

## TEMPLATE FOR COURSE SPECIFICATION(Thermodynamics)

### HIGHER EDUCATION PERFORMANCE REVIEW: PROGRAMME REVIEW

#### COURSE SPECIFICATION

This Course Specification provides a concise summary of the main features of the course and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if he/she takes full advantage of the learning opportunities that are provided. It should be cross-referenced with the programme specification.

1. Teaching Institution	University of Technology
2. University Department/Centre	Chemical Engineering Department
3. Course title/code	Thermodynamic /341
4. Programme(s) to which it contributes	CE.341
5. Modes of Attendance offered	Fall
6. Semester/Year	2 semester/year
7. Number of hours tuition (total)	1 <sup>st</sup> semester: Theory (3Hr/week). 2 <sup>nd</sup> semester: Theory (3Hr/week) & Practical (2 Hr /week)
8. Date of production/revision of this Specification	5-6-2016
9. Aims of the Course	
1.To familiarize the students with basic concepts of the first and second lawsof thermodynamics and their applications in engineering proplems.	
2.Develop a practical ability to solve energy balance proplems , minimum work.	
3.To prepare the student to effectively analysis the basic thermodynamic power and refrigeration cycles.	
4.Develop practically ability in calculation of phase and reaction equilibria and an	

understanding of calculation methods.

5.Share ideas and work in a team in an efficient and effective manner under controlled supervision or independently.

6.Predict necessary thermodynamics analysis of full scale projects by performing simple model experiments.

## **10• Learning Outcomes, Teaching ,Learning and Assessment Method**

### **A- Knowledge and Understanding**

A1.Students will demonstrate basic understanding of basics and definitions of thermodynamics and properties of pure substances.

A2.Understanding first and second laws of thermodynamics and thermodynamic cycles.

A3.Describe the reversible and irreversible processes (macroscopic description of an ideal and real processes).

A4.Recognize the theoretical principles of the second law of thermodynamics and heat engines, entropy.

A5.An ability to apply knowledge of calculations using the energy balance, entropy balance, phase equilibria or reaction equilibria constraints.

### **B. Subject-specific skills**

B1. Planning heat and work diagrams for use in solving simple problems in the first law of thermodynamics,thermodynamic processes, the second law of thermodynamics and heat engines.

B2. Planning and installing of the refrigeration and liquefaction processes.

B3.An ability to use the techniques, skills and modern engineering tools necessary for chemical engineering practice such as use of Excel / Matlab in the flash calculations.

B4.Designed to introduce the student to the application of cognitive skills utilizing thermodynamics knowledge in the laboratory,generate and analyse experimental data.

B5.Students will gain the ability to write laboratory reports.

### **Teaching and Learning Methods**

- Lectures, Tutorials , Example Classes.
- Discussions in the class.
- Informal and formal teamwork.
- Weekly homework problems and assignments at home.
- Case study report (Internet search ).

### **Assessment methods**

Midterm exams , Final exam , Quizzes, Weekly homework, Team and homework problems , Open questions that have a definite answer , or do not have a definite answer

### C. Thinking Skills

- C1. An ability to apply effective, creative and innovative solutions, both independently and cooperatively, to current and future problems.
- C2. Communicate effectively and logically, both orally and in writing.
- C3. An ability of scientific analysis for thermodynamics problems and evaluate their solutions.
- C4. Work in teams with the ability to use modern sources (Internet, PC, references).
- C5. An ability to understanding the work and heat, the first law of thermodynamics for control mass, a basic knowledge of the second law, the basic of gas and vapor power and refrigeration cycles.

### Teaching and Learning Methods

Lectures, Tutorials, Example Classes, Informal and formal teamwork, Weekly homework problems, Analysis of cases linked to the work environment, Practical Applications.

### Assessment methods

- Oral examination with written preparation: a number of open questions evaluate the student's understanding of the knowledge obtained in the hearing classes.
- Written open book examination: a number of new, complex problems require calculation by the student.
- Mid-term exams, Final-term exam.
- Quizzes, Weekly homework, Team and homework problems.
- Open questions that have a definite answer, or do not have a definite answer.

