & extraction, usage rate and limitations, Impact on environment and their issues & challenges. Overview of Indian & world energy scenario with latest statistics–consumption & necessity. Need of eco-friendly & green energy & their related technology, Environmental issues and Renewable sources of energy, Sustainability.

Unit II

Solar energy: Solar Energy-Key features, its importance, Merits & demerits of solar energy, Applications of solar energy. Solar water heater, flat plate collector, solar cooker, solar green houses, solar cell. Need and characteristics of photovoltaic (PV) systems, PV modules, and sun tracking systems.

Wind and Tidal Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different types of wind turbines, An overview of developments in Offshore Wind Energy,
Tidal Energy, Tide Energy Technologies, Wave energy systems, Ocean Thermal Energy Conversion.
B**iomass**, biochemical conversion, biogas generation, geothermal energy, Small Hydroelectricity.

Practicals:

1. Demonstration of training modules on solar energy, wind energy etc
2. Conversion of thermal energy into voltage using thermoelectric modules
3. VI characteristics of solar cell/modules
4. Field trip to nearby hydroelectric stations/ solar power installation
5. Project report on solar, hydro energy scenario in India.
6. Visit to site of Geothermal energy
7. Visit to wind farm
8. Project report on energy crisis in the world
9. Project report on potential of solar energy in the world and in India
10. Study of rural electrification plants of Govt. of India.

Reference Books:

1. Non-conventional energy sources – G.D Rai – Khanna Publishers, New Selhi
2. Solar Energy – M.P Agarwal – S.Chand and Co. Ltd.
3. Solar Energy – Suhas P Sukhative Tata McGraw Hill Publishing Compant Ltd.
4. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009
5. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA)
6. Solar Energy: Fundamentals, Design, Modelling and Applications by G. N. Tiwari, Narosa Publications
7. Non-Conventional Energy Resources by B H Khan, McGraw Hill
8. Solar Photovoltaic Technology and Systems by C S Solanki, PHI Learning Publications