FIRST SEMESTER 2018 – 2019

Date : 2nd August 2018

Course Handout (Part II)

In addition to Part-I (general handout for all courses in the time-table), this handout provides specific details regarding the course.

Course No.:	ME F214 / MF F214
Course Title:	Applied Thermodynamics
Instructor-in-charge:	Dr. Manoj Soni
Instructors:	Vivek Tiwari, Santosh Saraswat, Chetan Jalendra

Scope: The subject matter in this course covers the applications of thermodynamics. This course is designed to acquaint the students with the thermodynamics of power generating and power absorbing machines. The course discusses gas and vapour power cycles, boilers, combined cycle power generation, vapour compression and absorption refrigeration cycles, gas mixtures, psychrometry, and air-conditioning, building cooling/heating load estimation.

Text Books:

1. **Çengel Y.A. and Boles M.A.,** *Thermodynamics*; 8th Ed., 2015; Mcgraw-Hill Education.
2. **NPTEL Notes:** *Refrigeration and Air Conditioning*,

   http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Ref%20and%20Air%20Cond/New_index1.html

Reference Books:

1. **Nag P.K.,** *Basic and Applied Thermodynamics*, McGraw-Hill Education, 2nd Ed., 2009
2. **Nag P.K.,** *Power Plant Engineering*, McGraw-Hill Education, 4th ed., 2014.
3. **Rayner Joel**, *Basic Engineering Thermodynamics*, Person Education.
4. **Arora RC,** *Refrigeration & Air conditioning*, 1st Ed., Prentice Hall India, 2010.
5. **Arora CP**, *Refrigeration and Air Conditioning*; 3rd Ed. 2009; McGraw-Hill Education.

Course Objectives:

- To determine the power output and evaluate the performance of simple thermodynamic cycles for power generation technologies in terms of thermal efficiency.
- To analyze and evaluate the performance of coal based or gas based power generations technologies.
- To analyze and evaluate the performance of vapor compression and vapor absorption refrigeration cycle.
- To analyze and evaluate gas turbine cycle with multistage compression with intercooling, multistage expansion with reheat and regeneration terms of its efficiency.
- To estimate air conditioning requirements of a space using various air-conditioning processes.

Course Plan

Module 1: Vapor Power Cycles

Learning Objectives

- To analyze ideal Rankine cycle for a vapor power plant using T-s plot and evaluate thermal efficiency by applying first law and second law of thermodynamics.
- To evaluate performance of Rankine cycle considering isentropic efficiencies of turbine and pump.
- To represent the Rankine cycle processes on the Mollier diagram (enthalpy-entropy chart).
- To analyze reheat Rankine cycle for a vapor power plant using T-s plot and evaluate its performance by applying first law of thermodynamics.
- To evaluate performance of regenerative Rankine cycle using feed water heaters.
- To study boilers their mountings and accessories.

Learning Strategy:

Lect. No	Topics	Text book Chap/Sec
1	Simple steam power plant, Internal Combustion Engines, Gas turbine plants, Refrigeration cycle, First and second Law efficiency, COP.	1, TB2
2-10	Carnot cycle deficiencies, Simple vapor power cycle, Ranking Cycle, Actual vapor power cycle, Mean temperature of heat addition. Techniques for efficiency improvement, Reheat and Regenerative cycles with open & closed feed water heaters. Combined cycle power plant and its thermodynamics. Combined Heat and Power.	10, TB2
11-12	Introduction, types of boilers, requirements of a good boiler, High pressure boilers, Fluidized bed Boiler, Boiler mountings and accessories.	Class Notes & RB2

Module 2: Gas Power Cycles

Learning Objectives

- To analyze Gas power cycles for a perfect gas using P-v and T-s plot and evaluate its performance using first law of thermodynamics.
- To evaluate and compare the thermal efficiency of regenerative Stirling/Ericsson cycle with that of Carnot cycle.
- To evaluate effects of multistage compression with intercooling, multistage expansion with reheat and regeneration on performance on a simple gas turbine cycle in terms of its efficiency.
- To analyze combined cycle and binary cycle power plants using first and second law of thermodynamics and evaluate their thermal efficiency.

Learning Strategy:

Lect. No	Topics	Text book Chap/Sec
13-19	Carnot Cycle, Stirling cycle, Ericsson Cycle, Air Standard Cycles, Otto Cycle, Diesel Cycle, Dual Cycle. Brayton cycle: intercooling, reheating and regeneration. Jet propulsion and Gas Turbine power plants.	9, TB1

Module 3: Refrigeration Cycles

Learning Objectives

- To study simple refrigerators and heat pumps systems and the evaluate of their performance.
- Analyze the ideal and actual vapor compression refrigeration cycle.
- Evaluate the second law efficiency of vapor compression refrigeration cycle.
- Introduce the concepts of vapor absorption-refrigeration systems.
- To determine maximum COP of an ideal absorption refrigeration system.

