

# Welding Metallurgy

## An EWI Online Micro-credential Course

The **Welding Metallurgy** course provides students with an overview of *physical metallurgy*, an introduction to *welding metallurgy of steel*, and a special unit on the *welding metallurgy of stainless steels*. Each of these three parts can be completed by a student on its own for 7.5 PDH credits, or all three can be taken together to complete the Welding Metallurgy micro-credential course for 22.5 PDH credits.



### Course Components

<b>Part I</b> <b>Physical Metallurgy: A Review</b>	<b>Part II</b> <b>Introduction to Welding Metallurgy of Steel</b>	<b>Part III</b> <b>Welding Metallurgy of Stainless Steels</b>
Understanding the heating and cooling effects of welding is critical for welding engineers and professionals. Part I covers the basic metallurgy principles of as background to studying how welding can create unexpected metallurgical phenomena that can impact results.	Heat from welding can affect of both the weld and the metal adjacent it, leading to cracks, variations in toughness, or other negative effects. Steels in particular undergo metallurgical transformations when heated and cooled. Specific procedures can ensure that welds are successful. Part II covers metallurgical principles involved in developing these procedures.	Due to their unique properties, stainless steels can be used in corrosive and extreme-temperature environments. Incorrect welding procedures or the wrong choice of filler metal, however, can cause rapid corrosion, cracking, and failure. Most mistakes, however, can be avoided. Part III focuses on the metallurgy in welding stainless steels.
<ol style="list-style-type: none"><li>1. <i>The making of iron and steel</i></li><li>2. <i>The iron-carbon phase diagram</i></li><li>3. <i>Differences between crystallography of ferrite and austenite lattice</i></li><li>4. <i>The role of carbon and other alloying elements in steel</i></li><li>5. <i>The effect of heating and cooling on steel</i></li><li>6. <i>Strengthening mechanisms</i></li><li>7. <i>Using general steel classifications</i></li></ol>	<ol style="list-style-type: none"><li>1. <i>The effects of heat flow and cooling rates</i></li><li>2. <i>Weld zone identification</i></li><li>3. <i>The effects of hydrogen</i></li><li>4. <i>Avoiding hydrogen-induced cold cracking</i></li><li>5. <i>Metallurgical transformations</i></li><li>6. <i>Cracking tests</i></li><li>7. <i>The causes of lamellar tearing</i></li><li>8. <i>Weld metal reactions</i></li><li>9. <i>Conditions that lead to solidification cracking</i></li><li>10. <i>Weld properties</i></li><li>11. <i>Uses of different steel types</i></li></ol>	<ol style="list-style-type: none"><li>1. <i>The role of different alloying elements in stainless steels</i></li><li>2. <i>Stainless steels groups and their properties</i></li><li>3. <i>Major problems in welding stainless steels and how to overcome them</i></li><li>4. <i>The unique properties of stainless steels that resist corrosion in certain environments</i></li><li>5. <i>Verifying welding procedures based on stainless steel properties</i></li><li>6. <i>The unique low and high temperature properties of certain stainless steels</i></li></ol>

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## Course Orientation



During the next **90 days**, you'll increase your knowledge of Metallurgy.

The following topics are covered.

- Review of Physical Metallurgy
- Introduction to Welding Metallurgy of Steel
- Welding Metallurgy of Stainless Steels

**COURSE ORGANIZATION**

This course contains 3 units, each divided into several lessons. Within each lesson, you'll find narrated content, learning interactions, and short non-graded Quick Check self-assessments to check your understanding. At the end of each unit you will test your knowledge by attending a Chapter Knowledge Check. You should complete the units in the order presented. At the end of each, you will complete a Chapter Exam that reviews the key concepts covered in the lesson. You must achieve 50% or greater on these Chapter Exams and complete 100% Online content completion in order to trigger a successful Certificate of completion.

**COURSE SCHEDULE**

This course runs for **90 days**. During this time, you can access all of the training materials at any time.

**READY TO BEGIN?**

[Quick Start Guide](#)

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## Summary - Chapter 5 Exam

Description

You should take this exam after reviewing the content of Chapter 5.

You must complete all Chapter Exams with a passing grade of 70% to complete the course. You have unlimited attempts to finish this quiz.

You have unlimited attempts of 30 minutes to answer 25 questions. Please review the answers before submitting the attempt.

**Quiz Details**

Exam Fee  
3.54 PM Update

Course Instructor  
Steven Linder (username: Steven.Linder)

Time Allowed  
30:00:00

Attempts  
Attempt - Unlimited. Completed - 0

Activity Completion Goals  
Score at least 60% to pass the quiz and complete the activity.

**Instructions**

Before you submit the quiz, you will have the opportunity to return to questions that you may have missed or have not yet answered. Once the allowed time period that you set for this quiz expires, you are required to submit your quiz responses.

Note: Any responses entered after the time limit expires will not be submitted.

Click "Start Quiz" to begin Attempt 1.

The timer will not begin until after the set-up process is finished.

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## Major Metals and Their Uses

**Metals have special properties that distinguish them from non-metals and make them particularly useful as engineering materials.**

**These differences arise from the structure of the atoms and electrons within the material, giving metals the property of good electrical and thermal conductivity. Most metals are also ductile\* and can be formed into useful shapes.**

**Alloys**

Alloys\* are mixtures of metal with other metals or non-metals. Alloying can change the properties of a metal and most metals in use today are alloys. Metals and alloys are generally divided into two classes; those containing iron as the principle element, called **ferrous** alloys and those without iron as the principle element, which are termed **non-ferrous**\*. Consider the following Figure 5.1.

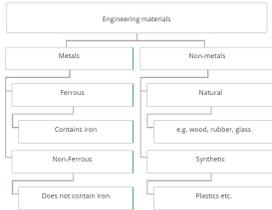


Figure 5.1. Grouping of engineering materials (p.6, 77).

**Ferrous Alloys**

The main groups of ferrous alloys are shown in the following Table 5.1, with some typical applications. The most important group, discussed more fully in this chapter, is the carbon and low alloy **steel**\* group, since these materials are used for major engineering constructions. Wrought iron, once a very common structural material, is very seldom used.

Alloy	Properties	Applications
Wrought iron	Ductile, can be hammered into complex shapes	Lifting tackle, decorative work
Cast iron	Lower melting point, easily cast	Machine castings
Carbon and low alloy steels	Good strength and ductility	Bridge girders, pressure vessels
Alloy steels	Many special properties depending on alloy	Tools, gears, high temperature uses, special applications

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