COURSE OVERVIEW FE0355
Steel Metallurgy

Course Title
Steel Metallurgy

Course Reference
FE0355

Course Duration/Credits
Five days/3.0 CEUs/30 PDHs

Course Date/Venu

Session(s)	Date	Venue
1	February 08-12, 2026	Crowne Meeting Room, Crowne Plaza Al Khobar, KSA
2	April 26-30, 2026	Tamra Meeting Room, Al Bandar Rotana Creek, Dubai, UAE
3	Julu 26-30, 2026	Meeting Plus 9, City Centre Rotana, Doha Qatar

Course Description

This practical and highly-interactive course includes real-life case studies and exercises where participants will be engaged in a series of interactive small groups and class workshops.

This course is designed to provide participants with a detailed and up-to-date overview of physical metallurgy of steel. It covers the basic chemistry, classification of materials including steel making, iron making, oxygen steel making, electrical steel making and secondary steel making; the atomic binding, lattice, basis, unit cells, crystal structures, miller indices, interstitial sites, X-Ray diffraction, FCC and BCC steels; the imperfections in the atomic arrangements, point defects, dislocations and significance of dislocations; the shmid's law including influence of crystal structure, surface and volume defects; the diffusion in metals, mechanisms for diffusion, rate of diffusion and the factors affecting diffusion; the composition profile, diffusion and materials processing and emphasize on carburizing and nitriding steel; the mechanical properties, the tensile test, properties obtained from tensile test, true stress and true strain as well as the hardness of steels and the strain rate effects and impact behaviour, creep and stress rupture, strain hardening mechanisms and properties versus cold work

Further, the course will also discuss the microstructures and crystallographic textures, deformation textures in steels and recrystallization texture in steels, the three stages of annealing and control of annealing in steels; the scanning electron microscopy (SEM), transmission electron microscopy (TEM), optical microscopy, quantitative microscopy and electrical resistivity; the principles of solidification, nucleation and growth mechanisms, cooling curves, cast structures, solidification defects and casting processes for manufacturing components; the ingot castings, jointing of steels, phases and phase diagram, the eutectic phase diagram and the non equilibrium freezing in the eutectic system; the eutectoid reaction, controlling the eutectoid reaction, the martensitic reaction and tempering as well as designation and classification of steels; the simple heat treatments, isothermal heat treatments, quench and temper heat treatments as well as the effect of alloying elements; the application of harden ability, speciality steels, surface treatments, weld ability of steel, stainless steels and cast iron and the corrosion in steels, chemical corrosion, electrochemical corrosion, the electrode potential in electrochemical cells, the corrosion current and polarization.

During this interactive course, participants will learn the types of electrochemical corrosion, protection against electrochemical corrosion as well as oxidation and other gas reactions; the technology of bar, rod and section rolling, mills for long products, types and capabilities of road mills; the design considerations for long products mills and endless rolling including the defects, strength, microstructures, reheating behaviour of steels and temperature modelling; the significance of product quality and applications of solid heat transfer, hot and warm rolling steel as well as the process option in steel, skin pass, temper rolling, reheating furnace, gauge and shape control, stainless steel, finite element modelling, aluminium rolling, coated strip products, crystallographic texture and cold roll strip surface quality; the fatigues design methods and list the characteristics of macro/micro aspects of fatigue in steels, the strain and stress life approach and explain the linear elastic fracture mechanics and fatigue crack growth including the worked example on fatigue in steel and the fracture mechanism applied to steels including the elements of fracture mechanics, transition temperature and fracture toughness

Course Objectives

Upon the successful completion of this course, each participant will be able to:-

- Apply and gain an in-depth knowledge on steel metallurgy
- Discuss the basic chemistry, classification of materials including steel making, iron making, oxygen steel making, electrical steel making and secondary steel making
- Explain atomic binding, lattice, basis, unit cells, crystal structures, miller indices, interstitial sites, X-Ray diffraction, FCC and BCC steels
- Identify imperfections in the atomic arrangements, point defects, dislocations and significance of dislocations
- Analyze shmid's law including influence of crystal structure, surface and volume defects
- Review diffusion in metals, mechanisms for diffusion, rate of diffusion and the factors affecting diffusion

