GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-IV

Course Title: Iron Making
(Course Code: 4342104)

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

1. RATIONALE

Iron is the base element of the ferrous materials group. Ferrous alloys are versatile materials having numerous applications in engineering field as well as day-to-day life. Iron making (i.e. ferrous extraction metallurgy) is a critical process for extraction of iron from its ore. Iron making can be processed by blast furnace route or alternative routes depending upon the quality of raw materials. Diploma metallurgy engineering students must be aware of the extraction process of iron from its ore by different routes. Student will be able to apply the knowledge of this course for production of iron through effective and sustainable operational practice.

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 the following competency:

- **Select a suitable iron making process for extraction of iron on the basis of the quality of raw materials.**

3. COURSE OUTCOMES (COs)

At the end of the study of this course the student will be able to:

CO1. Explain concept, history and modern iron making process.
CO2. Identify the raw materials and processing them for iron making process.
CO3. Explain the constructional features, reactions and products of blast furnace.
CO4. Describe operations of blast furnace and their irregularities.
CO5. Implement alternative methods of iron making on the basis of raw materials' qualities.
CO6. Select sustainable practice in the operation of iron making plant.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme	Total Credits	Examination Scheme

(In Hours)			(L+T+P/2)	Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	0	3	30*	70	--	--	100

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends:** **L**-Lecture; **T**–Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit; **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED TUTORIAL EXERCISES

NOT APPLICABLE

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

NOT APPLICABLE

7. AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned Cos. More could be added to fulfill the development of this course competency.

1. Work as a team member / a leader.
2. Follow ethical practices.
3. Practice environmentally friendly methods and processes.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of Revised Bloom's taxonomy that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Major Learning Outcomes	Topics and Sub-topics
UNIT – I Introduction of iron making	1.a. Discuss briefly about importance of ferrous extraction process 1.b. Identify importance of iron in engineering field 1.c. Explain history and modern ironmaking practice 1.d. Discuss products of ironmaking	1.1. Introduction of ferrous extractive metallurgy 1.2. Importance of iron as an engineering material 1.3. History of ancient Indian ironmaking 1.4. Modern ironmaking practices 1.5. Products of ironmaking: Wrought iron, and pig iron
UNIT-II Raw	2.a. Explain raw materials use for iron making process	2.1. Raw materials use for Iron making: a. Iron ore – types, Valuation of ore b. Metallurgical coke – functions,

Unit	Major Learning Outcomes	Topics and Sub-topics
materials of iron making	and their issues 2.b. Describe beneficiation of iron ore 2.c. Describe agglomeration processes 2.d. Discuss about testing method for agglomerates	properties c. Fluxes – importance and types d. Air 2.2. Issues of Indian's raw materials 2.3. Beneficiation of iron ore – Crushing, screening and magnetic separation 2.4. Agglomeration processes – Sintering, Pelletization, Briquetting, Nodulizing 2.5. Testing methods for agglomerates
UNIT – III Blast Furnace process	3.a. Describe about sections of blast furnace (BF) plant and construction and temperature zone of BF 3.b. Explain characteristics of charging materials and charging systems 3.c. Understand about reactions involved in BF and concept of TFT and RAFT 3.d. Discuss desulpurization, pig iron, slag and refractories used in BF 3.e. Summarize modern trends of BF practice	3.1. Plant layout and constructional features of blast furnace (BF) 3.2. Temperature profile of BF 3.3. Physical and chemical properties of charging (or burden) materials 3.4. Charging systems of BF – Two bell and Bell-less top 3.5. Reactions involved in each zone of BF; Direct and indirect reduction; Concept of Tuyere Flame Temperature (TFT) and Raceway Adiabatic Flame Temperature (RAFT) 3.6. Desulpurization of hot metal 3.7. Characteristics of pig iron and slag, Basicity and V ratio of slag 3.8. Refractories used in BF 3.9. Modern trends of BF practice
UNIT – IV Blast furnace auxiliaries and operations	4.a. Explain cleaning mechanism for BF gas in detail 4.b. Discuss briefly hot blast stoves 4.c. Describe operations of BF and irregularities	4.1. Cleaning of BF gas – Dust catcher, Primary and secondary cleaning system 4.2. Hot blast stoves 4.3. Operations of BF and irregularities in operations
UNIT – V Alternative methods of iron making	5.a. Discuss aspects of alternative methods of iron making 5.b. Explain raw materials, processes based on reducing agent and product of alternative methods 5.c. Describe Corex process	5.1. Alternative methods of Iron making - Needs, principle, advantages and limitations 5.2. Raw materials and their characteristics – iron ore, non- coking coal, natural gas, flux 5.3. Direct reduced iron or Sponge iron processes: Merits, demerits and types a. Coal based – Rotary kiln and Rotary hearth

