GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Metallurgy
Subject Code: BE04021041
Subject Name: Ferrous Metal Production

w.e.f.Academic Year:	2024-25
Semester:	4
Category of the Course:	Professional Core Course

Prerequisite:	Nil
Rationale:	Ferrous Metal Products-Iron and Steel are the most important engineering materials used abundantly in wrought or cast form in variety of engineering applications day to day life. The aim of this course is to gain an understanding different types of Ferrous Metal Productions such as iron and steelmaking processes with merits & demerits in terms of quality & productivity, process parameters, underlying metallurgical principles of reactions, Practice of Melting-Treating-Refining technologies & quality control aspects such as- Blast Furnace Technology, Primary Steel Making, Ladle Metallurgy and Secondary Steel Making & Continuous Casting Process.

Course Outcomes:

After successful completion of the course students should be able to:

Sr. No.	CO statement	Marks % Weightage
CO-1	Understand the basic principles & physical and chemical processes during iron making and steel making processes.	30
CO-2	Describe the various developments in Iron Making and Steel making processes and technologies.	40
CO-3	Apply the knowledge on controlling the quality of ferrous metal production.	30

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/CA (I)	PBL (I)	ESE (V)	
45	0	30	15	90	3	70	30	20	30	50	200

Content:

Sr. No.	Content	Total Hours	% Weightage
1	**Principles of Iron Making and Steel Making**: Importance, Factors related to cost, Principles, Brief history of Iron and steel Making.	03	7
2	**Feasibility of reactions and chemical kinetics:** Thermodynamics and kinetics of different reactions in Iron and Steel Making, physical chemistry of slag-metal reactions.	04	10
3	**Iron making :** Iron making through blast furnace route, heat and material balance in blast furnace. Burden, Palletisation, Profile, Reactions and Operations, Developments-RAFT (Raceway Adiabatic Flame Temperature). Fuel injection. Oxygen injection. High top pressure. High temperature blast.	06	13
4	**Alternate route of Iron making:** Limitations of blast furnace route, other options for iron production Mini blast furnace –characteristics; difference with conventional iron blast furnace Electro – Thermal Smelting Process, Direct Reduced Iron (Sponge Iron) Technology , Smelting Reduction (SR) technology , Environmental considerations in Iron making Technology	06	13
5	**Basic Oxygen Steel Making :** BOF practice, Equipment, Operation and Process, Development in Conventional BOF, Oxygen Lance: Design, Construction and Operation. Top and Bottom Blown processes, Its advantages and disadvantages. Steel making primary processes - pneumatic and hearth.	06	13
6	**Electric Steel Making** Details of Electric Arc Furnaces, (AC & DC). Sequence of EAF Operations. Raw materials, Single & double Slag Practice, Slag Control. UHP Arc Furnaces, Arc Furnace practices for Carbon and Low Alloy Steels. Comparison between induction Furnaces & Electric Arc furnaces. Induction Melting furnace.	08	18
7	**Secondary Steel Making** Secondary Steel Making Processes, Ladle Furnaces (L.F.), Vacuum treatment of Steel. Gases in steel. LF-VD processes and AOD, VOD, VAD techniques, R-H degassers. Ladle Stirring and its Advantages. ASEA-SKF processes- Principle and Technology. Deoxidation –	08	18

	Theory and practice, Floatation's of products, Modifications of Inclusions. Injection Metallurgy, Quality in Steel Making, Ladle Injection Metallurgy, Desulphurization & Dephosphorization		
8	**Continuous Casting (C.C.) and Ingot Casting** Ingot Casting: Types of Moulds, Advantages and Disadvantages. Ingot Defects and Remedies. Continuous casting: C.C. machines with its various units and types.	04	8
	Total	**45**	**100**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**30**	**30**	**20**	**00**	**00**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's 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.

Reference Books:

1. A first course in iron and steel making, Dipak Mazumdar, Orient Blackswan Pvt. Ltd., (2015)
2. Ironmaking and steelmaking: Theory and Practice, Ghosh Ahindra, Chatterjee Amit, PhiLearning Private Limited, (2001)
3. Extractive Metallurgy 1: Basic Thermodynamics and Kinetics, Alain Vignes (ISTE Ltd.,)
4. Extractive Metallurgy 2: Metallurgical Reaction Processes, Alain Vignes (ISTE Ltd.,)
5. Extractive Metallurgy 3: Processing Operations and Routes, Alain Vignes (ISTE Ltd.,)
6. An introduction to modern steel making, R. H. Tupkary, Khanna Publishers (2000)
7. An introduction to modern iron making, R. H. Tupkary, Khanna Publishers (2004)

List of Experiments:

1. Calculate the amount of coke, iron ore, and flux needed per ton of hot metal.
2. Create a comparison chart on process flow, energy efficiency, capital cost, and environmental impact. (Comparison of Blast Furnace vs. Sponge Iron Technology)
3. Use an Ellingham diagram to determine which reducing agent is more suitable for iron oxide reduction.
4. Study how lance design and blowing patterns affect carbon removal and productivity.
5. Draw and compare process flows of BF-BOF, DRI-EAF, and SR technologies.
6. Calculate CaO/SiO_2 ratios and determine basicity for a given slag composition.

7. Prepare a short report comparing LF, VD, VOD, and RH degassing methods.
8. Calculate the amount of deoxidizers (Al, Si, Mn) required for a specific oxygen content in molten steel.
9. Discuss benefits and limitations of both casting processes-Continuous Casting vs. Ingot Casting based on defect rates, speed, and yield.
10. Chart Preparation of conventional and modern route of steel Making
11. Seminar presentation and Report Submission of a given topic based on Recent developments in Steel Making Technology.
12. To write Industrial visit / Expert Talk Report.

Major Equipment: This is an introductory subject to discipline so equipment's available in different subject laboratories of discipline will be used for demonstration.

List of Open Source Software/learning website:

1. https://nptel.ac.in/courses/113104059/
2. www.ocw.mit.edu

- **Activities suggested under Problem Based Learning:**

Sr.No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numericals based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Expert Lecture/session	Lecture 2 hr Report 1 hr	Report should contain observation and learning.

5.	Self learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.

13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.

Note:

1. All the suggested activity should be related to the subject.
2. The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.

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