

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT
Course Curriculum

MATERIALS & METALLURGY
(Code: 333503)

Diploma Programme in which this course is offered	Semester in which offered
Fabrication Technology	3 rd Semester

1. RATIONALE

The polytechnic graduate is required to select and use metals, non-metals and other engineering materials for fabrication works. Knowledge and skills about metallurgy is essential for fabrication engineers. Metallurgy is the materials science that studies the physical and chemical properties of metals, and their metallic compound / mixtures, which are called alloys. Metallurgy is also the technology of metals: the way it is applied to their practical use. This course is intended to provide knowledge and skills of metallurgy and engineering materials, along with its codes and standards (ASME/EN/ASTM/SAE), which are in use in fabrication industries. The course also covers cladding metals and heat treatment of metal as per ASME SEC VIII DIV 1 UCS 56. The course develops understanding of commercial form of metals applicable in fabrication industry. This course intends to provide adequate knowledge and skills about materials for fabrication. Therefore learning this course is must for all fabrication engineers.

2. COMPETENCY (Programme Outcome according to NBA Terminology):

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

- **Select appropriate metals, alloys and cladding materials along with required treatment processes to fulfil the requirement of products to be fabricated.**

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
4	-	2	6	70	30	20	30	

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

4. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes (Course Outcomes in cognitive domain as per NBA terminology)	Topics and Sub-topics
Unit – I Introduction to Material Science & Engineering Material	1a. Describe materials classification and properties 1b. Describe commercial forms of available materials. 1c. Select material for different service and fabrication application	1.1 Material science & metallurgy. 1.2 Engineering materials : classification & requirement. 1.3 Properties of engineering materials. 1.4 Effect of mechanical properties on service & fabrication requirement. 1.5 Selection of materials. 1.6 Commercial forms of materials available 1.7 Difference of metals and non-metals.
Unit– II Ferrous Metals	2a. Describe properties, application and types of various ferrous metals used in fabrication industry 2b. Explain effects of alloying elements on properties of steel and cast iron	2.1 Introduction & classification, 2.2 Chemical composition, types, properties & application of 2.2.1 Pig Iron & Cast Iron 2.2.2 Steel & its types 2.2.3 Alloy steel 2.2.4 Tool steel 2.2.5 Stainless steel 2.2.6 HSLA steel 2.3 Effect of alloying elements on properties of Steel 2.4 Effect of alloying elements on properties of cast iron
Unit– III Non Ferrous Metal	3a. Describe properties, Application and types of various non-ferrous metals used in fabrication industry 3b. Differentiate between ferrous and non-ferrous metals.	3.1 Chemical composition, properties & application of 3.1.1 Copper & its alloys 3.1.2 Aluminium & its alloy 3.1.3 Ni & its alloy 3.1.4 Titanium & its alloy
Unit– IV Miscellaneous Materials	4a. Select the material for high & low temperature service requirement 4b. Describe properties, application and types of various non-metallic materials for fabrication industry 4c. Explain methods and application of cladding	4.1 Requirement & Classification of High & Low Temperature service materials 4.2 Classification, Properties & Application of Ceramic materials, Glass, Plastic materials, Composite materials, Adhesive materials, Insulating Materials, Elastomer (Rubber) materials, Teflon, Glass-wool materials 4.3 Cladding Materials -- Objective of cladding , available forms of cladding material, Methods of cladding, Application of

Unit	Major Outcomes (Course Outcomes in cognitive domain as per NBA terminology)	Learning (Course Outcomes in cognitive domain as per NBA terminology)	Topics and Sub-topics
	material in fabrication industry		cladding of cladding
Unit- V Physical Metallurgy	5.a. Describe metal structure, metallography and cryatallography 5.b. Explain IC & TTT diagram and its use in fabrication industry 5.c.Explain effect of grain size on Mechanical properties of material.		5.1 Crystallography -- Type of solid, Structure of atoms, Space lattice, Unit cell 5.2 Study of different crystal structure of metal like SC, BCC, FCC, HCP 5.3 Introduction & types of solid solution 5.4 Phase diagram 5.5 Iron Carbon system & TTT diagram 5.6 Solidification of metal 5.7 Metallography 5.8 Effect of grain size on Mechanical properties of material
Unit- VI Heat Treatment	6.a Describe heat treatment and its classification. 6.b Explain principle and application of heat treatment processes in fabrication industry. 6.c Describe Austempering, Martempering Maraging, & Case Hardening.		6.1 Definition & Classification of heat treatment process 6.2 Purpose & Principles of heat treatment Process 6.3 Introduction to annealing, normalizing, hardening by quenching, tempering process, Austempering, Martempering & Maraging Case Hardening & Surface treatment
Unit- VII Material Codes & Standards	7a.Describe chemical composition, mechanical properties and application of various metals from various codes and standards.		7.1 Need, Scope & importance of codes & standards in industries 7.2 Introduction of codes and standard ASME-II-A,B,C,D ,DIN,ASTM,BIS,EN,JIS 7.3 Chemical composition, mechanical properties & application of coded materials used in industries such as : BIS 2002, 2062 etc. SA 515, 516, 105, 106, 336, 386 etc SS 304, 304L, 316, 316L, 310, 321, 347 etc EN-8 etc 7.4 Study of material test certificate with reference to ASME code

