KIT For Engineering Innovation	**KIT for Engineering Innovation Training Programs**	**Address**: 24 Al-gahez steet-Al Hay as Sabea-Nasr City-Cairo-Egypt] **Website**: www.kitegy.com **Phone**: 01012000780 – 01012000760

Course Title:	Metallurgy for the Non-Metallurgist
Category:	METALLURGY & MATERIALS ENGINEERING
Course Code:	KIT-603
Duration:	5 days
Certificate:	Attendance Certificate

About the Course

This course provides this important knowledge to those who are not metallurgists. You will gain an understanding of what metals are, how they behave, and why they behave differently than ceramics, glass, and plastics. You will also learn how metals can be made stronger or more corrosion resistant, how they can be shaped by casting, forging, forming, machining, or welding, and how these processes can alter properties.

- Presents a brief history of metals, providing insight into the discovery and use of pure metals and alloys thousands of years before the modern era
- Provides an explanation of the unique physical characteristics of metals, including the reasons that metals behave differently than such non-metals as plastics, glass, wood, etc.
- Explains the basis for the selection of different metals for specific engineering applications.
- Describes how metals are alloyed to achieve desired properties.
- Provides details on one of the most important of all alloys -- steel – and discusses how steel is heat-treated to achieve various combinations of strength and ductility.
- Explains how metals are formed into the components that are used in our most important engineered machines and structures.
- Describes how metals are tested to determine critical properties, such as strength, ductility and toughness.
- Discusses why metals corrode, why different metals behave differently in corrosive environments, and how the corrosion of metals can be controlled.

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Course Objectives

Desired skills obtained, upon course completion include:

- Describe how and why metals behave and form,
- Recognize how metals can be strengthened by alloying, cold-working, and heat treatment,
- Determine why metals and alloys are not behaving as expected and can be made to behave as needed and
- Select the specific metal/alloy to use for explicit combinations of properties.

WHAT YOU'LL LEARN

- How metals are recovered from nature and processed into usable forms
- The characteristics of different metal alloy systems
- A basic understanding of phase diagrams
- Factors that affect selection of the proper material
- Mechanical properties and various testing methods
- How the properties of metals can be altered through heat treatment
- Introduction to mechanisms of corrosion and comparative corrosive potential

Course Outline:

1. **Metals: A History:** History of the discovery of the major commercially important metals; the first primitive refining techniques; brief descriptions of cultural significance of metals.
2. **Extractive Metallurgy:** Techniques used to win metals from mineral ores, including hydrometallurgical, pyrometallurgical, and electrometallurgical techniques.
3. **Solidification of Metals:** Introduction to the science of metallurgy, including crystal structure; concepts of solidification and solid solubility; basic binary phase diagrams.
4. **Metal Forming:** Forging, rolling, extrusion, swaging, and other techniques employed to form metals at elevated temperatures; rolling, stamping, coining, spinning, and other techniques used to form metals at ambient temperatures.

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5. **Mechanical Properties and Their Measurement:** Definitions of mechanical properties and explanations of testing procedures; introduction to concepts of standardization and quality control.
6. **Steels and Cast Irons: Applications and Metallurgy:** Description of the allotropic nature of iron and its effect on the properties of steels and cast irons; listing of selected applications of steels and cast irons.
7. **Heat Treatment of Steel:** Hardness and hardenability of steel; specific processes and their applications; heat treating procedures, equipment, quenchants, and hardness measurements.
8. **Case Hardening of Steel:** Techniques used to harden the case of a metal, including carburizing, nitriding, carbonitriding; procedure for measuring case depth.
9. **Strengthening Mechanisms:** Techniques used to harden the nonferrous metals, including age hardening, strain hardening and related metallurgical concepts for aluminum, titanium, copper, and other nonferrous metals.
10. **Nonferrous Metals: Industrial Applications and Properties:** Light metals, aluminum, beryllium, magnesium, and titanium; copper and its alloys; lead, tin, and zinc; precious metals.
11. **Joining:** Techniques of welding, brazing, and soldering, including descriptions of specific applications of each process described.
12. **Corrosion and Corrosion Prevention:** Causes of corrosion and the environmental factors which contribute to it; types of corrosion are discussed, together with techniques for minimizing it.
13. **Quality Control and Failure Analysis:** Procedures for predicting and/or evaluating the performance of metals in service.
14. **Materials Characterization and the Selection Process:** Explanation of the designation systems for classes of metals and alloys in worldwide use today; descriptions of factors which affect the selection of a material for a particular application; brief comparison of polymers and ceramics related to metals; case studies of material selection problems.