- Explain composition profile, diffusion and materials processing and emphasize on carburizing and nitriding steel
- Illustrate mechanical properties, the tensile test, properties obtained from tensile test, true stress and true strain as well as the hardness of steels
- Discuss strain rate effects and impact behaviour, creep and stress rupture, strain hardening mechanisms and properties vs cold work
- Explain microstructures and crystallographic textures, deformation textures in steels and recrystallization texture in steels, the three stages of annealing and control of annealing in steels
- Recognize scanning electron microscopy (SEM), transmission electron microscopy (TEM), optical microscopy, quantitative microscopy and electrical resistivity
- Discuss principles of solidification, nucleation and growth mechanisms, cooling curves, cast structures, solidification defects and casting processes for manufacturing components
- Analyze ingot castings, jointing of steels, phases and phase diagram, the eutectic phase diagram and the non equilibrium freezing in the eutectic system
- Illustrate the eutectoid reaction, controlling the eutectoid reaction, the martensitic reaction and tempering as well as designation and classification of steels
- Discuss the simple heat treatments, isothermal heat treatments, quench and temper heat treatments as well as the effect of alloying elements
- Describe the application of harden ability, speciality steels, surface treatments, weld ability of steel, stainless steels and cast iron
- Determine corrosion in steels, chemical corrosion, electrochemical corrosion, the electrode potential in electrochemical cells, the corrosion current and polarization
- Identify the types of electrochemical corrosion, protection against electrochemical corrosion as well as oxidation and other gas reactions
- Demonstrate the technology of bar, rod and section rolling, mills for long products, types and capabilities of road mills
- Recognize the design considerations for long products mills and endless rolling including the defects, strength, microstructures, reheating behaviour of steels and temperature modelling
- Determine the significance of product quality and applications of solid heat transfer, hot and warm rolling steel as well as the process option in steel, skin pass, temper rolling, reheating furnace, gauge and shape control, stainless steel, finite element modelling, aluminium rolling, coated strip products, crystallographic texture and cold roll strip surface quality
- Formulate fatigues design methods and list the characteristics of macro/micro aspects of fatigue in steels, the strain and stress life approach and explain the linear elastic fracture mechanics and fatigue crack growth including the worked example on fatigue in steel
- Analyze fracture mechanism applied to steels including the elements of fracture mechanics, transition temperature and fracture toughness

Exclusive Smart Training Kit - H-STK®

*Participants of this course will receive the exclusive "Haward Smart Training Kit" (**H-STK®**). The **H-STK®** consists of a comprehensive set of technical content which includes **electronic version** of the course materials conveniently saved in a **Tablet PC**.*

Who Should Attend

This course provides an overview of all significant aspects and considerations of steel metallurgy for non-metallurgist engineers and those who need a working understanding of metals and their applications. It has been designed for those with no previous training in metallurgy including technical, laboratory personnel as well as engineers from other disciplines, management and administrative staff and non-technical support staff consisting of purchasing and receiving agents who order and inspect incoming material.

Training Methodology

All our Courses are including **Hands-on Practical Sessions** using equipment, State-of-the-Art Simulators, Drawings, Case Studies, Videos and Exercises. The courses include the following training methodologies as a percentage of the total tuition hours:-

30% Lectures
20% Practical Workshops & Work Presentations
30% Hands-on Practical Exercises & Case Studies
20% Simulators (Hardware & Software) & Videos

In an unlikely event, the course instructor may modify the above training methodology before or during the course for technical reasons.

Course Fee

Al Khobar	**US$ 5,500** per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.
Dubai	**US$ 5,500** per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.
Doha	**US$ 6,000** per Delegate. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

Accommodation

Accommodation is not included in the course fees. However, any accommodation required can be arranged at the time of booking.

Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course who completed a minimum of 80% of the total tuition hours.

