



204: Steel Fundamentals for Gearing

INSTRUCTOR:

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COURSE INFORMATION

Course Description

Develop an understanding of the key relationships among steel composition, processing, and properties. Learn how to select and specify steel composition and heat treatment options that optimize gear performance and comply with AGMA rating standards.

Who Should Attend

This course is intended for gear designers, engineers, metallurgists, heat treatment specialists, quality professionals, technical sales personnel, and managers involved in the specification, manufacture, or performance evaluation of steel gearing.

Learning Objectives

- Recognize basic gear terminology, geometry, and operating concepts.
- Distinguish between different gear failure modes and the factors that contribute to them.
- Understand basic principles of metal structure and behavior.
- Become familiar with common steel alloy designations and nomenclature.
- Select steel compositions and heat treatments that produce properties that meet the demands of the application and AGMA gear rating standards.
- Understand the influence of steel selection and heat treatment on the manufacturing and performance of gears.
- Learn how to specify and verify required steel properties.
- Compare the gear performance of steels produced in cast, wrought, powder metallurgy, and additive manufacturing forms.

Required Textbook

Textbook will be provided by MPMA

COURSE OUTLINE

1. Introduction & Gear Basics

- Why Steel for Gears? Attributes of steel compared with other gear materials.
- Gear Basics: Nomenclature, geometry, motion, and AGMA rating/material standards.
- Gear Failure Modes: Appearance, causes, and remedies for wear, bending fatigue, contact fatigue, and scuffing.

2. Metallurgy Essentials

- Metal Basics: Crystal structures, defects, phases, alloying effects, phase diagrams, and grain size.
- Steel Types: Classification systems, alloy designations, and typical uses.

3. Steel Processing & Heat Treatment

- Steel Mill Processing: Steelmaking, casting, deformation processes, and their impact on gear performance.
- Heat Treatment Principles: CCT diagrams, Jominy hardenability, and prediction of structures and properties.
- Heat Treatment Processes: Annealing, normalizing, through hardening, induction hardening, tempering, carburizing, nitriding, deep freezing.
- Residual Stress & Distortion: Causes, implications, and control methods.
- Machining: Effects of structure and properties on machinability and dimensional stability.
- Processing Issues: Origins, measurement, effects, and remedies for decarburization, intergranular oxidation, and grinding injury.

4. Properties, Case Depth & Inspection

- Mechanical Properties: Hardness, hardenability, tensile strength, toughness, fatigue resistance; effects of microstructure and cleanliness.
- Case Depth: Criteria and measurement for induction hardening, carburizing, and nitriding; selection guidelines and avoidance of insufficient or excessive case depth issues such as core crushing and TIFF.
- Inspection Methods: Techniques, applications, and acceptance criteria.

5. AGMA Requirements & Specification Writing

- Requirements in AGMA Rating Standards: Compositional, structural, property, and inspection criteria; comparison of AGMA grades for given heat treatment.
- Steel Composition & Heat Treatment Selection: Examples based on performance requirements, geometry, and production volume.
- Putting It All Together: Writing steel material and processing specifications; review of typical supplier documentation.

6. Advanced & Application-Specific Topics

- Finishing, Surface Treatments & Coatings: Grinding, superfinishing, phosphating, electroplating, vapor deposition.
- Welding: When welding is allowed or practical, typical processes, and post-weld thermal treatments.
- Powder Metallurgy: Process paths, key parameters, and performance relative to wrought steel.
- Additive Manufacturing: Opportunities, challenges, and current development activities for steel gears.
- Steels for Aerospace Gearing: Unique requirements, compositions, and processing.
- Steels for Cylindrical Mill Gears: Requirements for extremely large gears (≥ 6 m diameter).

STUDENT FEEDBACK AND GRADING PROCEDURES

Assignments

The instructor will provide illustrations and brief knowledge checks during the course. There will be a short self-graded quiz at the end to show knowledge transfer.

COURSE MANAGEMENT

Weather Delays and Cancellations

We will communicate any cancellations, delays or other concerns for safety prior to class via email, voicemail, and/or text message. Please be sure that we have all pertinent contact information as you travel to your class location.

Attendance for Domestic and International Students

Please be mindful that these are short, accelerated courses. Attendance is extremely important. If you are going to be absent from any class day, please contact the course coordinator.

Plagiarism, Cheating and other types of Misconduct

Plagiarism¹, cheating and other types of misconduct are unacceptable.

Students with Disabilities

Students requiring assistance and accommodation should complete the Special Accommodation Request form and submit it to our Education inbox at education@motionpower.org. Or we can be reached by calling 703-684-0211.

Grievance Procedures

Students who have concerns about the class are encouraged to contact any Education Department staff at education@motionpower.org or by calling 703-684-0211.

Outline Changes

The instructor reserves the right to modify the outline during the course of the class.

LEARNING AND OTHER RESOURCES

Links for writing resources:

- grammar.ccc.commnet.edu/grammar
- www.merriam-webster.com

Links for Math resources:

- www.sosmath.com
- Khan Academy on www.youtube.com

Links for time management, study skills and note taking resources:

- www.mindtools.com
- www.testtakingtips.com

Links for career resources:

- <https://www.agma.org/newsroom/jobs/>

Industry News:

- <https://www.agma.org/newsroom/industry-news/>

¹ Plagiarism is defined as "the use or close imitation of the language and thoughts of another author and the representation of them as one's own original work."