GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: ADVANCE PHYSICAL METALLURGY
(Code: 3342104)

Diploma Programme in which this course is offered	Semester in which offered
Metallurgy Engineering	4th Semester

1. RATIONALE

This course deals with the understanding of physical and chemical behavior of different ferrous and non ferrous metals and alloys with respect to their composition, properties and applications including phase diagrams. This course will help the student to understand the effect of alloying elements leading to modification of properties in the alloys and their applications. It is therefore a key course for metallurgical engineers who want to advance in this field.

2. COMPETENCY

The course content should be taught and curriculum should be implemented with the aim to develop different skills in the students so that they are able to acquire following competency:

- **Use physical and chemical behavior of different ferrous and non ferrous metals and alloys with respect to their composition, and properties for production and application of metals and alloys**.

3. COURSE OUTCOMES (COs)

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. Distinguish between metals and alloys
ii. Explain transformation for various carbon percentages
iii. Relate Carbon, microstructure and mechanical properties
iv. Distinguish different types of stainless steel with reference to composition, microstructure, properties, and applications.
v. Compare different types of Copper alloys based on properties and applications

4 TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
4	0	4	8	70	30	40	60	200

Legends: L - Lecture; **T -** Tutorial/Teacher Guided Student Activity; **P -** Practical; **C -** Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. COURSE DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Introduction to Metals & Alloys	1a. Distinguish between metals and alloys 1b. Explain phase transformation 1c. Construct equilibrium diagram from cooling curve 1d. Explain types of systems	1.1 Metals, Alloys and their structural constituents, systems & phases. 1.2 Thermodynamic consideration of phase transformations. 1.3 Equilibrium diagrams & cooling curves. 1.4 Types of systems.
Unit – II Iron-Carbon Equilibrium Diagram	2a. Draw Iron-Carbon Equilibrium Diagram and explain critical and invariant points, allotropic forms of iron 2b.Establish relationship between phases and mechanical properties 2c.Explain transformation for various carbon percentages	2.1 Introduction of Iron-Carbon Equilibrium Diagram. 2.2 Critical points & invariant points / allotropic forms. 2.3 Definitions of related Phases & micro constituents and their effect on mechanical properties. 2.4 Transformations in steel and cast iron with various carbon percentages.
Unit – III Physical Metallurgy of Ferrous Metals and Alloys	3a. Distinguish between steel and cast iron 3b. Relate Carbon, microstructure and mechanical properties 3c. Describe applications and limitations of plain carbon steels and cast iron 3d. Explain cast iron with respect to composition, microstructure, properties and applications.	3.1 Definition and Classification of Steel and Cast Iron 3.2 Relationship between Carbon, microstructure and mechanical properties. 3.3 Application and Limitations of plain carbon steels. 3.4 Types of cast iron with respect to composition, microstructure, properties and application.
Unit – IV Physical Metallurgy of High Alloy steels	4a. Describe attributes of tool steel, HSS, Stainless Steel 4b. Describe composition and applications of HSS 4c. Distinguish different types of stainless steel with reference to composition, microstructure, properties, and applications.	4.1 Classification of tool steels. 4.2 High speed tool steels(HSS) classification, composition and applications. 4.3 Classification of stainless steels. 4.4 Types of stainless steel with reference to composition, microstructure, properties, and application.
Unit – V Physical Metallurgy of Non-Ferrous Metals and Alloys	5a. Compare different types of Copper alloys based on properties and applications 5b. Differentiate different types of Aluminium alloys with reference to properties and applications 5c. Distinguish various white bearing metals based on properties and applications	5.1 Copper and its alloys: Binary equilibrium diagram of Cu- Zn, Cu- Sn, Composition, properties, uses and microstructure. 5.2 Aluminium and its alloys: Binary equilibrium diagram of Al-Si, Al –Cu, Al- Mg, Composition, properties, uses and Microstructure. 5.3 White bearing metal: Composition, properties, uses and Microstructure.