Certificate Accreditations

Haward's certificates are accredited by the following international accreditation organizations:

- British Accreditation Council (BAC)

  Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. Haward's certificates are internationally recognized and accredited by the British Accreditation Council (BAC). BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

- The International Accreditors for Continuing Education and Training (IACET - USA)

  Haward Technology is an Authorized Training Provider by the International Accreditors for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 2018-1 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 2018-1 Standard**.

  Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units** (CEUs) in accordance with the rules & regulations of the International Accreditors for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

  Haward Technology Middle East will award **3.0 CEUs** (Continuing Education Units) or **30 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

Course Instructor(s)

This course will be conducted by the following instructor(s). However, we have the right to change the course instructor(s) prior to the course date and inform participants accordingly:

Mr. Steve Magalios, CEng, PGDip (on-going), MSc, BSc, is a **Senior Mechanical & Maintenance Engineer** with almost **40 years** of extensive **On-shore/Offshore** experience in the **Oil & Gas**, **Construction**, **Refinery** and **Petrochemical** industries. His expertise widely covers in the areas of **Material Science & Selection**, **Composite Repair Materials**, **Material Selection & Properties**, **Material & Inspection Foundation**, **Refractory Material Design, Application**, **Installation & Inspection**, **Preventive & Predictive** Maintenance, **Reliability Centered** Maintenance, **Applied Maintenance** Management, **Reliability** Modelling, **Reliability** Techniques, **Reliability Design** Techniques, Advanced **Root Causes** Analysis & Techniques, **Reliability** Management, **Pipeline Hot Tapping**, **Hot Tapping** Equipment, **Hot Tapping Operation**, **Boiler** Inspection & Maintenance, **Boiler** Systems, **Boiler** instrumentation & Controls, **Boiler** Start-up & Shutdown, **Boiler** Operation & Steam System Management, **Pipe Cuttings**, **Flange Bolt Tightening** Sequence, **Hydro Testing**, **Pump** Technology, Fundamentals of **Pumps**, **Pump** Selection & Installation, **Centrifugal Pumps & Troubleshooting**, **Reciprocating & Centrifugal Compressors**, **Screw Compressor**, **Compressor** Control & Protection, **Gas & Steam Turbines**, **Turbine** Operations, **Gas Turbine** Technology, **Valves**, **Process Control Valves**, **API 598: Valve Inspection and Testing**, **Bearings & Lubrication**, Advanced **Machinery Dynamics**, **Rubber Compounding**, **Elastomers**, **Thermoplastic**, **Industrial Rubber Products**, **Rubber** Manufacturing Systems, **Heat Transfer**, **Vulcanization Methods**, **Welding** Engineering, **Fabrication** & Inspection, **Welding** Techniques, Practical **Welding** Technology, **Welding** Inspection, **Welding & Machine Shop**, **Welding & Machining**, **Welding** Types & Applications, **Welding** Safety, **Welding** Defects Analysis, **TIG & Arc Welding**, **Shielded Metal Arc Welding**, **Gas Tungsten & Gas Metal Arc Welding**, **Welding** Procedure Specifications & Qualifications (WPS & WPQ), **Aluminium Welding**, Safe **Welding**, International **Welding Codes**, **Welding Procedure** Specifications, **Welding & Brazing**, **Welder** Performance Qualification, **Pipeline** Operation & Maintenance, **Pipeline** Systems, **Pipeline** Design & Construction, **Pipeline** Repair Methods, **Pipeline** Engineering, Pipeline Integrity Management System (**PIMS**). Currently, he is the **Chartered Professional Surveyor Engineer & Urban-Regional Planner** wherein he is deeply involved in providing exact data, measurements and determining properly boundaries. He is also responsible in preparing and maintaining sketches, maps, reports and legal description of surveys.