### D. General and Transferable Skills (other skills relevant to employability and personal development).

- D1. Work together in same-discipline teams to solve engineering problems.
- D2. Use the technology tools like internet to obtain subject specific information.
- D3. Speed intuitive, predictability and evaluate information and ideas in the handling of thermodynamics fundamentals.
- D4. The ability to work in groups: work with other as a part of a team to solve the problem exercises that give students the chance to develop their theoretical understanding and problem.

## 11. Course Structure

Week	Hours	ILOs	Unit/Module or Topic Title	Teaching Method	Assessment Method
1 <sup>st</sup> semester					

1	3	Ability to characterization and specify of thermodynamic concepts related to the steady-state flow process.	Review on 1 <sup>st</sup> law and applications. First law and other concepts: steady-state flow process, the heat capacity and Joules experiments.	Lectures, Tutorials, Example Classes, Practical Applications	partial test (Oral questions :- alternative response), Open questions that have a definite answer, or do not have a definite answer.
2	3	Ability to characterization and specify of a special kind of nonflow process characterized as reversible.	formulation of the first law, thermodynamics state and state functions, the reversible processes and phase rule.	Lectures, Tutorials, Example Classes, Practical Applications	partial test (Oral questions :- alternative response), Open questions that have a definite answer, or do not have a definite answer.
3	3	Ability to characterization and specify of the pressure-volume-temperature behavior of pure fluids.	Volumetric properties of pure fluids: Review on virial equation of state.	Lectures, Tutorials, Example Classes, Practical Applications	partial test (Oral questions :- alternative response), Open questions that have a definite answer, or do not have a definite answer.
4	3	Ability to characterization equations that are a simplest capable of representing both liquid and vapor behavior.	Review on cubic equations of state: Redlich – Kwong equations to calculate (vapor – volumes and liquid volumes).	Lectures, Tutorials, Example Classes, Practical Applications	partial test (Oral questions :- alternative response), Open questions that have a definite answer, or do not have a definite answer.
5	3	Ability to characterization and specify of equations convenient iterative solution for the compressibility factor Z at any conditions $T_r$ and $P_r$ .	Generalized correlations for gases and for liquids.	Lectures, Tutorials, Example Classes, Practical Applications	partial test (Oral questions :- alternative response), Open questions that have a definite answer, or do not have a definite answer.
6	3	Ability to estimate the thermodynamics and its concise statement constitutes the	Review on The second law of thermodynamics and Carnot heat engine.	Lectures, Tutorials, Example Classes, Practical Applications	partial test (Oral questions :- alternative response), Open questions that have a definite answer, or do not have a definite answer.

		second law and heat engine.			
7	3	Ability to specify of four reversible steps on PV diagram of Carnot cycle for ideal gas.	Review on the Carnot cycle for ideal gas.	Lectures, Tutorials , Example Classes , Practical Applications	partial test (Oral questions :- alternative response ), Open questions that have a definite answer , or do not have a definite answer.
8	3	Ability to specify of the principal characteristic of a property is that the sum of its change is zero for any complete cycle.	Review on the entropy balance for open system, calculation of ideal work and lost work.	Lectures, Tutorials , Example Classes , Practical Applications	partial test (Oral questions :- alternative response ), Open questions that have a definite answer , or do not have a definite answer.
9	3	Ability to availability of numerical values for the thermodynamic properties that is essential to the calculation of heat and work for industrial processes.	Thermodynamic properties of fluids: Review on the property relations ( $\Delta H$ , $\Delta S$ , $\Delta U$ and $\Delta G$ ) residual properties.	Lectures, Tutorials , Example Classes , Practical Applications	partial test (Oral questions :- alternative response ), Open questions that have a definite answer , or do not have a definite answer.
10	3	Ability to characterization and specify of an exact thermodynamic relations, providing a vital connection between the properties of different phases.	Two phase systems : Clapeyron equation, Antoine equation and Riedel equation.	Lectures, Tutorials , Example Classes , Practical Applications	partial test (Oral questions :- alternative response ), Open questions that have a definite answer , or do not have a definite answer.
11	3	Ability to represent the temperature, pressure, volume , enthalpy and entropy of substance on a single plot.	Review on important terms relating steam formation , thermodynamic diagrams and tables.	Lectures, Tutorials , Example Classes , Practical Applications	partial test (Oral questions :- alternative response ), Open questions that have a definite answer , or do not have a definite answer.
12	3	Ability to application of	Applications of thermodynamics to flow	Lectures, Tutorials ,	partial test (Oral questions :- alternative

