

GUJARAT TECHNOLOGICAL UNIVERSITY

METALLURGY ENGINEERING (21)

STEEL MAKING

SUBJECT CODE: 2152108

B.E. 5th SEMESTER

Type of course: Engineering Science

Prerequisite: Knowledge of Iron Making

Rationale: Steels are the most important engineering materials used abundantly in wrought or cast form in variety of applications as material of Construction of components, fabrications, equipment of Power Sectors, Engineering Machine Components, Dairy equipment, Pharmaceutical Equipment, Constructions etc., apparently demanding different sets of Physical / Mechanical / Electrical & Magnetic Properties. However All variety of Steels are produced from iron, scrap and other ferrous materials but different properties are developed by using different Steel Production Technologies ,while adding alloying elements such as Manganese, Nickel, Chromium, and Vanadium etc.. These are purposefully added to produce different grades of steels. Students should understand the different types of steelmaking processes associated Merits & Demerits of Steel Produced in terms of Quality & Productivity, underlying metallurgical Principles of reactions, Practice of Melting-Treating-Refining technologies & Quality Control aspects in Steel making. The student explores the knowledge of the State-of-the art practices of steelmaking such as- Ladle Metallurgy, Secondary Metallurgy & Continuous Casting Process.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks		
L	T	P		Theory Marks			Practical Marks					
				ESE (E)	PA (M)		ESE (V)		PA (I)			
				PA		ALA	ESE	OEP				
4	1	0	5	70	20	10	30	0	20	150		

Content:

Sr. No.	Content	Total Hrs.	% Weightage
1	General Brief History of Steel Making, Integrated and Mini Steel Plants in India. Different Route of Steel making, from Bessemer Steel Making to present day Equipment and practices outline.	04	05
2	Physical Chemistry of Steel Making Thermodynamic and Kinetics of Refining Reactions, Carbon Reaction, Phosphorus Reaction, Sulphur Reaction, Silicon Reaction, Refining Slags and its Properties. Importance and Mechanism of Decarburization Reaction. Types of slags - Acid, Basic, Dry and Wet slags, Reaction at Slag Metal interface.	08	15
3	Basic Oxygen Steel Making BOF practice, Equipment, Operation and Process, Raw material and flux practices. Modifications and further Development in Conventional BOF, Oxygen Lance: Design, Construction and Operation. Top and Bottom Blown processes, Its advantages and disadvantages.	10	15
4	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.	08	15

	Arc Furnace practices for Carbon and Low Alloy Steels. Comparison between induction Furnaces & Electric Arc furnaces.		
5	Quality Steel Making Introduction, Sources of Inclusions, Sulphur, Phosphorus, and Gases In Steels, Development of Secondary Steel Making and its Importance Under Indian Conditions, Metallurgical Principles in Secondary Steel Making: Ladle Injection Metallurgy, Desulphurization & Dephosphorization.	08	10
6	Secondary Steel Making Secondary Steel Making Processes, Ladle Furnaces (L.F.), Vacuum Systems and 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 – Theory and practice, Floatation's of products, Modifications of Inclusions. Injection Metallurgy	10	15
7	Inclusions in Steel Influence of Inclusions on Mechanical Properties of Steel, Inclusion Identification and Cleanness Assessment, Origin of Non Metallic Inclusions, Inclusion Control	04	10
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. C.C. Of Blooms, Slabs and Thin slabs. Re-oxidation prevention methods during Steel Casting. Advantage of C.C. Environmental issues related to Steel Making, Heat Transfer & Solidification Rate in Ingot Casting and Continuous Casting, Distinguishing Metallurgical Aspects of Continuous Casting of Steel.	08	15

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	25	25	15	10	5

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:

- I. Iron Making and Steel Making: Theory and Practice By Ahindra Ghosh, Amit Chatterjee, PHI Learning Pvt. Ltd.
- II. An Introduction To Steel Making Tupkary R.H.- Khanna Publishers, Delhi
- III. Steel Making; Kudrin V. Mir Publisher, Moscow
- IV. Physical Chemistry of Metals (with a collection of problems), Darken and Gurry- McGraw Hill.
- V. Electrometallurgy of Steel & Ferro.Alloys Vol I & II:- E.P.Edneral, MIR Publ, Moscow
- VI. Making, Shaping and Treating of steel:- H.M.Gannon, USS Pub. Pittsburg.

Course Outcome:

After learning the course the students should be able to:

- Explain different route of steel making Processes.
- Differentiate between acid and basic steel making as well acid and basic Bessemer process

- Understand the Importance & Mechanisms of Reactions in Steel Making.
- Explain Basic Oxygen and electrical process with their merits and limitations
- Differentiate between Bessemer process, L.D. process, Kaldo process
- Explain secondary steel making Processes & its significance.
- Identify the inclusion types & Methods of Preventions.
- Understands the Merit & Demerits of Ingot Castings & Continuous castings
- Identify ingot defects and suggest remedies.

Design based Problems (DP)/Open Ended Problem:

1. Chart of different routes of Steel Making.
2. Problems based on Charge Calculations.
3. Chart of inclusions found in Steel ingots.
4. Chart of flow-sheet of Flat Products production.
5. Collection of defective ingots & their macroscopic analysis.
6. Group discussion and Presentations on recent scenario and advancement in Steel Making.
7. Any other problem decided by faculty based on syllabus.

List of Open Source Software/learning website:

Searching engine could be used to locate steel manufacturing related sites, such as:

- i. <http://www.industry.siemens.com/verticals/metals-industry/en/metals/steelmaking/ld-steelmaking/Pages/home.aspx>
- ii. http://www.carbonandgraphite.org/pdf/steel_production.pdf
- iii. <http://corporate.arcelormittal.com/who-we-are/from-ore-to-steel>
- iv. <http://www.topforge.co.uk/Processes.htm>
- v. <http://en.wikipedia.org/wiki/Steelmaking>
- vi. <http://www.steel.org>
- vii. http://www.steelconstruction.info/Steel_manufacture
- viii. <http://www.tatasteelindia.com/products-and-processes/processes/steel-making-process.asp>
- ix. <http://www.nptel.ac.in/syllabus/syllabus.php?subjectId=113104059>

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.