

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT
COURSE CURRICULUM
COURSE TITLE: METALLURGICAL THERMODYNAMICS AND KINETICS
(COURSE CODE: 3352104)

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

1. RATIONALE

Thermodynamics is a science of energy transfer and its effect on physical properties of Substances. This course deals with the understanding of different laws of thermodynamics and will provide understanding of the basic principles of thermodynamics which is must for understanding of any metallurgical processes involving chemical reactions and physical changes at high temperature.

2. LIST OF COMPETENCY

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

Apply concepts, and principles of thermodynamics for obtaining desired results in metallurgical processes.

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. Explain concepts and laws of thermodynamics.
- ii. Relate 1st and 2nd Law of thermodynamics.
- iii. Interpret Ellingham Diagram for oxides.
- iv. Determine order of reaction

4. TEACHING AND EXAMINATION SCHEME

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

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	1a. State Laws of thermodynamics 1b. Explain Terms related to thermodynamics 1c. Explain types of changes in system 1d. Explain concept of equilibrium	1.1 Laws of Thermodynamics. 1.2 Basic Terms used in Thermodynamics. 1.3 Properties of System. 1.4 Reversible and Irreversible changes 1.5 Equilibrium
Unit – II Energy and Laws of Thermodynamics	2a. Establish the concept of energy and first law of thermodynamics 2b. Apply first law of thermodynamics 2c. Explain concept of entropy 2d. Relate 1 st and 2 nd Law 2e. Define Free Energy 2f. Explain third law of thermodynamics 2g. Verify third law of thermodynamics.	2.1 Energy and First Law of Thermodynamics. 2.2 First law in terms of enthalpy 2.3 Entropy 2.4 Combined Expression of 1 st and 2 nd Law. 2.5 Free Energy as Criteria of Equilibrium. 2.6 Third Law of Thermodynamics. 2.7 Experimental verification of Third Law
Unit – III Free Energy – Temperature Diagram	3a. Explain importance of Ellingham diagram 3b. Interpret Ellingham Diagram for oxides.	3.1 Ellingham Diagram for oxides. 3.2 Important features of Ellingham diagram
Unit – IV Phase Rule and Reaction Kinetics	4a. Explain phase rule 4b. Explain types of reactions 4c. Explain rate of reaction and its importance 4d. Determine order of reaction	4.1 Phase rule 4.2 Types of Reaction; Homogenous and Heterogeneous 4.3 Rate of Reaction. 4.4 Order of Reaction- Zero, First and Second Order.

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

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I.	Introduction	8	6	4	2	12
II.	Energy and Laws of Thermodynamics	18	12	10	8	30
III.	Free Energy – Temperature Diagram	08	6	4	4	14

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
IV.	Phase Rule and Reaction Kinetics	08	6	4	4	14
Total		42	30	22	18	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 TUTORIAL EXERCISES

The tutorials should be properly designed and implemented with an attempt to develop different types of skills so that students are able to acquire the competency as indicated above. Following is the list of tutorial exercises for guidance.

S. No.	Unit No.	Tutorial Exercises	Approx. Hrs. Required
1	I	Define Basic terms and its importance in thermodynamics.	2
2	I	Explain Laws of thermodynamics	2
3	II	Solve given problems based on first law of thermodynamics.	4
4	III	Solve given problems based on second law of thermodynamics.	4
5	IV	Solve given problems based on third law of thermodynamics.	4
6	VI	Solve given problems based on phase rule.	4
7	VI	Draw and explain phase diagrams of a) Iron-Iron Carbide b) Copper-Nickel c) Aluminium-Magnesium	4
8	V	Explain Ellingham diagram for oxides.	4
9	VI	Solve problems based on rate of reaction and order of reaction.	4
Total			32

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Students will solve as many numerical problems as possible for them to learn the concepts in depth.

9. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)

In tutorial sessions give different problems to different group of students depending upon their ability (i.e. groups of average students, below average students, bright students). This would reduce chances of copying from each other and would provide appropriate amount of challenge to different students depending upon their abilities. This would also create interest of learning in students.

10. SUGGESTED LEARNING RESOURCES

A. List of Books:

S. No.	Title of Books	Author	Publication
1	Metallurgical Thermodynamics Kinetics and Numericals	Dr. S.K.Dutta and Prof A B Lele	S.Chand
2	Introduction to Metallurgical Thermodynamics	D.R.Gaskel	Mc-Graw Hill, NY
3	Introduction to Materials and Metallurgical Thermodynamics	A. Ghosh	PHI
4	Problems in Metallurgical Thermodynamics and Kinetics,	G. S. Upadhyaya and R. K. Dube	Pergamon Press

B. List of Software/Learning Websites

- I. <http://nptel.iitm.ac.in/>
- II. <http://ocw.mit.edu/>
- III. <http://wikipedia.com/thermodynamics>
- IV. <http://www2.estrellamountain.edu/faculty/farabee/biobk/biobookener1.html>
- V. http://chemwiki.ucdavis.edu/Physical_Chemistry/Thermodynamics
- VI. <https://www3.nd.edu/~powers/ame.20231/planckdover.pdf>

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. I. B. Dave**, HOD, Dept of Metallurgy, Dr S & S. S. Ghandhy College of Engg. & Technology
- **Prof. V. J. Rao**, Associate Professor, Dept of Metallurgical & Materials Engineering, Faculty of Technology and Engg., Kalabhavan, The M.S. University of Baroda.
- **Prof. M.S. Dani**, Assistant Professor, Metallurgy Department, Government Engineering College, Sector 28, Gandhinagar
- **Prof. H. H. Jadav**, Assistant Professor, Metallurgy Department, Government Engineering College, Sector 28, Gandhinagar

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. C.K Chugh**, Professor, Department of Mechanical Engineering
- **Prof Shashi Kant Gupta**, Professor and Coordinator for State of Gujarat.