# Gear Failure Analysis

**INSTRUCTORS:**
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## COURSE INFORMATION

**Course Description**
Explore gear failure analysis in this combination lecture and hands-on seminar where students not only see slides of failed gears but can hold and examine specimens with the same failure modes covered in the seminar. Approximately half of the course time consists of students in groups identifying failure modes on failed gears and working on a case study. Microscopes are available to examine failed specimens.

**It is recommended that you spend a minimum of 1 hour reading and reviewing the material each day.**

**Course Rationale/Students Course is Designed to Serve**
Suitable for gear engineers, gear/gearbox designers, users, researchers, maintenance technicians, lubricant experts, and managers as it highlights in great details what can go wrong.

**Expected Student Learning (Course Level) Outcomes**
- Identify the primary and secondary failure modes
- Use the proper nomenclature to describe the morphology of gear failure
- Understand common tools and methods used in gear failure analysis
- Diagnose the root causes of failure
- Prescribe remedies to prevent repeat failures
- Use the AGMA textbook and other provided resources for ongoing study of gear failure analysis
- Tailor failure analysis techniques for their specific requirements

**Required Textbook (Provided by AGMA)**
*Gear Failure Analysis Seminar,* Developed by Robert Errichello, Provided by AGMA

**Reference Materials (articles, websites.)**
- *Standard for Design and Specifications of Gearboxes for Wind Turbines (ANSI/AGMA/AWEA 6006-A03)*
- *Point-Surface-Origin, PSO, Macropitting Caused by Geometric Stress Concentration (AGMA Technical Paper, 10FTM11)*
- *Morphology of Micropitting (AGMA Technical Paper, 11FTM17)*
- *Appearance of Gear Teeth – Terminology of Wear and Failure (ANSI/AGMA 1010-F14)*
- *Textbook includes the Gear Failure Atlas*

**Materials and Tools for Learning**
- Various gears showing failures for hands-on experience

## COURSE OUTLINE

I. Fracture
   a. Brittle Fracture
   b. Ductile Fracture
   c. Mixed Mode Fracture
II. Plastic Deformation
   a. Cold Flow/Hot flow
   b. Indentation
   c. Rolling
   d. Rippling
   e. Root Fillet Yielding
   f. Tip to Root Interference
III. Bending Fatigue
   a. Low-Cycle Fatigue
   b. High-Cycle Fatigue
   c. Subsurface Initiated Fatigue
IV. Hertzian Fatigue
   a. Macropitting
   b. Micropitting
   c. Subcase Fatigue
V. Wear
   a. Adhesion
   b. Abrasion
   c. Corrosion
   d. Fretting Corrosion
   e. Polishing
   f. Electric discharge
   g. Cavitation
   h. Erosion
VI. Scuffing
VII. Cracking
   a. Hardening Cracks
   b. Grinding Cracks
   c. Rim & Web Cracks
   d. Case/Core Separation

## STUDENT FEEDBACK AND GRADING PROCEDURES

**Assignments**
Group work, case studies, and a quiz are administered during this course. Immediate feedback is given, and the material is reviewed by the instructor.

## COURSE MANAGEMENT

**Weather Delays and Cancelations**
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**
Plagiarism[1], 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 Stephanie Smialek, Education Manager at smialek@motionpower.org. She can be reached at 773-302-8026.

**Grievance Procedures**
Students who have concerns about the class are encouraged to contact Stephanie Smialek, Education Manager, at smialek@motionpower.org or 773-302-8026.

**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.testakingtips.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."