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 to Metals & Alloys	8	6	4	2	12
II	Iron-Carbon Equilibrium Diagram	10	8	5	2	15
III	Physical Metallurgy of Ferrous Metals and Alloys	12	6	5	4	15
IV	Physical Metallurgy of High Alloy steels	12	6	6	8	20
V	Metallurgy of Non-Ferrous Metals and Alloys	14	4	2	2	8
Total Hrs		**56**	**30**	**22**	**18**	**70**

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

***Note**: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes (**as given in a common list at the beginning of curriculum document for this programme) would be assured.*
Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical/Exercise (Outcomes' in Psychomotor Domain)	Approx. Hrs. Required
1	I	Preparation of metallic specimen for microscopic examination as per I.S. code.	12
2	I	Draw equilibrium diagram for given data.	4
3	II	Draw and label iron carbon equilibrium diagram and explain cooling of hypo eutectoid, eutectoid, hyper eutectoid steel.	4
4	III	Prepare sample specimen. Identify and Distinguish microstructures of plain carbon steels.	4
5	III	Prepare sample specimen. Observe and compare microstructure of various types of C.I.	4
6	IV	Observe and draw microstructures of High Speed Tool steels.	4

S. No.	Unit No.	Practical/Exercise (Outcomes' in Psychomotor Domain)	Approx. Hrs. Required
7	IV	Observe, draw and compare microstructures of Stainless steels.	4
8	V	Identify, draw and distinguish distinct features of microstructure of Copper and alloys.	4
9	V	Identify, draw and distinguish distinct features of microstructure of Aluminium and alloys.	4
10	V	Identify and distinguish distinct features of microstructure of white bearing metal	4
11	I to V	Microstructure analysis by Image analyser and Photo metallography as per I.S. code.	8
Total Hrs			**56**

8. SUGGESTED LIST OF STUDENT ACTIVITIES

i. Students may be given data to draw equilibrium diagram of different system and apply lever rule and Gibb's phase rule.
ii. Students may be given sample to prepare microstructure and identify phases and relate it to properties of materials.
iii. Students will prepare file and get it checked from concerned faculty.

9. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)

i Show video/animation films or photographs explaining microstructure of metals and their effect on properties of metals/alloys.
ii Seminar by group of students on different topic related to the course. .

10. SUGGESTED LEARNING RESOURCES

A. List of Books

S. No.	Title of Books	Author	Publication
1	Physical Metallurgy Principles	R.E. Reed Hill	East - West
2	Introduction to Physical Metallurgy	S. H. Avner	Tata Mc-Graw Hill
3	Physical Metallurgy for Engineers	D. S. Clark and W. R. Varney	East-West press
4	Engineering Metallurgy : Applied Physical Metallurgy	R. A. Higgins	Viva Books
5	Material science and Metallurgy	V.D. Kodgire	Everest Publishing House

B. List of Major Equipment/Materials

i. Metallurgical Microscope
ii. Standard specimens
iii. Polishing disc machine to prepare specimens with necessary consumables.
iv. Emery papers, etching reagents
v. Image Analysis System

C . List of Software/Learning Websites

i. http://nptel.iitm.ac.in/courses.php?disciplineId=113
ii. http://www.sv.vt.edu/classes/MSE2094_NoteBook/96ClassProj/examples/kimcon.html
iii. http://www.youtube.com/watch?v=IskiZaGDQow
iv. http://ocw.mit.edu/courses/index.htm#materials-science-and-engineering

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Dr I. B. DAVE**, HOD, Dept of Metallurgy, Dr S & S.S.Ghandhy College of Engg. & Technology
- **Prof. (Smt.) B. H. Goyal**, I/c. Head of Department of Metallurgy, Dr S and S.S Ghandhy college of Engg. and Technology
- **Dr. G. H Upadhyay**, Professor of Metallurgy, Department of Mechanical Engineering, L.D.College of Engineering, Ahmedabad
- **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
- **Dr. K.K. Jain**, Professor and Dean, Department of Mechanical Engineering