KL UNIVERISTY
FIRST SEMESTER 2010-11
Course Handout
Academic Division

Dated: 07-07-2010

Course No. : **ME C205**
Course Title : **Material Science and Metallurgy**
Course Structure : **3-0-2**
Course coordinator : **T Vijaya Kumar**
Instructors : **T Vijaya Kumar, D Suneel, K V Ravishankar**

1. Course Description:

The course has been planned to cover the selection of materials for various Industrial and practical applications. It would elicit knowledge on various heat treatment process and the steps to be followed in each process, process variants, and necessity of going for various processes and their effects on properties. It also covers the study of recent advanced materials like Biomaterials, Nanomaterial and smart materials.

2. Scope and Objective of the Course:

After thorough learning of Material science and metallurgy the student:
1. Will understand how the mechanical properties of materials namely metals and alloys are inter related with the crystal structure.
2. Will understand various ferrous and nonferrous materials, ceramics, composites, biomaterial, nano material and smart materials and their applications.
3. Will understand the concepts of the cooling curves for the construction of phase diagram and apply them in finding relative amounts of solid/liquid phase present in it.
4. Will analyze the heat treatment processes of steels with reference to various properties and apply them in finding the suitable material properties while designing the structures, gears, camshafts, boilers etc.,

3. Books:

(i) Textbook:

a. Introduction to Physical Metallurgy-Sidney.H.Avner-TMH publications, Second Edition.
b. Material science & Metallurgy-C.Daniel Yesudian, D G Harris Samuel-Scitech Publications,2006 Edition

(ii) Reference Book:

a. Material science and Engineering by William D Callister, John Wiley publishers, 6th Edition.
b. Material science and Metallurgy for Engineers by Dr.V.D.Kodgire. EPH, 25th Edition 2009.
c. Material science and Engineering by V.Raghavan, PHI, Fourth Edition.

4. Syllabus:

UNIT-I

Introduction to Engineering Materials –Properties
Crystallography: Terms related to Crystallography-crystal systems- Bravai's lattices-Miller Indices-Crystal Imperfections-Density calculations

UNIT-II

Ferrous & Non Ferrous Materials: Composition-properties-applications of cast irons, steels, aluminum and copper

Ceramics: Introduction-classification-processing-refractories-mechanical and electrical properties

Composites: Introduction-classification-properties-advantages and disadvantages-applications-fiber reinforced composite-particulate reinforced composite-Hybrid composite-concept and problems on Rule of Mixtures-manufacturing methods of composites

UNIT-III

Nano materials: Introduction-advantages & disadvantages-applications-manufacturing methods-nano tubes-nano particles-nano films

Bio materials: Introduction-Bio compatibility- classification-bio polymers-metallic bio materials-ceramic biomaterials-bio composites

Smart materials: Introduction, piezo electric ceramics-piezo electric polymers-chemical sensors and Shape memory alloys.

UNIT-IV

Constitution of Alloys: Introduction-terms-solid solution types-Hume Rothery rules.

Phase Diagrams: Cooling curves-Gibb's Phase rule-construction of binary phase diagrams-Isomorphous and Eutectic sytem-reactions in phase diagrams-Eutecit-eutectoid-peritectic-peritectoid-syntectic and monotectic-Iron-iron carbide diagram

UNIT-V

Heat treatment of steels: Heat treatment cycle-purposes-stages-TTT diagram-CCT diagram

Heat treatment process: Annealing-Normalising-Hardening-Tempering-Austempering-Martempering-surface Hardening-Case Hardening-Age Hardening-Hardenability test (Jominy End Quench Test)

Powder Metallurgy: Introduction-advantages and disadvantages-applications-process-preparation of metal powders-characteristics of metal powders-compaction types-sintering

5.Course Plan:

Course plan is meant as a guideline. There may probably be changes.

Lec No.	Learning Objective	Topics to be covered	Reference
1	Introducing Engineering Materials	Introducing Engineering Materials their brief history with applications.	T-2 1.1
2	Introducing properties of Materials	Some important Properties –Mechanical, Electrical, Magnetic, and Thermal.	T-2 2.3-2.5
3	Introducing Structure of Materials	Terms related to Crystallography Crystal systems & Bravai's Lattices	R-2 Pg:1-4
4	Introducing Crystal Structures	Simple Cubic, Body Centered Cubic Structure	R-2 Pg:14-15
5	Introducing Crystal Structures	Face Centered Cubic and Hexagonal close packed structure	R-2 Pg:16-17

