GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM

COURSE TITLE: CHEMICAL ENGINEERING THERMODYNAMICS (COURSE CODE: 3350505)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	5th Semester

1. RATIONALE

Diploma Chemical engineer has to deal with the laws of thermodynamics which are applied to flow and non-flow processes in the plant to evaluate heat effects and energy transformation calculation accompanying physical and chemical changes, for calculating temperature change and to determine power generation efficiencies of engines and power plants. Understanding of basic concepts and application of thermodynamics are therefore necessary for chemical engineers. Hence the course has been design to develop these competencies and its associated cognitive, practical and effective domain learning out comes.

2. LIST OF COMPETENCY

The course should be taught and implemented with the aim to develop required skills in students so that they are able to acquire following competency:

- **Solve the problems related to heat and work requirements for physical and chemical changes.**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Distinguish systems, functions, properties and processes
ii. Explain various laws of Thermodynamics
iii. Implement the first law of thermodynamics for non-flow & flow process.
iv. Access the PVT behaviour of the fluids.
v. Calculate the effects of heat changes during chemical reaction.
vi. Apply the concepts of second law of thermodynamics.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	100
3	2	0	5	70	30	00	00	

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** - Practical; **C** - Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Introduction and Basic Concept	1a. Describe scope of thermodynamics 1.1 Define System, functions, properties Process and surrounding 1b. Explain the System, functions, properties , Process and surrounding with examples of chemical engineering field 1c. Differentiate systems, functions, properties and processes 1d. Describe Extensive and intensive properties 1e. Explain importance of Force, Pressure, Work and Energy physical quantities, phase rule and zeroth law of thermodynamics 1f. Solve simple problems on -Force, Pressure, Work and Energy physical quantities, phase rule and laws of thermodynamics	1.1 Scope and limitations of thermodynamics 1.2 System, functions, properties Process and surrounding 1.2.1 System-Homogeneous and heterogeneous, Closed and open, State of System 1.2.2 Properties -Extensive and intensive 1.2.3 Function -State and Path function 1.2.4 Process -Reversible and irreversible process 1.3 Force, Pressure, Work and Energy 1.4 Steady state, Equilibrium state and Phase rule 1.5 Temperature and zeroth law of thermodynamics 1.6 Ideal gas temperature scale 1.7 Simple examples (numerical)on Force, Pressure, Work and Energy physical quantities, phase rule and laws of thermodynamics
Unit – II First Law of Thermodynamics	2a. Explain first law and energy - Internal Energy, Enthalpy and Heat capacity concepts with examples of chemical engineering 2b. Apply first law for non-flow & flow process of chemical engineering 2c. Solve simple problems on first law and energy - Internal Energy, Enthalpy and Heat capacity	2.1 First law of thermodynamics 2.2 Internal Energy, Enthalpy and Heat capacity 2.3 First law for non-flow processes and flow processes of chemical engineering 2.4 Simple numerical on first law and energy - Internal Energy, Enthalpy and Heat capacity
Unit – III PVT Behavior	3a. Explain PVT behaviour of pure fluids 3b. Distinguish Ideal gas Processes 3c. Compare equations of state for real gases 3d. Solve simple problems on Ideal gas Processes, Equation of state for real gases,	3.1 PVT behavior of pure fluids 3.2 Ideal gas and equation of state 3.3 Ideal gas Process : 3.3.1 Constant Volume process 3.3.2 Constant Pressure process 3.3.3 Constant Temperature process 3.3.4 Adiabatic Process 3.3.5 Polytropic Process 3.4 Equation of state for real gases 3.4.1 Vander Waals Equation 3.4.2 Virial Equation 3.4.3 Compressibility charts 3.5 Simple examples(numerical)