		thermodynamics to flow processes that is based on conservation of mass and on the first and second laws.	process: Duct flow of compressible fluids, conservation of mass and energy.	Example Classes , Practical Applications	response ), Open questions that have a definite answer , or do not have a definite answer.
13	3	Ability to estimate the equation derived in physics for the speed of sound in the fluid.	Mechanical energy balance "Bernoulli equation", flow in pipes (sub sonic, sonic ,supersonic) velocity.	Lectures, Tutorials , Example Classes , Practical Applications	partial test (Oral questions :- alternative response ), Open questions that have a definite answer , or do not have a definite answer.
14	3	Ability to characterization and specify of flow processes accompanied by sharp reductions in pressure i.e (expansion processes).	Review on nozzles , throttling process and turbines or expanders,.	Lectures, Tutorials , Example Classes , Practical Applications	partial test (Oral questions :- alternative response ), Open questions that have a definite answer , or do not have a definite answer.
15	3	A bility to specification of energy requirements for the steady-state compression of fluids from one pressure to a higher one and other devices designed for this purpose.	Review on compression processes and pumps	Lectures, Tutorials , Example Classes , Practical Applications	partial test (Oral questions :- alternative response ), Open questions that have a definite answer , or do not have a definite answer.
<b>2<sup>nd</sup> semester</b>					
16	5	Ability to illustrate the calculation of thermal efficiencies and analyze several common heat – engine cycles.	Production of power from heat:the steam power plant, Rankin cycle.	Lectures, Tutorials , Example Classes , Practical Applications <b>laboratory</b>	partial test (Oral questions :- alternative response ), Open questions that have a definite answer , or do not have a definite answer.
17	5	Ability to characterization and specify of the power cycles in which up to the high temperature, high pressure	Internal combustion engine: Otto engine, diesel engine and gas turbine engine.	Lectures, Tutorials , Example Classes , Practical Applications <b>laboratory</b>	partial test (Oral questions :- alternative response ), Open questions that have a definite answer , or do not have a definite answer.

		gas, the compression and expansion steps are carried out in devices of different types.			
18	5	Ability to present a thermodynamic analysis of refrigeration processes and known its use in the air conditioning of buildings, in the treatment, preservation of foods and transportation.	Refrigeration : the Carnot refrigerator, the vapor compression cycle.	Lectures, Tutorials , Example Classes , Practical Applications <b>laboratory</b>	partial test (Oral questions :- alternative response ), Open questions that have a definite answer , or do not have a definite answer.
19	5	Ability to indication of the magnitudes of coefficients of performance for refrigeration cycles and comparison between its.	Comparison of refrigeration cycle, the choice of refrigerant, two-stage cascade refrigeration system.	Lectures, Tutorials , Example Classes , Practical Applications <b>laboratory</b>	partial test (Oral questions :- alternative response ), Open questions that have a definite answer , or do not have a definite answer.
20	5	Ability to characterization and specify of the direct use of heat as the energy source for refrigeration in addition, liquefaction of gas mixtures for separation purpose.	Absorption- refrigeration, the heat pump, liquefaction processes.	Lectures, Tutorials , Example Classes , Practical Applications <b>laboratory</b>	partial test (Oral questions :- alternative response ), Open questions that have a definite answer , or do not have a definite answer.
21	5	Ability to characterization and specify of (VLE) for the vaporization of a mixture or pure species at constant pressure or at constant temperature.	Phase equilibrium (VLE): the nature of equilibrium, the phase rule, diagrams for vapor-liquid equilibrium.	Lectures, Tutorials , Example Classes , Practical Applications <b>laboratory</b>	partial test (Oral questions :- alternative response ), Open questions that have a definite answer , or do not have a definite answer.