6	Miller Indices	Indexing of directions and planes in a cubic crystal structures.	R-2 Pg: 5-10
7	To Study Crystal Imperfections	Introducing various crystal defects –Point defect, Edge & Screw Dislocations	R-2 Pg: 29-34
8	Crystal Imperfections	Planar defect- Grain boundary, Twin boundary, stacking fault	R-2 Pg: 35-38
9	Density calculations	Volume density related problems, linear and planar atomic density problems	R-2 Pg: 20-29
10	To study Ferrous Materials	Composition, properties and applications of Cast irons-WCI, GCI, SGCI, MCI	T2 Pg:6.1-6.5
11	To Study Ferrous Materials	Composition, properties and applications of - low carbon, medium carbon and high carbon steels	T2 Pg:6.6-6.20
12	To study Non Ferrous Materials	Composition, properties and applications of Aluminum	T2 Pg:8.7-8.8
13	To study Non Ferrous Materials	Composition, properties and applications of copper	T2 Pg:8.1-8.7
14	Introduction to Ceramics	Classification and processing of ceramics	T2 Pg:10.1-10.4
15	Introducing Refractory material	Defintion, classification and mechanical & electrical property	T2 Pg:10.5-10.9
16	Composite material	Introduction, classification, advantages and disadvantages, application	T-2 16.1,16.11
17	Fibre reinforced composites	Rule of mixture and problems related to FRP	T-2 522-526
18	Particulate composites	Classifiaction and applications	T-2 33.1
19	manufacturing methods of composites	Pultrusion process, filament winding process and hand lay up process	T-2 16.9-16.10
20	Introducing Nano materials	Nano material –manufacturing method	T2 44.1-44.2
21		Advantages, disadvantages and applications of Nano materials	T2 44.15
22		Nano tube technology, fullerenes	T2 44.4
23		Nano particle,nano dendrimers, Nano film	T2 44.5-44.7
24	Introducing Biomaterials	Biocompatibility, classifaction	T2 46.1
25		Ceramic biomaterials and metallic biomaterials	T2 46.2-46.4
26	Introducing Smart materials	Piezo electric ceramics, piezo electric polymers	T2 48.1
27		Chemical sensors, Shape memory alloys	T2 48.5
28	Introduction to Metallurgy	Constituion of alloys, terms,classification	R-2 159
29	Study of Solid solution	Substituional and Interstitial type	R-2 161-162
30	Rules of solid solubility	Hume Rothery rules of Solid solubility	R-2 161-162

31	Phase diagram	Cooling curve and Gibbs phase rule	R-2 161-162
32	Introducing construction method	Construction of Phase diagram-Isomorphous and eutectic type	R-2 173
33		Types of Phase diagram based on component and transformation	R-2 177
34	Reactions in phase diagram	Eutectic, eutectoid, peritectic, monotectic and peritectoid reactions in binary phase diagram	R-2 175
35	Important binary phase diagrams	Fe- C, Cu-Ni, Bi-Cd	R-2 309
36	Heat treatment Process	Introduction, heat treatment cycle,stages and purpose	R-2 373-376
37	Concepts	TTT diagram and CCT diagrams-significance	R-2 348-350
38	Heat treatment process	Annealing, Normalising	R-2 373-376
39	Hardenability measurement	Hardening, Jominy end quench test,	R-2 395-398
40		Tempering and its types, Austempering, Martempering	R-2 381-382
41	Intoduction to Special Heat treatment processess	surface Hardening-Induction and flame hardening processes	R-2 400
42		Case Hardening-carburising,nitriding,cyaniding and carbonitriding processes	R-2 400-407
43	Introducing Powder Metallurgy	Operations, advantages and disadvantages, applications	T-1 531-532
44	Preparation and characteristics	Metal powders	T-1 546-548, 539-542
45		Compaction and sintering process	T-1 532

6.Self learning material:

Unit	Topic	Source
I	a)Characteristics of HCP structure b) Miller Bravai's Indices (Direction and Plane)	http://departments.kings.edu/chemlab/animation/clospack.html http://www.seas.upenn.edu/~chem101/sschem/metallicsolids.html http://en.wikipedia.org/wiki/Miller_index
II	a) Some important Cast iron and their alloys b) Advanced Composites	http://en.wikipedia.org/wiki/Cast_iron Engineering Materials by William D.Callister
III	a) Nano film Technology b) SMA & FSMA materials	Material science & Metallurgy by C. Daniel Yesudian & D.G.Harris Samuel Page: 44.8-44.9

		Material science & Metallurgy by C. Daniel Yesudian & D.G.Harris Samuel Page:48.11-48.13
IV	a) Composition rule and lever rule b)Intermetallic compounds and intermediate phases	A text book on Physical metallurgy by Sidney H Avner Material science & Metallurgy by C. Daniel Yesudian & D.G.Harris Samuel Page: 23.7-23.8
V	a) Ausforming and Mar aging process b)Ageing/precipitation hardening process	http://en.wikipedia.org/wiki/Maraging_steel Material science & Metallurgy by C. Daniel Yesudian & D.G.Harris Samuel Page: 28.9-28.10 http://info.lu.farmingdale.edu/depts/met/met205/agehardening.html Material science & Metallurgy by C. Daniel Yesudian & D.G.Harris Samuel Page: 31.2-31.3

7.Evaluation Scheme:

Component	Duration (minutes)	% Weightage	Marks	Date & Time	Venue
Test-1	50 Min	7.5	10	12-08-2010 9.30 to 10.20 A.M	CSE005,101, 104,105,106, 201,202,204, 205,209,301, 309,502,509
Test-2	50 Min	7.5	10	16-09-2010 9.30 to 10.20 A.M	CSE005,101, 104,105,106, 201,202,204, 205,209,301, 309,502,509
Assignement submission		3.75	5	Continuous	
Assignment Test	50 Min	3.75	5	28-10-2010 9.00 to 10.20 A.M	CSE005,101, 104,105,106, 201,202,204, 205,209,301, 309,502,509
Quiz	30 Min	3.75	5	28-10-2010 9.00 to 10.20 A.M	CSE005,101, 104,105,106, 201,202,204, 205,209,301, 309,502,509
Regular Lab Evaluation	Continuous	12.5	50		
Comprehensive Lab Exam	3 Hrs	10	40		
Comprehensive Exam	3 Hrs	45	60		
Attendance for Theory & Tutorial		3.75	5	Continuous	

Attendance for Lab		2.5	10	Continuous	

8. Chamber consultation hour: Informed in the class in first week.

9. Notices: All notices regarding the course will be put in E-learning website.

Course Coordinator