ENGINEERING THERMODYNAMICS II

ENME 203

Lecture : 3 **Year : II**
Tutorial : 1 **Part : I**
Practical : 1.5

Course Objectives:
The objective of this course is to comprehend the various applications of thermodynamics across different fields, apply its laws, and analyze the functioning of various mechanical system components using thermodynamic principles.

1 Boilers (8 hours)

- 1.1 Classification and applications of boilers
- 1.2 Comparison of fire tube and water tube boiler
- 1.3 Requirements of an ideal boiler
- 1.4 Boiler mountings and accessories: Water level indicator, feed check valve, blow-off cock, steam separator, safety valves, feed pump, air preheater, super heater and economizer
- 1.5 Water conditioning
  - 1.5.1 Water problems and benefits of water conditioning
  - 1.5.2 Types and causes of scale and deposits
  - 1.5.3 Scale deposit prevention methods

2 Air Compressor (4 hours)

- 2.1 Classification and applications
- 2.2 Reciprocating air compressors: Types, construction, working principle and performance
- 2.3 Centrifugal air compressors: Types, construction, working principle and performance
- 2.4 Construction and working of rotary, vane and roots compressors
- 2.5 Multi stage compression and its advantages, inter-cooling, work done of multi-stage compression

3 Condensers (3 hours)

- 3.1 Classification of condenser, elements of a condensing plant
- 3.2 Condenser performance parameters
- 3.3 Comparison of jet and surface condenser
- 3.4 Condenser vacuum and its efficiencies

4 Refrigeration Systems (8 hours)

4.1 Definition and applications of refrigeration
4.2 Simple and modified vapor compression refrigeration cycles
  4.2.1 Ideal and actual vapor compression refrigeration cycles
  4.2.2 Representation of corresponding processes on Pressure-enthalpy (P-h) and Temperature-entropy (T-s) diagram
  4.2.3 Work done and coefficient of performance
  4.2.4 Vapor absorption refrigeration system
  4.2.5 Basic vapor absorption refrigeration system, practical vapor absorption refrigeration system, Electrolux vapor absorption refrigeration system and air refrigeration system
4.3 Refrigerants
  4.3.1 Introduction
  4.3.2 Classifications of refrigerants
  4.3.3 Desirable properties of an ideal refrigerant
  4.3.4 Properties and uses of commonly used refrigerants
  4.3.5 Ozone depletion potential and global warming potential of common refrigerants

5 Air-Conditioning (9 hours)

5.1 Definition and scope of air-conditioning
5.2 Psychometrics and properties of air
5.3 Psychometric chart: Various processes on psychometric chart and their analysis: sensible heating, sensible cooling, cooling with dehumidification, cooling with humidification, heating with dehumidification, heating with humidification, adiabatic mixing of two streams of moist air
5.4 Types of air-conditioning systems: Direct expansion system, split type, central A/C, variable air flow and variable refrigerant volume system, all air system, all water system, air-water system, merits and demerits of each system
5.5 Components of air-conditioning systems: Ducts, fans, grills, registers, diffusers, balancing dampers, air filters, air handling units, fan coil units, humidifiers and dehumidifiers
5.6 Heating and cooling load calculation

6 Vapour Power Cycles (5 hours)

6.1 Rankine cycle: Ideal and real cycle, components, working mechanism, efficiency calculation, operational parameters affecting its efficiency, reheat cycle and regenerative cycle
6.2 Combined Rankine cycles: Working mechanism and component diagram

6.3 Co-generation cycle: Types, working mechanism and component diagram
6.4 Working mechanism and classification of steam engines
6.5 Essential components of steam power plant
6.6 Layout of steam power plant

7 Other Power Cycles (8 hours)

7.1 Air standard cycles
7.2 Brayton cycle: Working principle, component diagram and efficiency
  7.2.1 Analysis of closed and open cycles
  7.2.2 Cycle with intercooling, reheating, and regeneration
  7.2.3 Gas turbine power plant layout and components
7.3 Otto cycle: Working principle, component diagram and efficiency
7.4 Diesel cycle: Working principle, component diagram and efficiency
  7.4.1 Essential components of diesel power plant
  7.4.2 Plant layout of diesel power plant
7.5 Dual cycle

Tutorial (15 hours)

1. Energy balancing of boiler and efficiency calculations through direct and indirect methods
2. Performance evaluation of air-compressor
3. Calculation of condenser's efficiency
4. Power consumption and efficiency calculation of refrigeration system while using Pressure-enthalpy (P-h) diagram
5. Numerical on various psychrometric processes and use of psychrometric chart
6. Efficiency calculation of ideal and real Rankine cycle and use of steam table
7. Variation in operating pressure and temperature of boiler and condenser, and their effect on Rankine cycle's efficiency
8. Problems on Brayton, Otto and Diesel cycle

Practical (22.5 hours)

1. Study on performance of boiler and its mountings and accessories, energy and mass balancing
2. Performance analysis of air-compressor
3. Performance of vapor compression refrigeration system and Electrolux type refrigerator
4. Air-conditioning processes: Cooling with dehumidification and cooling with humidification; heating with dehumidification and heating with humidification
5. Air-conditioning process: Mixing of two streams of moist air
6. Performance of cooling tower
7. Study of components of central air-conditioning systems

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	8	10
2 and 3	7	9
4	8	11
5	9	12
6	5	8
7	8	10
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Wood, B. D. (1982). *Applications of thermodynamics* (2nd edition, illustrated). United States: Addison-Wesley Publishing Company.
2. Handbook of Air Conditioning System Design. (1965). United Kingdom: McGraw-Hill.
3. ASHRAE Terminology of Heating, Ventilation, Air Conditioning & Refrigeration. (1991). Russia: American Society of Heating, Refrigerating, and Air-Conditioning Engineers.
4. Arora, S. C., & Domkundwar, S. (1989). *A course in refrigeration and air-conditioning* (5th edition). India: Dhanpat Rai and Sons.
5. Rajput, R. K. (2010). *Thermal Engineering* (Reprint ed.). India: Laxmi Publications.
6. Rajput, R. K. (2009). Refrigeration and Air-Conditioning. India: S. K. Kataria & Sons.