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. The course starts off with an introductory lecture on basic gear terminology and meshing action, however MPMA courses on basic gear design and metallurgy are available and recommended as prerequisites. The first 12 hours is lecture following Power Point presentations, and the remaining time has students in groups identifying failure modes on failed gears and working on a case study. A hard copy of all course materials is provided to each participant. Microscopes are available to examine failed specimens. The course follows ANSI/AGMA 1010-F14, "Appearance of Gear Teeth-Terminology of Wear and Failure", covering 8 classes, 28 general modes and 29 specific modes of gear and bearing failure.

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 MPMA

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

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 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.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."