****

**Gear Failure Analysis**

**INSTRUCTOR:**

**Andrew Milburn**

Email: andy@milburnengineering.com

|  |
| --- |
| **COURSE INFORMATION** |

**Course Description**

Explore gear failure analysis in this hands-on seminar where students not only see slides of failed gears but can hold and examine over 130 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 Designed to Serve**

Suitable for gear engineers, users, researchers, maintenance technicians, lubricant experts, and managers.

**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 GEARTECH 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,* Robert Errichello

**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 |

|  |
| --- |
| 1. Fracture
2. Brittle Fracture
3. Ductile Fracture
4. Mixed Mode Fracture
5. Plastic Deformation
6. Cold Flow/Hot flow
7. Indentation
8. Rolling
9. Rippling
10. Root Fillet Yielding
11. Tip to Root Interference
12. Bending Fatigue
13. Low-Cycle Fatigue
14. High-Cycle Fatigue
15. Subsurface Initiated Fatigue
16. Hertzian Fatigue
17. Macropitting
18. Micropitting
19. Subcase Fatigue
20. Wear
21. Adhesion
22. Abrasion
23. Corrosion
24. Fretting Corrosion
25. Polishing
26. Electric discharge
27. Cavitation
28. Erosion
29. Scuffing
30. Cracking
31. Hardening Cracks
32. Grinding Cracks
33. Rim & Web Cracks
34. 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]](#footnote-1), cheating and other types of misconduct are unacceptable.

**Students with Disabilities**Students requiring assistance and accommodation should complete the [Special Accommodation Request form](http://www.graduateschool.edu/images/stories/AcademicPrograms/AdmissionsApplicationGuideD3.pdf) and submit it to Stephanie Smialek, Education Manager at smialek@agma.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@agma.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](http://www.merriam-webster.com)

**Links for Math resources:**

* [www.sosmath.com](http://www.sosmath.com)
* Khan Academy on www.youtube.com

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

* [www.mindtools.com](http://www.mindtools.com)
* [www.testakingtips.com](http://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.” [↑](#footnote-ref-1)