

NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

COURSE OUTLINE TEMPLATE			
Course Title	Metallurgical Thermodynamics		
Course Code	MTPC13	No. of Credits	4
Department	MME	Faculty	Dr. D. Nagarajan
Pre-requisites Course Code			
Course Coordinator(s)	Not applicable		
Other Course Teacher(s)/Tutor(s)	----	Telephone No.	0431-2503712
Course Type	Theory subject (Core)		
COURSE OVERVIEW			
The course explains the different laws of thermodynamics, derives the relationship between different thermodynamic properties and, applies the concepts of these thermodynamic properties to solve metallurgical problems involving chemical reactions and physical changes at high temperatures.			
COURSE OBJECTIVES			
<ul style="list-style-type: none"> ➤ Briefing the fundamentals of thermodynamics through precise definitions and examples to form a sound footing on thermodynamics. ➤ Developing an understanding of the physical meaning of the concepts underlying the various laws of thermodynamics. ➤ Introducing and familiarizing students to systematic problem-solving techniques that are encountered in metallurgical engineering applications. 			
COURSE OUTCOMES (CO)			
Upon completing the course, the student will be able to :			
Course outcomes (Cos)		Aligned POs	
➤ Understand the different laws of thermodynamics and gain fundamental knowledge on metallurgical thermodynamic concepts.		[1, 5]	
➤ Acquire knowledge on the thermodynamics of solutions and estimate the thermodynamic properties of the ideal and real solutions.		[1, 5, 11]	
➤ Apply the thermodynamic relations to solve the metallurgical engineering related problems.		[1, 2, 5, 11, 12]	
➤ Observe and distinguish the different metallurgical thermodynamic related processes happening around them and solve them.		[1, 2, 3, 5, 8, 11, 12]	
COURSE SYLLABUS:			
Types of system, state of a system, state properties - First law of thermodynamics; heat of reaction, heat of formation, standard heats, heat of transition; Hess's law of heat summation. Second law, entropy of irreversible processes, combined statements of 1st and 2nd laws - Maxwell's relations, Clausius - Clapeyron equation, Trouton's rule, Gibb's - Helmholtz relations.			
Third law of thermodynamics, relation between C_p and C_v , Nernst heat theorem, equilibrium constant, Van't Hoff equation, concept of fugacity, activity, mole fraction.			
Thermodynamics of solutions, Gibb's Duhem equation, partial molar properties of mixing, concept of chemical potential, ideal solution, Raoult's law, Henry's law; non ideal solution, excess functions, regular solutions.			
Sievert's law - residual gases in steel - properties and functions of slags, slag compositions, structure of molten slags, molecular theory, concept of basicity index, ionic theory; thermodynamics of slag-metal reactions.			
Numerical problems on the concepts mentioned in all the above units.			

COURSE TEACHING AND LEARNING ACTIVITIES			
S.No.	Week	Topic	Mode of Delivery
1.	1 st week	System and surrounding, Types of system, State of a system, Functions, Processes, Reversible and irreversible processes.	Chalk & talk
2.	2 nd week	First law of thermodynamics; Heat of reaction, Heat of formation	Chalk & talk
3.	3 rd week	Standard heats, Heat of transition; Hess's law of heat summation.	Chalk & talk
4.	4 th week	Second law, Entropy of irreversible processes, Combined statements of 1 st and 2 nd laws	Chalk & talk
5.	5 th week	Maxwell's relations, Clausius - Clapeyron equation	Chalk & talk
6.	6 th week	Trouton's rule, Gibb's - Helmholtz relations.	Chalk & talk
7.	7 th week	Third law of thermodynamics, Relation between C_P and C_V , Nernst heat theorem	Chalk & talk
8.	8 th week	Equilibrium constant, Van't Hoff equation	Chalk & talk
9.	9 th week	Concept of fugacity, Activity, Mole fraction	Chalk & talk
10.	10 th week	Thermodynamics of solutions, Gibb's Duhem equation, Partial and integral molar properties of mixing	Chalk & talk
11.	11 th week	Concept of chemical potential, Ideal solution, Raoult's law, Henry's law	Chalk & talk
12.	12 th week	Non-ideal solution, Excess functions, Regular solutions	Chalk & talk
13.	13 th week	Sievert's law, Residual gases in steel, Properties and functions of slags, Slag compositions	Chalk & talk
14.	14 th week	Structure of molten slags, Molecular theory, Concept of basicity index	Chalk & talk
15.	15 th week	Ionic theory; Thermodynamics of slag-metal reactions	Chalk & talk
16.	16 th week	Introduction to Kinetics, Homogeneous and heterogeneous reactions, Factors affecting the heterogeneous reactions kinetics.	Chalk & talk
17.	17 th week	First, Second and third order reactions; Numerical problems.	Chalk & talk

COURSE ASSESSMENT METHODS				
Sl. No.	Mode of Assessment	Week/Date	Duration	% Weightage
1.	Quiz – 1 (Objective type)	7 th week	½ hr	10%
2.	Mid Semester Evaluation (Descriptive and problem solving)	8 th week	2 Hours	30%
3.	Quiz – 2 (Objective type)	13 th or 14 th week	½ hr	10%
4.	Assignment (Problem solving)	14 th or 15 th week	1 week time for submission	10%
5.	End Semester Evaluation (Descriptive and problem solving)	17 th or 18 th week	2 ½ Hours	40%

ESSENTIAL READINGS : Textbooks, reference books Website addresses, journals, etc

TEXT BOOKS:

1. David .R. Gaskell, "Introduction to the Thermodynamics of Materials", 4th edition, Taylor & Francis, London, 2003.
2. Moore, J.J, "Chemical Metallurgy", Butterworth-Heinemann Ltd, 1990.
3. Upadhyaya, G.S, and Dube.R.K, "Problems in Metallurgical Thermodynamics & Kinetics", Pergamon, 1977.

REFERENCES:

1. Gokcen and Reddy R. G, "Thermodynamics", Second Edition, Plenum Press, New York & London, 1996.
2. David V. Ragone, "Thermodynamics of Materials - Volume-1", John Wiley & Sons, Inc. 1995.
3. Darken.L.S., and Gurry,R.W., "Physical Chemistry of Metals", McGraw Hill, 1987.
4. Parker.R.H., "An introduction to chemical metallurgy", 2nd edition, Pergamon press, New York, 1978.
5. Swalin,R.A., "Thermodynamics of solids", John Wiley Sons Inc, 3rd edition, 1966.
6. Nag P K, "Engineering Thermodynamics", Tata McGraw Hill, Delhi, 2004.

COURSE EXIT SURVEY

With a questionnaire covering the following aspects: (1 to 10; 1 is poor and 10 is excellent) –
Either with the faculty through the questionnaire or through MIS.

1. Whether class was conducted as per schedule and in regular manner.
2. Whether prescribed syllabus was completed
3. Whether sufficient/suitable study material was given to the students on-time.
4. Whether assessment of the students was carried out properly and is satisfactory.

*NOTE: No make-up examination is conducted, unless prior approval is obtained from the HoD.
For genuine medical reasons, a letter from the Institute Medical Officer is required.*

COURSE POLICY (including plagiarism, academic honesty, attendance, etc.)

Copying in examination, plagiarism in assignment are highly penalized.

ADDITIONAL COURSE INFORMATION

No minimum attendance is required.

FOR SENATE'S CONSIDERATION

Φ. N. S. →

Faculty

*R. S. →
Aug. 20 18*

Class Committee Chairman

(MME: SRS)

*M. S. →
21-8-18*

HoD