WHO SHOULD ENROLL?

This is an ideal first course for anyone who needs a working understanding of metals and their applications. It has been designed for those with no previous training in metallurgy, such as technical, laboratory, and sales personnel; engineers from other disciplines; management and administrative staff; and non-technical support staff such as purchasing and receiving agents who order and inspect incoming material.

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LEARNING OBJECTIVES

Upon the completion of this course, you should be able to:

- Understand how metals are made stronger, more corrosion resistant, and how they are shaped
- Recognize how metals can achieve greater strength and more corrosion resistance through alloying, cold-working, and heat treatment
- Assess practical information on how metals can be shaped by casting, forging, forming, machining, or welding, and how these processes can alter metal's properties.

Training Methodology

Throughout this course, the attendees will have the opportunity to practice their skills through a variety of hands-on exercises. These exercises focus on the skills introduced in each lesson. The following are our tools for course conduction:

- Pre-Assessment Questionnaire for use before the Course
- Post-Assessment Questionnaire for use after the Course
- Lectures, Demonstrations, Group Exercises & Case Studies
- Visual aid (Video Simulation) to increase the efficiency of the information
- Evaluation Questionnaires (Course, Instructor, & Administration) filled by Attendees
- Evaluation Questionnaires for Attendees filled by Instructor

Course Content

DAY ONE - Testing and Mechanical Properties of Metals

- Tensile tests
- Impact tests
- Hardness tests
- Compression of mechanical properties
- The Crystalline Structure of Metals
- Bonding in metals
- Solidification crystal growth and structures of metals
- Defects in metals during solidification

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DAY TWO- Specimen Preparation and Microscopic Examination

- The preparation (Mounting Grinding, Polishing and Etching) of metal specimens
- Metallurgical and Electron Microscopes
- Dislocations and Strengthening Mechanisms in Metals
- Edge Dislocation (line imperfections) in crystals
- Strengthening of metals by Grain Size Reduction, Solid Solution and Strain Hardening
- Softening of metals by annealing
- Comparison of Cold and Hot working of Metals

DAY THREE - Binary Equilibrium Diagrams

- Solubility and cooling curves
- Thermal Equilibrium Diagrams (Eutectic Type, Solid Solution Type and Combination Type)
- Ferrous Alloys
- Definitions and classifications and some uses of ferrous alloys including;
- Carbon steels
- Alloy steels
- Stainless steels
- Cast irons
- Fabrication of Metals
- A selection of metal fabrication methods, including;
- Forming
- Casting
- Welding

DAY FOUR- Heat Treatment of Plain Carbon Steel

- Hardening of carbon steel (by quenching)
- Annealing
- Normalising

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- Tempering
- Austempering
- Surface treatments
- Heat affected zone (HAZ) in welding
- Non-Ferrous Alloys
- Nickel and cobalt
- Titanium alloys

DAY FIVE- Corrosion in Metals

- The electrochemical cell
- Types of electrochemical corrosion
- Pitting
- Crevice
- Stress corrosion
- Hydrogen induced, etc. Protection against Electrochemical Corrosion and Inspection
- Coatings
- Internal
- External
- Polymers
- Galvanizing, etc.
- Inhibitors, Types and usage
- Cathodic protection, Impressed current, Sacrificial
- Inspection
- Standards

Course Summary & Conclusion

References:

1- Metallurgy for the Non-Metallurgist by ***Harry Chandler***
2- Materials Science Engineering Introduction by ***Callister***
3- Physical Metallurgy: Principles and Practice by ***Raghavan***