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
1	Introduction to Material Science & Engineering Material	05	2	2	2	06
2	Ferrous Metals	12	4	6	5	15
3	Non Ferrous Metal	08	2	4	2	08
4	Miscellaneous Material	08	4	3	4	11
5	Physical Metallurgy	12	4	6	5	15
6	Heat Treatment	07	2	3	4	9
7	Material Codes & Standards	04	2	2	2	6
	Total	56	20	26	24	70

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

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

6. SUGGESTED LIST OF EXERCISE/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of practical skills (**Course 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 Course Outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of **Programme Outcomes/Course Outcomes in affective domain** as given in a common list at the beginning of curriculum document for this programme. Faculty should refer to that common list and should ensure that students also acquire those Programme Outcomes/Course Outcomes related to affective domain

S. No.	Unit No.	Exercise/Experiment (Course Outcomes in Psychomotor Domain according to NBA Terminology)	Approx Hours required
1	V	Demonstrate use of metallurgical microscope	02
2	V	Prepare specimen for microscopic examination	04
3	II	Determine microstructure of ferrous metals	04
4	III	Determine microstructure of non ferrous metals	04
5	VI	Demonstrate functioning of heat treatment furnace and thermocouple pyrometer	02
6	VI	Analyze effect of quenching media on hardness of steel	04
7	VI	Demonstrate case hardening process for steel	04
8	VI	Perform heat treatment of steel as UCS 56	04
Total			28

7. SUGGESTED LIST OF PROPOSED STUDENT ACTIVITIES

Following is the list of proposed student activities:

- i. Read fabrication drawing and prepare a report on MOC and classify the material from it.
- ii. Write report on properties of given materials
- iii. Write report on alloy steel and effect of different alloying elements on properties of steel
- iv. Write report on High strength Low Alloy (HSLA) steel
- v. Write report on cladding material used in fabrication industry
- vi. Draw drawing sheet / sketch book of IC, TTT and Cooling curve & TTT diagram,
- vii. Micro constituents on ferrous, non ferrous metals and crystal structure of materials
- viii. Write report on effect of grain size on properties of material
- ix. Write report on ASME sec 2 A/B/C/D
- x. Write report on material test certificate as per ASME sec 2

8. SUGGESTED LEARNING RESOURCES

A. List of Books

S.No.	Title of Books	Author	Publication
1	Material science & metallurgy	O.P.Khanna	Dhanpat Rai publications, latest edition
2	Materials & Metallurgy	GBS Narang	Khanna Publisher, latest edition
3	Material science & metallurgy	G.R.Nagpal	latest edition
4	Heat treatment of metals	Zakhrov	latest edition
5	Materials Technology	C.M.Desai	Atul Prakashan latest edition
6	Engineering Materials & Metallurgy	R.K.Rajput	S. Cahand latest edition
7	Codes and standard ASME II-A/B/C/D, ASTM, BIS		

B. List of Major Equipment/ Instrument

- a. Metallurgical microscope
- b. Different grade sand paper with setup
- c. Etchants

C. List of Software/Learning Websites

- i. http://en.wikipedia.org/wiki/Materials_science
- ii. <http://www.castlemetalsuk.com/blog/ferrous-nonferrous-metals-uses/>
- iii. http://web.iitd.ac.in/~suniljha/MEL120/L4_Heat_Treatment_of_Metals.pdf
- iv. <http://www.cmse.ed.ac.uk/MSE3/Topics/MSE3-ferrous1.pdf>
- v. <http://www.youtube.com/watch?v=98lh5Q0M0cg>
- vi. <http://www.youtube.com/watch?v=H9GrDMbwbdA>

10. COURSE CURRICULUM DEVELOPMENT COMMITTEE**Faculty Members from Polytechnics**

- **Prof. P.B.PATHAK, I/C HOD**, Dept of Fabrication Technology, Sir B.P.I., Bhavnagar
- **Prof. B.K.GANDHI**, Sr. Lecturer, Dept of Fabrication Technology, Sir B.P.I., Bhavnagar
- **Prof. S.Y.MERCHANT**, Sr. Lecturer, Dept of Fabrication Technology, Sir B.P.I., Bhavnagar

Coordinators and Faculty Members from NITTTR Bhopal

- **Dr. A.K. SARATHE**, Associate Professor, Department of Mechanical Engineering.
- **Dr. C.K.CHUGH**, Professor, Department of Mechanical Engineering.