120: Fundamentals of Parallel Axis Gearing Design

INSTRUCTOR:
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COURSE INFORMATION

Course Description:
Gain a solid and fundamental understanding of gear geometry, types and arrangements, and basic design principles. Starting with the basic definitions of gears, conjugate motion, and the Laws of Gearing, learn the tools needed to understand the inter-relation and coordinated motion operating within gear pairs and multi-gear trains. Basic gear system design process, gear measurement and inspection techniques will also be explained. In addition, the fundamentals of understanding the stepwise process of working through the iterative design process required to generate a gear pair will be reviewed. Learn the steps and issues involved in design refinement and some manufacturing considerations. An explanation of basic gear measurement techniques, how measurement equipment and test machines implement these techniques, and how to interpret the results from these basic measurements will also be covered. Finally, a brief overview of in-service failure modes and causes.

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

Who Should Attend:
This course will appeal to anyone who is interested in gears, gear systems, design development or measurement and inspection techniques. More specifically, anyone responsible for the following will benefit; Mechanical power transmission system design, development, durability assessment and application; Application and development of geared systems technologies; Management of transmission designers and manufacturers; and supply of components and sub-systems to mechanical power transmission system manufacturers.

Learning Objectives:
- Develop a full appreciation for the meaning and correct use of gear nomenclature
- Describe conjugacy and its relationship to transmission error
- Appreciate and correctly select the basic geartrain arrangements as a function of application
- Be able to describe and discuss the external factors that effect a gear pair and / or a geartrain
- Describe how the applied torque manifests itself as a force on the surface of the tooth and further how this develops into stress within the body of the tooth
- Be able to describe and discuss the various common manufacturing techniques for gears
- Describe the measurement and inspection techniques used to qualify a gear
- Develop a high-level of appreciation for various gear failure modes and causes

Required Textbook (Provided by MPMA):
MPMA's Fundamentals of Gear Design and Analysis, by William Mark McVea

COURSE OUTLINE

- Principles of Gears

- Purpose of gears
- Basic concepts -- Law of gearing; common tooth forms

- Gear Tooth Action
  - Conjugacy
  - Transmission error
  - Involute profile curves

- Gear Geometry and Nomenclature
  - Gear form types
  - Classification of gears
  - Some basic definitions, nomenclature, and terms used in gearing

- Gear Arrangements
  - Simple gear train
  - Compound gear train -- ratios
  - Epicyclic configurations (solar, planetary, star);
    - Ratios
    - Tooth number selection
    - Build requirements
    - Application

- Gear System Design Process and Introduction to Analysis
  - Stress and strain within a tooth
  - Synthetic analysis technique
  - Lewis equation development and application
  - Material and heat treatment considerations
  - Calculation of gear tooth data
  - Gear rating practice

- Design Modifications
  - Tooth number as it effects tooth form
  - Profile shift
  - Profile modification
  - Lead modification

- Gear Drawing Data, Requirements and Format

- Introduction to Manufacturing Techniques and Systems
  - Broaching
  - Shaper Cutting
  - Hobbing
  - Roll Forming
  - Milling
  - Grinding

- Gear Measurement and Inspection
  - Dimension over pins
  - Pin diameter
  - Modify pin diameter and dimension over pins
  - Pin contact point
  - Charts - involute; lead; red liner
  - CMM and GMM systems and techniques
  - How to interpret GMM reports
- Gear Failure Modes and Mechanisms
  - Transmission error, a workable definition
  - Gear failure mechanisms
  - Causes and corrections

STUDENT FEEDBACK AND GRADING PROCEDURES

Assignments
There will be a short self-graded quiz at the end to show knowledge transfer.

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.

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."

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/