Unit	Major Learning Outcomes	Topics and Sub-topics
	and mini-blast furnace	b. Gas based – Midrex and HyL 5.4. Characteristics and use of sponge iron 5.5. Corex process and Mini-blast furnace
UNIT – VI Sustainable development in iron making plant	6.a. Discuss importance and actions required for pollution control in plant 6.b. Describe energy conservation at various stage of processes	6.1. Pollution control – waste materials processing and utilization, CO_2 emission, etc. 6.2. Energy conservation practices in plant

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of theory marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to iron making	4	4	2	0	6
II	Raw materials of iron making	6	4	5	2	11
III	Blast furnace process	14	8	8	4	20
IV	Blast furnace auxiliaries and operations	6	5	4	2	11
V	Alternative methods of iron making	10	8	6	2	16
VI	Sustainable development in iron making plant	2	2	2	2	6
	Total	**42**	**31**	**27**	**12**	**70**

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

Notes:

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

b) Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related co-curricular activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group.

a) Visit nearby industry which is engaged in Iron Making (if any) and study the processes are being used.

b) Collect the production data of any iron making industry in India like which raw material used, which type of product they are producing etc.
c) Collect the various types of iron and steel object from your surroundings.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Sr. No.	Unit Title	Strategies
I	Introduction to iron making	Real life examples. Demonstration of real systems. Movies/Animations. Numerical.
II	Raw materials of iron making	
III	Blast furnace process	
IV	Blast furnace auxiliaries and operations	
V	Alternative methods of iron making	
VI	Sustainable development in iron making plant	

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project is group-based. However, in the fifth and sixth semesters, it should be preferably be individually undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should not exceed three.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain a dated work diary consisting of individual contributions in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than 16 (sixteen) student engagement hours during the course. The student ought to submit a micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a. Prepare chart for extraction processes of iron making.
b. Make a demonstrative model of blast furnace.
c. Make a demonstrative model of rotary kiln.
d. Prepare flow sheet of different mineral dressing processes used for iron-ore.
e. Prepare a report on integrated iron and steel plants in India.
f. Prepare a report on iron ore mines in India.
g. Study on sustainable development in iron making processes.
h. Prepare a brief report on production of iron for last five years.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author / Editor	Publication with place, year and ISBN
1	Basic concepts of Iron and Steel Making	S. K. Dutta and Y. B. Chokshi	Springer, Singapore, 2020 (ISBN: 978-981-15-2436-3)
2	Ironmaking and Steelmaking – Theory and Practice	A. Ghosh and A. Chatterjee	PHI Learning, New Delhi, 2011 (ISBN: 978-81-203-3289-8)
3	Alternate methods of Ironmaking	S. K. Dutta and R. Sah	S. Chand, New Delhi, 2012 (ISBN: 81-219-4058-3)
4	An Introduction to Modern Iron Making	R. H. Tupkary	Khanna Pub., New Delhi, 2004 (ISBN: 978-81-740-9021-8)
5	Fuels, Furnaces and Refractories	R. C. Gupta	PHI Learning, New Delhi, 2016 (ISBN: 978-81-203-5157-8)

14. SOFTWARE/LEARNING WEBSITES

- https://youtu.be/ysLqUDa5GEA
- https://www.youtube.com/watch?v=7foK-wVNSMw
- https://www.youtube.com/watch?v=k6vut9m-5xU
- https://www.youtube.com/watch?v=BivYeUZao6c
- https://youtu.be/LM4VOW6xZ5Y
- https://www.youtube.com/watch?v=jc-9F5Vc9eA
- https://youtu.be/EcPpoWNklz8
- https://youtu.be/xAVCY0WE8uM

15. PO-COMPETENCY-CO MAPPING

Semester IV	Iron Making [Course Code: 4342104]						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design / development of solutions	PO 4 Engineering tools, Experimentation & Testing	PO 5 Engineering practices for society, Sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	Select a suitable iron making process for extraction of iron on the basis of the quality of raw materials.						

Course Outcome: **CO1**: Explain concept, history and modern iron making process	3	-	-	-	-	-	-
CO2: Identify the raw materials and processing them for iron making process	3	1	1	2	-	1	-
CO3: Explain the constructional features, reactions and products of blast furnace	3	2	2	1	-	1	1
CO4: Describe operations of blast furnace and their irregularities	3	2	2	-	2	1	1
CO5: Implement alternative methods of iron making on the basis of raw materials' qualities	3	2	2	-	1	1	1
CO6: Select sustainable practice in the operation of iron making plant	3	-	2	-	3	-	1

*Legend: '**3'** for high, '**2**' for medium, **'1'** for low or **'-'** for the relevant correlation of each competency, CO, with PO/ PSO*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons:

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