Detailed Gear Design – Beyond Simple Service Factors

INSTRUCTOR:
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COURSE INFORMATION

Course Description
There is a distinct difference between "designing" a gear and "optimizing" a gear design. In this course, we will address the optimization process via an understanding of those factors beyond basic banding and pitting ratings. Optimization may focus on load capacity, economy of production or minimization of overall gear system envelope. In this course we will learn how to improve gear designs via optimization and gain new insight into concepts presented through illustrations and demonstrations. Explore all factors that go into good gear design from life cycle, load, torque, tooth, optimization, and evaluating consequences.

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
Gear Engineers, gear designers, application engineers, people who are responsible for interpreting gear designs, technicians and managers that want to better understand all aspects of gear design.

Learning Outcomes
- Improve their gear designs
- Apply their understanding of gear rating theory and analysis methods
- Investigate differences in stress states among various surface durability failure modes
- Discuss time dependent and time independent failure modes related to tooth design
- Use computer generated graphics to examine mesh action and tooth interaction
- Discuss the concepts presented

Required Textbooks (Provided by AGMA)
Detailed Gear Design, Beyond Simple Service Factors by. Raymond J. Drago, PE

Materials and Tools for Learning
Computer generated animated graphics will be used for examining mesh action and tooth interaction. Each section discussion will be followed by an interactive question and answer period.

COURSE OUTLINE

I. Basic Introduction to gear rating theory and Standardized AGMA/ISO Analyses Methods including theoretical modes for strength, durability, wear, and scoring hazard.

II. Practical considerations and limitations associated with the application of Standard AGMA/ISO durability rating analyses:

a. The theoretical surface contact stress model and its application to gear tooth contact conditions

III. Investigation of the differences in stress states among the various surface durability failure modes including pitting, spalling, case crushing, and subcase fatigue.

IV. Extended load capacity analysis techniques (beyond AGMA/ISO Standard methods) including:
   a. Subsurface shear stress analysis for the determination of optimum effective case depth and relation to subcase fatigue and case crushing
   b. Conversion of subsurface shear stress profile into required subsurface hardness profile

V. Consideration of friction in the calculation of Surface Compressive stresses:
   a. The relation between pure Hertz type compressive stress and pitting
   b. The relationship between spalling and the occurrence of a combined tension and compression state at the tooth surface due to mesh friction effects

VI. Practical considerations and limitations associated with the application of Standard AGMA/ISO strength rating analyses:
   a. The theoretical strength stresses model and its application to gear tooth bending stress evaluation
   b. Correspondence between calculated stress numbers and actual measured tooth root stresses

VII. The effect of gear blank rim thickness on the tooth root stress state:
   a. Rim bending participation
   b. The rim thickness factor – development and limitations

VIII. Discussion of differences between fatigue, time dependent, and time independent failure modes as related to gear tooth design.
   a. Durability and Strength
   b. Wear
   c. Scoring

IX. Wear evaluation by the application of Elastohydrodynamic analyses.
   a. Basis of the analysis development
   b. Probabilistic nature of wear evaluation
   c. Time dependent, non-fatigue nature of wear progression
   d. Self-propagating mechanism

X. Scoring Hazard evaluation by the application of Blok's Critical Temperature Theory.
   a. Basis of the analysis development
   b. Probabilistic nature of the problem
   c. Time independent nature of failures

XI. Optimization of gear tooth detail design parameters including:
   a. Considerations for minimum roll angles
   b. Effect of and design for specific sliding (slip ration) and entraining velocity
   c. Stress balanced or life balanced gear pinion and gear relative design

d. Influence of geometric characteristics such as tooth top land, tooth thickness, etc. on optimized tooth design

XII. Considerations of fillet geometry in the avoidance of fillet interference and excessive stress concentrations due to adverse fillet geometry.

ASSIGNMENTS AND ACTIVITIES

Assignments
Assignments and learning activities are given and directed at the discretion of 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

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."

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/**