22	5	Ability to treat in detail a particularly simple description of multicomponent vapor/liquid equilibrium as Raoult's law and know the determine of the dew point and bubble point calculation.	Simple models for (V-L) equilibrium: Raoult's law, dew point and bubble point calculation.	Lectures, Tutorials, Example Classes, Practical Applications <b>laboratory</b>	partial test (Oral questions :- alternative response), Open questions that have a definite answer, or do not have a definite answer.
23	5	Ability to characterization and specify of a partial definition of (f) and the dimensionless ratio for a mixture property ( $\phi$ ).	Partial properties, fugacity and fugacity coefficient.	Lectures, Tutorials, Example Classes, Practical Applications <b>laboratory</b>	partial test (Oral questions :- alternative response), Open questions that have a definite answer, or do not have a definite answer.
24	5	Ability to specify of the change occurs when a liquid under pressure passes through a valve to a pressure low of the fluid flashes.	K-value correlations, flash calculation.	Lectures, Tutorials, Example Classes, Practical Applications <b>laboratory</b>	partial test (Oral questions :- alternative response), Open questions that have a definite answer, or do not have a definite answer.
25	5	Ability to determine the effect of temperature, pressure and ratio of reactants on the equilibrium conversions of chemical reactions.	Chemical reaction equilibrium: the reaction coordinates, more independent reaction.	Lectures, Tutorials, Example Classes, Practical Applications <b>laboratory</b>	partial test (Oral questions :- alternative response), Open questions that have a definite answer, or do not have a definite answer.
26	5	Ability to specify the fundamental property relation for single phase system ( $\Delta G^\circ$ ) and the equilibrium constant for the reaction (K).	The standard Gibbs energy change and the equilibrium constant.	Lectures, Tutorials, Example Classes, Practical Applications <b>laboratory</b>	partial test (Oral questions :- alternative response), Open questions that have a definite answer, or do not have a definite answer.



27	5	Ability to specify the vary of the standared properties of the reaction with equilibrium temperature.	Effect of temperature on equilibrium constant, evaluation of equilibrium constan.	Lectures, Tutorials , Example Classes , Practical Applications <b>laboratory</b>	partial test (Oral questions :- alternative response ), Open questions that have a definite answer , or do not have a definite answer.
28	5	Ability to characterization of the real processes from the thermodynamic point of view based on a combination of the first and second laws.	Thermodynamic analysis of processes: second-law relation for steady state flow processes.	Lectures, Tutorials , Example Classes , Practical Applications <b>laboratory</b>	partial test (Oral questions :- alternative response ), Open questions that have a definite answer , or do not have a definite answer.
29	5	Ability to characterization the work resulting from the reversible change of state of the fluid( ideal work )and from irreversibilities in a process( lost work).	Calculation of ideal work and lost work.	Lectures, Tutorials , Example Classes , Practical Applications <b>laboratory</b>	partial test (Oral questions :- alternative response ), Open questions that have a definite answer , or do not have a definite answer.
30	5	Ability to characterization the properties at various key points of the process and the lost work calculations for many processes consist of a number of steps.	Thermodynamic analysis of steady state processes.	Lectures, Tutorials , Example Classes , Practical Applications <b>laboratory</b>	partial test (Oral questions :- alternative response ), Open questions that have a definite answer , or do not have a definite answer.

12. Infrastructure	
Required reading: · CORE TEXTS · COURSE MATERIALS · OTHER	<ul style="list-style-type: none"> <li>○ Lecturers</li> <li>○ Book “J. M. Smith, H.C. Van Ness, Introduction to chemical engineering thermodynamics, 6th edition (International Edition), Mc-Graw Hall, 2008.”</li> <li>○ Other support books :-              K.V.Narayanan, A text book of chemical engineering thermodynamics, prentice Hall of India, New Delhi, 2011.              B.G.Kyle, Chemical and process thermodynamics, (3rd Edition), prentice Hall Inc. New Jersey, 1984.              J. Rayner, Basic engineering thermodynamics in SI units, printed in great Britain, 1971.</li> </ul>
Special requirements (include for example workshops, periodicals, IT software, websites)	Websites
Community-based facilities (include for example, guest Lectures, internship, field studies)	field trips

13. Admissions	
Pre-requisites	Before undertaking this thermodynamics concepts the student should have undertaken the following: Basic Principles of chemical engineering I and II, mathematics I and II, Physical chemistry, computer programming II, fluid flow as well simultaneous courses:- Mass transfer, reactor design, and equipment design.
Minimum number of students	Central Admission
Maximum number of students	Central Admission