16AE202 ENGINEERING THERMODYNAMICS AND HEAT TRANSFER

Hours Per Week :

L	T	P	C
3	-	3	5

Total Hours :

L	T	P
45	-	45

WA/RA	SSH/HSH	CS	SA	S	BS
2	40	2	5	2	2

Course Description and Objectives:

This course provides fundamental concepts in thermodynamics, first and second laws of thermodynamics, entropy and energy, Ideal and real gases and non-reactive ideal gas mixtures and general thermodynamic properties. The objective of this course is to impart analytical and practical problem solving skills in thermodynamics.

Course Outcomes:

The student will be able to:

- distinguish various thermodynamic properties
- understand the first and second laws of thermodynamics and their applications.
- distinguish open and closed system, boundary conditions, work and heat interactions
- develop an understanding of various work interactions, cycles and subsequently apply first and second law of thermodynamics
- evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility
- understand the concepts of ideal and real gases, gas laws, Maxwell's relations and subsequently apply first and second laws of thermodynamics for an ideal gas and gas mixtures undergoing power and refrigeration cycles.

SKILLS:

- ü *Identify the type of systems, open or closed systems*
- ü *Identify reversible and irreversible processes*
- ü *Identify properties of ideal and real gases*
- ü *Estimate critical wall thickness of insulation*

ACTIVITIES:

- *Experimentation using Otto, Diesel and dual cycles and determination of their efficiencies.*
- *Estimation of Critical thickness for cylinders and spheres.*

UNIT - 1 **L- 10**

BASIC CONCEPT AND LAWS OF THERMODYNAMICS Basic concepts, Concept of continuum, Macroscopic approach, Thermodynamic systems, Closed, Open and isolated. Property, State, Path and process, Quasi-static process, Work, Modes of work, Zeroth law of thermodynamics, Concept of temperature and heat. Concept of ideal and real gases. First law of thermodynamics, Application to closed and open systems, Second law of thermodynamics, Reversibility and irreversibility. Carnot cycle reversed Carnot cycle, Efficiency, COP. Thermodynamic temperature Scale, Clausius inequality, Concept of entropy and availability.

UNIT - 2 **L-9**

IDEAL REAL GASES AND THERMODYNAMIC RELATIONS : Gas mixtures, Properties of ideal and real gases, Equation of state, Avagadro's law, Vander Waal's equation of states, Compressibility, and compressibility chart. Dalton's law of partial pressure, Exact differentials, T-D, Relations, Maxwell relations, Clausius Clapeyron equations, Joule Thomson Coefficient.

UNIT - 3 **L-9**

GAS POWER CYCLES : Air standard cycles-Otto-Diesel-Dual-Work output, Efficiency and MEP calculations –comparison of the cycles for same compression ratio and heat addition, Same compression ratio and heat rejection, Same peak pressure, Peak temperature and heat rejection, Same peak pressure and heat input, Same peak pressure and work output , Brayton cycle with inter cooling, Reheating and regeneration.

UNIT - 4 **L- 9**

RECIPROCATING AIR COMPRESSORS AND AIR COMPRESSORS AND AIR-CONDITIONING : Single acting and double acting air compressors, Work required, Effect of clearance volume, Volumetric efficiency, Isothermal efficiency, Free air delivery, Multistage compression, Condition for minimum work. Fundamentals of refrigeration, C.O.P., Reversed carnot cycle, Simple vapour compression refrigeration system, T-S, P-H diagrams, Simple vapour absorption refrigeration system, Desirable properties of an ideal refrigerant.

UNIT - 5 **L-8**

HEAT TRASNFER : One-dimensional Heat Conduction: Plane wall, Cylinder, Sphere, Composite walls, Critical thickness of insulation, Heat transfer through extended surfaces (simple fins).Convection: Free convection and forced convection, Internal and external flow, Simple Empirical relations. Radiation: Black–Gray bodies, Radiation Shape Factor (RSF)

LIST OF EXPERIMENTS: Total hours: 30

Thermodynamics (Any 5 must be performed)

1. Grease penetration Test
2. Viscosity measurement using Redwood viscometer and Saybolt Viscometer
3. Aniline point measurement
4. Carbon residue, cloud and pour point measurement
5. Flash and fire point measurement
6. Water tube and fire tube boilers demonstration
7. Boiler mountings and accessories study and demostration
8. Dryness fraction measurement of steam using steam calorimeter
9. Steam condenser efficiency measurement
10. Steam turbine blade efficiency measurement

Heat Transfer (Any 5 must be performed)

1. Overall heat transfer co-efficient measurement using Composite Slab Apparatus
2. Heat Transfer measurement through lagged pipe.
3. Heat Transfer measurement through a Concentric Sphere.
4. Thermal Conductivity of given metal rod.
5. Heat transfer through pin-fin
6. Experiment on Transient Heat Conduction.
7. Heat transfer in forced convection apparatus.
8. Heat transfer in natural convection.
9. Parallel and counter flow heat exchanger.
10. Emissivity apparatus.
11. Stefan Boltzman Apparatus.
12. Heat transfer in drop and film wise condensation.
13. Critical Heat flux apparatus.
14. Study of heat pipe and its demonstration.
15. Shell and tube heat exchanger.

TEXT BOOKS:

1. P.K.. Nag.“Engineering Thermodynamics”, Tata McGraw-Hill, 2007.
2. R.K.Rajput “Applied Thermodynamics”, Laxmi Publishing Co., 2007.
3. E. Rathakrishnan , “Fundamentals of Engineering Thermodynamics”, Prentice-Hall, 2005.
4. Sukhatme “The Fundamentals of Heat Transfer”, 4th edition, 2014.

REFERENCE BOOKS:

1. J.P. Holman., “Thermodynamics”, 3rd edition. McGraw-Hill, 2007.
2. A. Yunus Cengel, “Heat Transfer A Practical Approach” Tata McGraw Hill, 2004
3. C.P. Arora , “Thermodynamics”, Tata McGraw Hill, 2003.

WEB LINKS:

1. ocw.mit.edu
2. www.nptel.iitm.ac.in