NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF GEOLOGICAL, MINING AND METALLURGICAL ENGINEERING

METALLURGICAL ENGINEERING PROGRAM

ME522 - IRON AND STEEL INDUSTRIAL PROCESSES

I. GENERAL INFORMATION

CODE	**:**	ME-522 Iron and Steel Industrial Processes
SEMESTER	**:**	9
CREDITS	**:**	4
HOURS PER WEEK	**:**	6 (Theory–Practice–Laboratory)
PREREQUISITES	**:**	ME-424 Ceramics
CONDITION	**:**	Compulsory
DEPARTMENT	**:**	Transformation Metallurgy

II. COURSE DESCRIPTION

The course consists of knowing the thermodynamic concepts of reduction of oxidized iron ores in the blast furnace as well as the Corex and Hismeslt process. Besides, the transformation of pig iron in steel by converters; as well as the manufacturing process of steel in electric arc furnaces. The liquid steel is processed in the continuous casting machine to obtain billets and slabs for further processing in non-planar lamination for bars or flat rolling to obtain steel sheets.

III. COURSE OUTCOMES

1. Apply the concepts of Physical Chemistry and Thermodynamics in reducing iron ore in the blast furnace and direct reduction.
2. Analyzes the transformation of iron ore into steel using the blast furnace and converters.
3. Define and analyze the transformation of iron ore and scrap metal into liquid steel using electric arc furnace.
4. Use the equations of Thermodynamics and Stoichiometry for mass balances and energy balance.
5. Explain the Thermodynamics of the reduction of iron oxide ores in the blast furnace and the processing of pig iron into steel.
6. Understands and applies knowledge of reduction of the iron oxide ores.
7. Interpret the processes of transformation of steel by rolling flat and not flat products.
8. Build mathematical models of steelmaking processes.

IV. LEARNING UNITS

1. IRON ORE AND BLAST FURNACE / 7 hours

Course Overview / Iron ore and coke / Blast furnace design, thermodynamics of iron ore reduction, Rist equations and the obtaining of pig iron / Mass balance and energy problems / Corex and Hismelt furnaces.

2. CONVERTERS / 7 hours

Types of converters / Transformation of pig iron into steel / The obtaining of stainless steel using converters / Mass balance / Converters of combined blow.

3. DIRECT REDUCTION AND ELECTRIC ARC FURNACE / 7 hours

Midrex, HyL and SL/N processes for obtaining sponge iron / Reduction reactions / Types

of electric arc furnaces / Steelmaking using iron, sponge and scrap iron / Mass balance / DC electric furnaces.

4. SECONDARY METALLURGY / 7 hours

Calculation of gases in steel / VOD and RH vacuum processes / Vacuum degassing processes.

5. CONTINUOUS CASTING / 7 hours

Concept of heat transfer / Types of molds / Continuous casting machine / Calculation of heat transfer from liquid steel - cooling water / Types of billets and slabs.

6. ROLLING - NEW STEEL CASTING PROCESSES / 7 hours

Calculating the rolling pressure by Von Karman and Ekelund / Parts of a laminator. Lamination of not flats and calculations / Lamination of flats and calculations / CSP processes / Pickling and cold rolling / Galvanizing and tin processes / Manufacture of seamless tubes and welded tubes / Electric induction furnaces / Electric arc furnace on vacuum / Electron-beam process, ESR / Plasma furnaces / Applications.

V. LABORATORY AND PRACTICAL EXPERIENCES

Lab 1: Balance of matter and energy in the blast furnace.

Lab 2: Balance of matter and energy in the electric arc furnace.

Lab 3: Balance of matter and energy in converters.

Lab 4: Calculation of power in rolling steel sheets.

VI. METHODOLOGY

Active methodology is used during the lessons. Besides the classic lecture, exposure techniques of the topics in each class with active participation of students are used. The solution of problems proposed are developed by the students during the classes. Videos are presented in the classroom and technical visits are made to reinforce the theoretical concepts taught in class. Targeted and qualified practices are performed in the hours of practice.

VII. EVALUATION FORMULA

The Average Grade PF is calculated as follow:

PF = (EP + EF + PP) / 3

EP: Mid-Term Exam
EF: Final Exam
PP: Average of practices

VIII. BIBLIOGRAPHY

1. **ALEXEIEV, V.N.**
   Qualitative Analysis of Metallurgical Transformations. Edit. MIR Moscow.
2. **BUMBLAY, RAY U.**
   Qualitative Analysis of Metals. CECSA – Mexico

IX. COURSE CONTRIBUTIONS TO STUDENT OUTCOMES ATTAINMENT

Course contributions to Student Outcomes are shown in the following table:

Level 1: Know
Level 2: Comprehend, calculate
Level 3: Model, apply, solve
Level 4: Apply at advanced level, design. Achievement of Student Outcome

Outcome	Contribution
1. Engineering Design Design and integrate metallurgical systems and components satisfying requirements and needs as well as given technical, economic, social and legal constraints and limitations.	4
2. Problem solving Identify, formulate and solve engineering problems properly using the methods, techniques and tools of metallurgical engineering.	4
3. Sciences Application Apply the knowledge and skills of mathematics, sciences and engineering to solve metallurgical engineering problems.	4
4. Experimentation and Testing Conceive and conduct experiments and tests, analyze data and interpret results.	4
5. Modern Engineering Practice Use and apply techniques, methods and tools of modern engineering necessary for the practice of metallurgical engineering.	4
6. Engineering Impact Understand the impact of metallurgical engineering solutions on people and society in local and global contexts.	4
7. Project Management Determine the budgets, schedules and feasibility of engineering projects, and participate in its management for the attainment of goals.	3
8. Environmental Appraisal Take into account the importance of preserving and improving the environment in the development of their personal and professional activities.	4
9. Lifelong Learning Recognize the need to keep their knowledge and skills up-to-date according to advances of metallurgical engineering and engage in lifelong learning.	3
10. Contemporary Issues Know and analyze relevant contemporary issues in local, national and global contexts.	4
11. Ethics and Professional Responsibility Evaluate their decisions and actions from a moral perspective and assume responsibility for the executed projects.	3
12. Communication Communicate clearly and effectively in oral, written and graphical formats, interacting with different types of audiences.	4
13. Teamworking Appraise the importance of teamworking and participate actively and effectively in multidisciplinary teams.	4