IIT Mandi
Proposal for a New Course

Course number : **ME213**
Course Name : **Engineering Thermodynamics**
Credit : **4**
Distribution : ***3-1-0-4***
Intended for : **Core for B.Tech (Mechanical)**
Prerequisite : **None**
Mutual Exclusion: (Specify the equivalent courses in other schools. These *Courses (with high similarity) are not allowed to credit by the students after or along with this course.*)

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1. Preamble:

Thermodynamics is a subject which relates different forms of energies and energy conversions. Thermodynamics gives the possible direction of a process. The power and other energy conversion cycles are basis for the various systems in our daily life. At the end of the course, the students will be able to analyze and evaluate various thermodynamic cycles used for energy production- work and heat, within the natural limits of conversion.

2. Course Modules with quantitative lecture hours:

Unit 1: Introduction and Fundamental Concepts: Applications of Thermodynamics and Brief History, Macroscopic versus Microscopic Approach, Thermodynamic Systems and Control Volumes, Properties and State of a System, Thermodynamic Processes and Cycles, Primary Measurable Properties: Specific volume and density, Pressure, Temperature and its equality, Measurement of Temperature. **(3 Hours)**

Unit 2: Properties of Pure Substance: Pure Substance and its Different Phases, Phase Boundaries, Property Diagrams, Property Tables: Saturated liquid and saturated vapour states, Saturated liquid-vapour mixture, Superheated vapour states, Compressed or subcooled liquid states, Reference states for developing steam tables, Ideal Gas States, Compressibility Factor, Other Commonly Used Equations of State. **(3 hours)**

Unit 3: Energy and the First Law of Thermodynamics: Energy and Its Different Forms, Constituents of internal energy, Heat and work, Heat versus Work, Different Forms of Work Transfer: Displacement work, Shaft work, Spring work, First Law of Thermodynamics, Enthalpy: A Thermodynamic Property, Specific Heats, Internal Energy, Enthalpy and Specific Heats of Solids and Liquids, Internal Energy, Enthalpy and Specific Heats of Ideal Gases. **(8 Hours)**

Unit 4: Energy Analysis for Control Volumes: Conservation of Mass for a Control

Volume, Conservation of Energy for a Control Volume, Energy Analysis of Steady-Flow Processes, Examples of Steady Flow Devices: Nozzles and diffusers, Turbines and compressors, Mixing chambers, Heat exchangers, Throttle, Energy Analysis of Transient Processes. **(4 Hours)**

Unit 5: Second Law of Thermodynamics: Need for the Second Law of Thermodynamics, Heat Engines, Refrigerators and Heat Pumps, Second Law of Thermodynamics, PMM1 and PMM2, Reversible Process, Factors responsible for irreversibility, Internal and external reversibility, Carnot Cycle, Propositions Regarding the Efficiency of Carnot Cycle, Thermodynamic Temperature Scale, Ideal and Real Machines. **(6 Hours)**

Unit 6: Entropy: Clausius Inequality, Entropy, Entropy of a Pure Substance, Entropy Change for Internally Reversible Processes, Thermodynamic Property Relations, Entropy Change for Solids and Liquids, Entropy Change for an Ideal Gas, Property Diagrams Involving Entropy, Entropy Change for an Irreversible Process and Entropy Equation, Principle of Increase of Entropy, Entropy Rate Equation for a Closed System, Entropy Rate Equation for a Control Volume, Shaft Work for Steady Flow Devices, Isentropic Efficiency of Different Steady Flow Devices, Physical Inferences of Entropy. **(5 Hours)**

Unit 7: Exergy: Introduction to Exergy, Exergy Associated with Different Modes of Energy Transfer, Exergy Transfer by Heat, Exergy Transfer by Work, Exergy Potential of a Closed System, Exergy Potential of a Flowing Stream, Decrease of Exergy Principle, Exergy Balance Equation, Second Law Efficiency. **(3 Hours)**

Unit 8: Vapour Power Cycles: Introduction to Power Systems, Carnot Cycle, Rankine Cycle, Effect of Pressure and Temperature on the Rankine Cycle, Reheat Cycle, Regenerative Cycle and Feedwater Heaters, Deviation of Actual Cycles from Ideal Cycles. **(4 Hours)**

Unit 9: Air Standard Power Cycles: Air-Standard Power Cycles, Carnot Cycle, Brayton Cycle, Simple Gas-Turbine Cycle with a Regenerator, Gas-Turbine Power Cycle Configurations, Air-Standard Cycle for Jet Propulsion, Reciprocating Engine Power Cycles, Otto Cycle, Diesel Cycle, Dual Cycle. **(4 Hours)**

Unit 10: Refrigeration Cycles: Different Refrigeration Techniques, Carnot cycle,

Vapour Compression Refrigeration Cycle. **(2 Hours)**

Laboratory/practical/tutorial Modules:

Tutorial 1: Fundamental Concepts **(1 Hour)**

Tutorial 2: Properties of Pure Substances and Heat and Work Interactions **(2 Hours)**

Tutorial 3: Energy and the First Law of Thermodynamics **(2 Hours)**

Tutorial 4: First Law of Thermodynamics for Open Systems **(2 Hours)**

Tutorial 5: Second Law of Thermodynamics and Entropy **(2 Hours)**

Tutorial 6: Exergy **(1 Hour)**

Tutorial 7: Vapour Power Cycles **(2 Hours)**

Tutorial 8: Air Standard Power Cycles **(1 Hour)**

Tutorial 9: Refrigeration Cycles **(1 Hour)**

3. Text books:

1. Borgnakke, C. and Sonntag, R.E., Fundamentals of Thermodynamics, Vol. 8, Wiley, New York, 2013.
2. Cengel, Y.A. and Boles, M.A., Thermodynamics: An Engineering Approach, 8th edition, McGraw-Hill, Singapore, 2015. (eBook available at: https://www.expresslibrary.mheducation.com/product/thermodynamics-7e-sie)

4. References:

- Moran, M.J., Shapiro, H.N., Boettner, D.D. and Bailey, M.B., Fundamentals of Engineering Thermodynamics. John Wiley & Sons, 2010.
- Nag, P.K., Engineering Thermodynamics, Tata McGraw-Hill Education, 2013.
- Kumar, P. and Dhar, A., Basics of Thermodynamics, AICTE, 2023. (Softcopy available at: https://ekumbh.aicte-india.org/book.php)

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		IC142	Entire	100%

6. Justification of new course proposal if cumulative similarity content is >30%: The course code IC142 has been discontinued.