GUJARAT TECHNOLOGICAL UNIVERSITY

SUBJECT NAME: Metallurgical Thermodynamics
SUBJECT CODE: 2132102
B.E. 3RD SEMESTER

Type of course: Engineering Science

Prerequisite: None

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.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	1	0	5	70	20	10	30	0	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Importance of thermodynamics, Definition of thermodynamic terms, Concept of system, states and equilibrium, Types of system, Extensive and intensive properties, Homogeneous and heterogeneous systems, Quasistatic process, Zeroth law of thermodynamics.	**8**	15
2	First law of thermodynamics, Internal energy, Heat capacity, Specific heat and latent heat, Enthalpy, Isothermal and adiabatic processes, State properties, Heat of reaction, Heat of formation, Standard heats, Heat of transition, Hess's law, Kirchoff's law equation.	**8**	15
3	Second law of thermodynamics, Entropy of irreversible processes, Auxiliary functions, Combined statements of 1st and 2nd laws, Maxwell's relations, Clausius-Clapeyron equation, Gibb's-Helmholtz relations.	**8**	15
4	Third law of thermodynamics, Temperature dependence of entropy, Stastical interpretation of entropy, Relation between Cp and Cv , Consequences of third law, Nernst heat theorem, Equilibrium constant, Van-Hoff equation, Concept of fugacity, activity and mole fraction.	**8**	15
5	Ellingham diagram in detail for metal oxides, Activity, Gas phase Reactions, (H2O- H2 and CO2 -CO mixtures), Reactions involving solid and gases, Activities in concentrated solution, Activity in industrial liquid metallic solution.	**8**	10
6	Thermodynamics of solutions, Gibb's-Duhem equation, Partial molar properties of mixing, Ideal solution, Raoult's law, Henry's law, Non-ideal solution, Excess functions, Concept of 1 wt% standard state and Interaction coefficient, Regular solutions, Sievert's law-residual gases in steel.	**8**	10
7	Phase relations and phase rule-its aplications, Free energy-composition and	**6**	10

	temperature-composition diagrams for binary alloy systems and their corelation, determination of liquidus, solidus and solvus lines, Effect of pressure on phase transformation and phase equilibria.		
8	Functions of slags, Slag compositions, Structure of molten slags, Molecular theory, Concept of basicity index, Thermodynamics of slag-metal reactions.	**6**	10

Reference Books:

1. Metallurgical Thermodynamics Kinetics and Numericals by Dr. S.K.Dutta and Prof A B Lele published by S.Chand2. Introduction to Metallurgical Thermodynamics by D.R.Gaskel published by Mc-Graw Hill, NY
3. Introduction to Materials and Metallurgical Thermodynamics by A. Ghosh published by PHI
4. Problems in Metallurgical Thermodynamics and Kinetics by G. S. Upadhyaya and R. K. Dube published by Pergamon Press

Course Outcome:

After learning the course the students should be able to:

1. Explain concepts and laws of thermodynamics.
2. Derive different thermodynamic relations and solve problems.
3. Comprehend the concept and applications of energy, entropy and energy
4. Interpret Ellingham Diagram for oxides.

List of Open Source Software/learning website:

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

Active learning Assignments (AL) : Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The
Power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU