GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT
COURSE CURRICULUM

Course Title: Basic Physical Metallurgy
(Code: 3322101)

Diploma Programmes in which this course is offered	Semester in which offered
Metallurgy Engineering	Second Semester

1. RATIONALE

This elementary course deals with the relationship between structure and properties of metals and alloys. It forms a vital link in the processes of making, shaping and heat treating of metals. It thus interfaces with the other areas of metallurgy such as process metallurgy, mechanical metallurgy and engineering metallurgy. Therefore, an engineering diploma student must be conversant with the crystalline structures of metals, equilibrium diagrams, deformation of metals and effect of heat on cold –worked metals and metallography from the point of view of producing structures of metals that gives the best properties. The study of these basic concepts of physical metallurgy will help the students in understanding engineering courses where the emphasis is laid on the application of these metals and alloys.

2. COMPETENCY

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

- **Integrate knowledge of internal structure of metals and conditions for formation of alloys in metallurgy engineering applications**

3. 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	
3	0	2	5	70	30	20	30	150

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

Note: It is the responsibility of the institute heads that marks for **PA of theory** & **ESE and PA of practical** for each student are entered online into the GTU Portal at the end of each semester within the dates specified by GTU.

4. DETAILED COURSE CONTENT

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I **Introduction to Crystalline Structures of Metals**	1a. Distinguish between metals and non metals. 1b. Draw crystal structure and calculate atomic packing factor for BCC, FCC and HCP structures. 1c. Identify the directions and planes in simple cubic structure	1.1 Metals and non Metals 1.2 Structure of atom 1.3 Aspects of crystalline structure of metals- lattice, unit cell, space lattice, crystal structure, grain, grain boundary. 1.4 Types of bonding like primary and secondary. 1.5 Crystal structures like BCC, FCC, and HCP 1.6 Millers indices for directions and planes in simple cubic structure.
Unit– II **Cooling Curve**	2a. Describe the effect of temperature on change of structures of metals and alloys during cooling 2b. Explain the rules and conditions for formation of various types of solid solutions 2c. Draw the various types of cooling curves.	2.1 Mechanism of cooling 2.2 Structure of ingot 2.3 Types of solid solutions. 2.4 Cooling curve and its types.
Unit– III **Equilibrium Diagrams**	3a Construct the equilibrium diagram from given data 3b Explain different types of equilibrium diagram	3.1 System, phase, phase rule, lever rule and equilibrium diagram 3.2 Construction of equilibrium diagram from cooling curves. 3.3 Types of equilibrium diagram
Unit – IV **Mechanical Deformation of Metals**	4a Enlist the various mechanical properties of metals 4b Differentiate between elastic and plastic deformation 4c Describe the various lattice imperfections	4.1Definition of various mechanical properties 4.2Mechanism of deformation like elastic and plastic 4.3 Lattice imperfections. 4.4Strainhardening,recovery and re-crystallization
Unit – V **Metallography**	5a Differentiate between micro and macro examination 5b Explain the process of preparation of metallurgical micro- specimen and observe under microscope	5.1 Micro and Macro examination 5.2Principle and working of simple metallurgical microscope. 5.3 Steps of micro- specimen preparation

5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I.	Introduction to Crystalline Structures of Metals	10	15	5	5	25
II.	Cooling Curves	08	10	8	2	20
III.	Equilibrium Diagrams	10	10	5	5	20
IV.	Mechanical Deformation of Metals	08	15	5	5	25
V.	Metallography	06	4	4	2	10
	Total	**42**	**54**	**27**	**19**	**100**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as only general guideline for students and teachers. The actual distribution of marks in the question paper may vary from above table.

6. SUGGESTED LIST OF EXERCISES PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills leading to the achievement of the above mentioned expected competency.

S. No.	Unit No.	Practical/Exercises	Approx Hours Requird
1	I	Calculate atomic packing factor for BCC,FCC and HCP crystal structures	04
2	I	Assign directions and planes in simple cubic structures from the given data	04
3	II	Draw and study the cooling curve for pure iron	02
4	IV	Construct equilibrium diagram of solid solution type from given data. Eg. Cu-Ni system	02
5	IV	Construct equilibrium diagram for eutectic type from given data	02
6	IV	Construct equilibrium diagram for metals partially soluble in solid state from given data	04
7	V	Identify and label various parts of metallurgical microscope	04
8	V	Prepare micro-specimen and observe under microscope	04
9	V	Perform macro etching and observe	02
		Total	**28**

7. SUGGESTED LIST OF STUDENT ACTIVITIES

7.1 Students may be given data to draw equilibrium diagram of different system, various types of crystal structures, planes and directions etc

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7.2 Students will prepare file and get it checked from concerned faculty.

8. SUGGESTED LEARNING ACTIVITIES

A. List of Books

S. No.	Author	Title of Books	Publication/Year
1.	Dieter	Mechanical metallurgy	McGraw Hill
2.	Higgins	Physical Metallurgy- Volume I and II	ELBS
3.	Kodgire V.B.	Material Science And Metallurgy	Everest Publishing House
4.	Raghavan V.	Materials science and Engineering	EEE Edition, Prentice Hill, New Delhi.
5.	Sidney Avner	Physical Metallurgy	Tata McGraw-Hill, New Delhi.

B. List of Major Equipment/ Instrument

- Metallurgical Microscope
- Standard specimens
- Polishing disc machine to prepare specimens with necessary consumables.
- Emery papers, etching reagents
- Other consumables

C. List of Software/Learning Websites

http://en.wikipedia.org/wiki/Recrystalization_(Matellurgy)
http://www.youtube.com/watch?v=fHt0bOfj3T0&feature=related
http://en.wikipedia.org/wiki/matellurgy and Materials_science

9. 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**, Lecturer, Dept of Metallurgy, Dr S & S.S.Ghandhy College of Engg. & Technology

Co-ordinator and Faculty Member from NITTTR Bhopal

- **Dr. K.K.Jain**, Professor and Head; Dept. of Mechanical Engg
- **Dr. A.K.Sarathe**, Associate Professor; Dept. of Mechanical Engg