VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA

Department of Metallurgy& Materials Engineering

Lecture Plan-PT&HT

Subject Name	:	Phase Transformations & Heat Treatment
Credits	:	3-0-0-3
Prerequisite	:	Introduction to Physical Metallurgy
Department	:	Metallurgy & Materials Engineering
Session	:	2016-17 (Even Semester)
Level	:	Undergraduate (VI-Semester)
Course Instructor	:	**A Lava Kumar**
Category	:	Compulsory course for all B.Tech VI Semester students of MME Department.

Class Schedule			
Monday – B320	Tuesday – B320	Wednesday – B320	Thursday – B320
3:20-4:10 PM	3:20-4:10 PM	11:20-12:10 PM	8:00-08:50 AM

Marks Distribution		
End Term	Mid Term	Assignments + Class Test
70	**20**	**10**
Total -100 Marks		

Required Text book

1. Cost-free, PowerPoint visuals & extended notes are furnished to students by Instructor
2. Phase Transformations in Metals and Alloys by D.A.Porter, K.E. Easterling, and M.Y. Sharif, CRC Press , Taylor & Francis Group
3. Heat treatment –Principles & Techniques by T.V.Rajan, C.P.Sharma and A.Sharma, PHI publishers

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COURSE CONTENTS

Sl. No	TOPIC	HOURS
1.	Class Test -I | Introduction to the course	1
2.	Classification of Phase transformations	1
3.	Basics of Thermodynamics, Concept of Equilibrium, Gibbs Free Energy (G) vs T, H, S , Pressure effects	1
4.	Driving force for solidification, Thermodynamic parameters in binary system, ΔH_{mix}, ΔS_{mix}, ΔG_{mix}	1
5.	Binary phase diagrams, Free energy Vs Composition phase diagrams.	1
6.	Chemical Potential & Activity of elements	1
7.	Equilibrium vacancy concentration, Equilibrium vacancy concentration of interstitial atoms, Carbon solubility in Iron	1
8.	Concluding remarks	1
	Class Test –II	-
9.	Diffusion : Introduction, Diffusion under thermodynamic driving force	1
10.	Diffusion Mechanism, Fick's I Law	1
11.	Fick's II Law, Solutions to Fick's second Law	1
12.	Solutions to Fick's second Law	1
13.	Activation energy for diffusion , Factors effecting diffusion	1
14.	Concluding remarks	1
	Class Test –III	-
15.	Nucleation and growth: Homogeneous nucleation, Homogeneous nucleation rate	1
16.	Driving force for a transformation, Interfacial energy	1
17.	Heterogeneous nucleation, Heterogeneous nucleation rate	1
18.	Solid-Solid transformation rate	1
19.	Kinetics of phase transformations-I	1
20.	Kinetics of phase transformations-II	1
21.	Interface-controlled growth and Diffusion controlled growth	1
22.	Avarami Kinetics/JMAK Equation	1
23.	Concluding remarks	1
	Class Test –IV	-
24.	Iron-carbon alloy system: iron-carbon diagram, Various transformations	1
25.	TTT & CCT Diagrams	1
26.	Heat treatment Processes : Annealing, Normalizing & Hardening	1
27.	Retained Austenite, Subzero treatment, Tempering	1
28.	Recovery, Recrystllization & Grain Growth	1
29.	Diffusional Transformations: Introduction	1
30.	Precipitation in age hardening alloys	1
31.	Misfit strain effects, Particle coarsening	1
32.	Spinodal decomposition	1

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33.	Cellular transformations	1
34.	Order-disorder transformations & Massive Transformations	1
35.	Concluding remarks	1
	Class Test –V	-
36.	Martensitic transformations: Characteristics	1
37.	Driving force for martensitic transformation & Why tetragonal structure for martensite?	1
38.	Hardenability	1
39.	Development of microstructures in cast irons.	1
40.	Role of alloying elements in steels	1
	Total	40

Note for students:

1. This is the syllabus; I planned for the "Phase Transformations & Heat Treatment" course of Session 2016-17 (Even semester). If you have any query/suggestions mail me on lavakumaravala@gmail.com
2. Our course includes Assignments (from every chapter), some model charts (for laboratory), Term paper (for laboratory) and Class test.
3. By end of this course student must have 75% attendance, to eligible for the end semester examination.

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General Comments

WELCOME to PT&HT…….! As a core course in the Metallurgy& Materials Engineering curriculum, the Phase Transformations & Heat Treatment plays a role as fundamental as thermodynamics and transformations in materials. In the classical scheme of processing, microstructure, and properties, thermodynamics and phase transformations mostly determine the microstructure, which in turn mainly determines the mechanical properties of a material. Although materials reveal a host of properties, microstructural properties have maintained their status as arguably the most important property - at least for structural applications. For undergraduates who continue in industry, classical aspects of heat treatment such as annealing, normalizing, hardening will play a crucial role. The knowledge gained in this course overlaps with some aspects of course on Introduction to physical metallurgy.

Learning outcomes**:** Enhanced critical thinking, analytical and problem solving skills in materials science and engineering. An understanding of the principles underlying liquid-to solid and solid-state phase transformations in a range of materials. An understanding of the importance of phase transformations for controlling microstructure and properties in engineering alloys.

Group Term Paper (for groups of three)

Step 1) Select a paper after discussions with Course Instructor, before Jan 31st 2017

Step 2) This paper must be from Journal (research) article, and must be concerned with the mechanical properties/behavior of materials.

Step 3) Critically review the paper. (You will have to read a lot of background material to be able to do this. The references given in the paper will help you in this process.)

Step 4) Write a report highlighting the new observations made in the paper and possible drawbacks, loopholes, etc. The report should be of highest professional quality with a clear and concise structure and must be submitted by 28-02-2017.

Step 5) Prepare a Power Point Presentation (10-minute duration) that highlights some salient points of the paper. The presentation must be very clear and graphics that are pleasing to the eye.

The earlier you start on the project, the better grade you are going to get!

Assignment

As classes are progressing, in between I will give you, to solve set of problems related to specific topics in our course. You need to solve, each and every problem, and need to submit on given deadlines.

Don't miss the classes, be aware of questions/problems, given in the class

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