During his career, Mr. Magalios has gained his expertise and thorough practical experience through challenging positions such as a **Project Site Construction Manager**, **Supervision Head/Construction Manager**, **Construction Site Manager**, **Project Manager**, **Deputy PMS Manager**, **Head of the Public Project Inspection Field Team**, **Technical Consultant**, **Senior Consultant**, **Consultant/Lecturer**, **Construction Team Leader**, **Lead Pipeline Engineer**, **Project Construction Lead Supervising Engineer**, **Lead Site Engineer**, **Senior Site Engineer Lead Engineer**, **Senior Site Engineer**, **Mechanical Engineer**, **R.O.W. Coordinator**, **Site Representative**, **Supervision Head**, **Contractor**, Client Site Representative and Acting Client Site Representative for international Companies such as the Public Gas Corporation, Penspen International Limited, Eptista Servicios de Ingeneria S.I., J/V ILF Pantec TH. Papaioannou & Co. – Emenergy Engineering, J/V Karaylannis S.A. – Intracom Constructions S.A., Ergaz Ltd., Alkyonis 7, Palaeo Faliro, Piraeus, Elpet Valkaniki S.A., Asprofos S.A., J/V Depa S.A. just to name a few.

Mr. Magalios is a **Registered Chartered Engineer** and has **Master** and **Bachelor** degrees in **Surveying Engineering** from the **University of New Brunswick**, **Canada** and the **National Technical University of Athens**, **Greece**, respectively. Further, he is currently enrolled for **Post-graduate** in **Quality Assurance** from the **Hellenic Open University**, **Greece**. He has further obtained a Level 4B Certificates in Project Management from the National & Kapodistrian University of Athens, Greece and Environmental Auditing from the Environmental Auditors Registration Association (EARA). Moreover, he is a **Certified Instructor/Trainer**, a **Chartered Engineer** of Technical Chamber of Greece and has delivered numerous trainings, workshops, seminars, courses and conferences internationally.

Course Program

The following program is planned for this course. However, the course instructor(s) may modify this program before or during the course for technical reasons with no prior notice to participants. Nevertheless, the course objectives will always be met:

Week 1:

Day 1	*Basic Chemistry, Classification of Materials • The Electronic Structure of the Atom • The Periodic Table*
Day 2	*Introduction to Steel • Making and Historical Background • Iron Making in the Blast Furnace*
Day 3	*Basic Oxygen Steel Making • Electrical Steel Making • Secondary Steel Making*
Day 4	*Atomic Binding • Lattice • Basis • Unit Cells • Crystal Structures, Allotropic or Polymorphic Transformations*
Day 5	*Points, Directions and Planes in the Unit Cell • Miller Indicees • Interstitial Sites • X- Ray Diffraction • Identification of FCC and BCC Steels*

Week 2:

Day 1	*Imperfections in the Atomic Arrangements • Point Defects • Dislocations*
Day 2	*Significance of Dislocations • Shmid's Law • Influence of Crystal Structure*
Day 3	*Surface Defects • Volume Defects • Diffusion in Metals and more specifically in Steels*
Day 4	*Mechanisms for Diffusion • Rate of Diffusion (Fick's First Law) • Factors Affecting Diffusion*
Day 5	*Composition Profile (Fick's Second Law) • Diffusion and Materials Processing • Emphasis on Carburizing and Nitriding Steel*

Week 3:

Day 1	*Mechanical Properties • The Tensile Test*
Day 2	*Properties Obtained from the Tensile Test • True Stress and True Strain*
Day 3	*Hardness of Steels • Strain Rate Effects and Impact Behavior*
Day 4	*Creep and Stress Rupture with examples relating to Steels • Strain Hardening and Annealing • Cold Work and the Stress Strain Curve*
Day 5	*Strain Hardening Mechanisms • Properties vs. Cold Work*

Week 4:

Day 1	*Microstructures and Crystallographic Textures*
Day 2	*Deformation Textures in Steels and Recrystallization Textures in Steels, The Three Stages of Annealing*
Day 3	*Control of Annealing in Steels • Scanning Electron Microscopy (SEM)*
Day 4	*Transmission Electron Microscopy (TEM) • Optical Microscopy*
Day 5	*Quantitative Microscopy, Electrical Resistivity*

Week 5:

Day 1	Principles of Solidification • Nucleation and Growth Mechanisms
Day 2	Cooling Curves, Cast Structures • Solidification Defects
Day 3	Casting Processes for Manufacturing Components • Continuous Casting • Ingot Castings
Day 4	Joining of Steels • Phases and Phase Diagram
Day 5	The Eutectic Phase Diagram • Nonequilibrium Freezing in the Eutectic System

Week 6:

Day 1	The Eutectoid Reaction • Controlling the Eutectoid Reaction • The Martensitic Reaction and Tempering
Day 2	Designation and Classification of Steels • Heat Treatment of Steels • Simple Heat Treatments
Day 3	Designations and Classification of Steels • Simple Heat Treatments • Isothermal Heat Treatments • Quench and Temper Heat Treatments
Day 4	Effect of Alloying Elements • Application of Hardenability • Specialty Steels • Surface Treatments
Day 5	Weldability of Steel • Stainless Steels • Cast Iron

Week 7:

Day 1	Corrosion in Steels • Chemical Corrosion
Day 2	Electrochemical Corrosion
Day 3	The Electrode Potential in Electrochemical Cells
Day 4	The Corrosion Current and Polarization • Types of Electrochemical Corrosion
Day 5	Protection against Electrochemical Corrosion • Oxidation and Other Gas Reactions

Week 8:

Day 1	The Technology of Bar, Rod & Section Rolling – Engineering • Considerations in Rolling Mills • Mills for Long Products • Rod Mills – Types and Capabilities • Long Products Rolling
Day 2	Design considerations for Long Products Mills & Endless Rolling • Defects in Long Products • Strength and Microstructures • Reheating Behavior of Steels
Day 3	Temperature Modeling for Rod & Bar Rolling • Roll Pass the Technology of Bar, Rod & Section Rolling – Engineering • Considerations in Rolling Mills, Mills for Long Products • Rod Mills – Types and Capabilities
Day 4	Long Products Rolling • Design considerations for Long Products Mills & Endless Rolling • Defects in Long Products • Strength and Microstructures • Reheating Behavior of Steels
Day 5	Temperature Modeling for Rod & Bar Rolling • Roll Pass Design Fundamentals and Applications • Roll Cooling & Lubrication • NDT of Rolled Bar • Customer Requirements

Week 9:

Day 1	*Introduction to Product Quality • Applications for Flat Products, Mill Drives, Solid State Heat Transfer, Scaling/Descaling, Hot and Warm Rolling of Steel • Cold Rolling/Annealing of Steel – Metallurgy • Process Options in Steel*
Day 2	*Skin Pass & Temper Rolling • Mill Design I & II • Rolls • Reheating Furnaces • Mill Vibration, Roll Marking & Chatter*
Day 3	*Lubrication, Plasticity, Control, Hot Rolling Temperature control, Sensors and Instrumentation • Gauge & Shape Control • Rolling of Stainless Steel*
Day 4	*Modeling Microstructural Evolution • Finite Element Modeling • Data Analysis, Aluminum Rolling • Coated Strip Processes & Products*
Day 5	*Crystallographic Texture • Cold Roll Strip Surface Quality • Challenges for the Future*

Week 10:

Day 1	*Fatigue • Fatigue Design Methods*
Day 2	*Macro/Micro Aspects of Fatigue in Steels*
Day 3	*Stress Life Approach • Strain Life Approach*
Day 4	*Linear Elastic Fracture Mechanics and Fatigue Crack Growth*
Day 5	*Worked Examples on Fatigue in Steels*

Week 11:

Day 1	*Fracture Mechanics Applied to Steels*
Day 2	*Overview of Fracture*
Day 3	*Elements of Fracture Mechanics*
Day 4	*Transition Temperature Approach to Fracture*
Day 5	*Fracture Toughness*

Week 12:

Day 1	*Introduction to Cambridge Engineering Selector (CES) Database*
Day 2	*Materials Selection Charts*
Day 3	*Ashby's Methods, Materials Selection without Shape*
Day 4	*Selection of Material and Shape as Related to Steels*
Day 5	*Plants Visits*

Practical Sessions

This practical and highly-interactive course includes real-life case studies and exercises:-

Course Coordinator

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