Learning Strategy:

Lect. No	Topics	Text book Chap/Sec
20-23	Vapor Compression Refrigeration Cycle, Actual Vapor Compression Cycle, Heat Pump, Second Law Efficiency of Vapor Compression Cycle.	11, TB1
24-26	Basic principle of a Simple Vapour–Absorption System, Comparison of vapour compression refrigeration systems with continuous vapour absorption refrigeration systems, maximum COP of an ideal absorption refrigeration system, properties of ideal and real refrigerant-absorbent mixtures, single stage vapour absorption refrigeration system with solution heat exchanger.	15, TB2; RB3 & RB4

Module 4: Air and Gas Compressors

Learning Objectives

- To classify compressors
- To study reciprocating compressors and the evaluate of their performance.
- To study the effect of clearance volume on performance of reciprocating compressors.
- Analyze multistage reciprocating compressor with intercooling and determine condition of minimum work required.

Learning Strategy:

Lect. No	Topics	Text book Chap/Sec
27-29	General Introduction, The reciprocating air compressor, Effect of clearance volume, Multistage Reciprocating Compressor	14, RB2

Module 5: Properties of moist air and Psychrometry of air-conditioning systems

Learning Objectives

- Differentiate between dry air and atmospheric air.
- To define and calculate the specific and relative humidity of atmospheric air.
- To Calculate the dew-point temperature of atmospheric air and to relate the adiabatic saturation temperature and wet-bulb temperatures of atmospheric air.
- To determine the properties of atmospheric air using psychrometric chart.
- To apply the principles of the conservation of mass and energy to various air-conditioning processes.
- To estimate heating and cooling loads of a space to be air conditioned.

Learning Strategy:

Lect. No	Topics	Text book Chap/Sec
30-32	Psychometric Properties, Psychrometric Chart, Mixing of moist air, Psychrometry of air conditioning processes.	13 & 14, TB1; TB2, RB3 & RB4
33-36	Inside and Outside Design Conditions, Simple Summer Air Conditioning System, Supply Air condition and flow rate, Apparatus Dew Point, Winter Air Conditioning. Building Cooling Load and Heating Load Estimate.	13 & 14, TB1; 30, TB2 RB3 & RB4

Module 6: Compressible fluid flow

Learning Objectives

- To develop the general relations for compressible flows encountered when gases flow at high speeds.
- To derive the relationships between the static and stagnation fluid properties as functions of specific-heat ratios and Mach number.
- Derive the effects of area changes for one-dimensional isentropic subsonic and supersonic flows.
- Solve problems of isentropic flow through converging and converging–diverging nozzles.

Learning Strategy:

Lect. No	Topics	Text book Chap/Sec
37-38	Stagnation properties, Flow through Nozzle, Chocking, Normal shocks, Adiabatic and diabatic flow	17, TB1

Evaluation Scheme:

Components	Duration	Weight age (%)	Maximum Marks [200]	Date & Time	Remarks
Tutorial Tests	15 min.	20	40	Surprise	Closed book
Lecture Test	10 min.	10	20	Surprise	Closed book
Mid Semester Test	90 min.	25	50	13/10 2:00 - 3:30 PM	Open book
Team based/Game based learning	30 min	10	20	Will be announced	Open book and discussion
Comprehensive Test	180 min	35	70	12/12 FN	Closed Book

Mid-semester grading: It will be announced normally in the month of October. It is done in the same manner as that of the final grading.

Tutorials Tests: Best two will be taken out of three. Two before mid semester test and two will be after mid semester tests.

Lecture Tests: Best two will be taken out of four. Two before mid semester and two after mid semester.

Chamber Consultation Hours (Instructor Incharge): Room No.: First floor WILP. Time: 4.00-5.00 PM Wednesday

Notices: All notices related to this course will be put on the Nalanda.

Make-up Policy: Make-up will be granted for genuine cases only. Certificate from authenticated doctor from the Medical Center must accompany make-up application (*only prescription or vouchers for medicines will not be sufficient*). The make-up application must reach the I/c before commencement of the scheduled exam (mid sem/compre). **No make-up will be allowed for the tutorial tests and lecture class tests.**

Instructor-in-charge
Dr. Manoj Soni
MEF214/MFF214