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – IV Heat Effects	4a. Explain the heat effects of chemical reactions 4b. Apply Hess's law of constant heat summation 4c. Calculate heat of reaction and temperature of reaction 4d. Solve simple problems on heat Effects in chemical reactions	4.1 Heat effects accompanying chemical reactions: 4.1.1 The standard heat of reaction 4.1.2 The standard heat of combustion 4.1.3 The standard heat of formation 4.2 Hess's Law of constant heat summation 4.3 Effects of temperature on heat of reaction 4.4 Temperature of reaction 4.5 Simple numerical
Unit – V Second Law of Thermodynamics	5a. Discuss limitation of first law 5b. Compare different statements of Second law 5c. Describe the concepts of Heat reservoir, Heat engine and Heat pump 5d. Explain entropy 5e.Explain carnot cycle and thermodynamic temperature scale 5f. Calculate entropy changes 5g. Explain the concept of entropy and irreversibility 5h. Solve simple problems on Second law	5.1 Limitations of first law 5.2 Statements of Second law 5.3 Heat reservoir, Heat engine and Heat pump 5.4 Concept of Entropy 5.5 Carnot cycle and thermodynamic temperature scale 5.6 Calculation of Entropy change during 5.6.1 Phase change 5.6.2 Ideal gas processes 5.6.3 Adiabatic mixing 5.6.4 Isothermal mixing 5.6.5 Chemical reaction 5.7 Clausius Inequality 5.8 Mathematical statement of Second law 5.9 Entropy and Irreversibility 5.10 Simple numerical

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (Theory)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Mark
I	Introduction and Basic Concept	07	3	4	5	12
II	First Law of Thermodynamics	06	3	3	4	10
III	PVT behavior	09	5	5	5	15
IV	Heat Effects	07	4	4	4	12
V	Second Law of Thermodynamics	13	7	7	7	21
Total		**42**	**22**	**23**	**25**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills ***(outcomes in psychomotor and affective domain)*** so that students are able to acquire the competencies/course outcomes. Following is the list of practical exercises for guidance.

Note*: outcomes in psychomotor domain are listed here as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes (****as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

----------NIL----------

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities. These could be individual and group based.

i. Course/topic based presentation
ii. MCQ/Quiz

9. SPECIAL INSTRCTIONAL STRATEGY (IF ANY)

Give as many simple numerical problems to students as possible in class itself and help them to solve if they get stuck.

10. SUGGESTED LEARNING RESOURCES

A. List of Books:

Sr. No.	Title of Books	Author	Publication
1	Chemical Engineering Thermodynamics	K. V. Narayanan	PHI publishers
2	Introduction to Chemical Engineering Thermodynamics	J. M. Smith H.C. Vanness M. M. Abott	Tata McGraw Hill
3	Thermodynamics	C.P.Arora	Tata McGraw Hill
4	Chemical Engineering Thermodynamics	Y. V. C. Rao	Universities Press
5	Chemical Process Principles Vol.2	A.Hougen K.M.Watson R.A.Ragatz	Asia Publications
6	Textbook of Engineering Thermodynamics	R. K. Rajput	Laxmi Publication
7	Chemical Engineering Thermodynamics	R. B . Varia	Atul Prakashan
8	Applied Thermodynamics	P. B. Joshi	Nirali Prakashan

B. List of Major Equipment/Materials

----------**Nil** ----------Theoretical Approach)

C. List of Software/Learning Websites

i. www.unitoperation.com
ii. www.nptel.com

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. Manish R. Nasit,** Lecturer in Chemical Engineering, N. G. Patel Polytechnic, Isroli - Ahwa.
- **Prof. Mukesh B. Dhangar,** Lecturer in Chemical Engineering, N. G. Patel Polytechnic, Isroli-Ahwa.
- **Prof. R. P. Hadiya,** Lecturer in Chemical Engineering, Government Polytechnic, Rajkot.

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. Abhilash Thakur.** Associate Professor, Department of Applied Sciences
- **Prof. Bashirullah Shaikh,** Assistant Professor, Department of Applied Sciences