



EV Gearbox Concepts, Design, and Development Considerations

INSTRUCTOR:

William 'Mark' McVea

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COURSE INFORMATION

Course Description:

This course will cover all aspects of gearbox concept, development, design, and through the initial stages of analysis as related to product requirements. We will review all the most common EV transaxle architectures, power flow and layout and the 'whys' of packaging as such. Independent of the architecture and / or layout, there are many similarities in the functional and operational requirements of an EV transaxle gearbox. We will work through all of those and develop a workable set of requirements that will then be used as the design basis. From a high-level point of view the 'Big' difference between transaxles for EVs (Electric Vehicles) and transmissions designed for more traditional Manual Transmissions (MTs) and / or Automatic Transmissions (ATs) is the lack of the 'noisy' internal combustion engine or ICE motor. An internal combustion engine driving into a typical gearbox provides a great deal of NVH masking. Thus, we obviously need to design quieter gearboxes to reduce the potential of observed gearbox NVH, now potentially unmasked by the lack of the ICE signature and magnitude. However, and moreover, the signature from an ICE is much different than from the electric motor. The new input signature, frequency, and magnitude, cause a shift to higher frequencies and generally lower magnitudes of vibrational energies. That in turn becomes a more significant consideration in terms of gear design and application. We will discuss this and more throughout the course.

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 all involved in gear design, application, and analysis. Individuals more focused on actual EV gearbox design should gain value from the unique perspective brought to gear design specific to EV transaxles. We will discuss the specific and nuanced design details and development considerations related to the needs of an EV transaxle.

Learning Objectives:

- A brief and initial overview of common gear design techniques and best practices
- Understand the design challenges and constraints an electric motor presents to gear development,
- Extend our understanding of beneficial effects and uses of gear microgeometry to the new EV application,
- Incorporate design and application considerations of bearings, shafts, and seals to development and integration of EV transaxles,
- Appreciate the new, more expansive requirements for the lubricant and coolant,
- Discuss added application requirements and their effect on design and development,
- Summarize design and development requirements as a function of the additional constraints presented by the EV driveline.

Required Textbook (Provided by AGMA):

AGMA's EV Gearbox Concepts, Design, and Development Considerations, by William Mark McVea

COURSE OUTLINE

- Differences between conventional, hybrid and electrical drivelines
- Refresher on gears, bearings and other things effected by lubrication
- CVT function, operation and benefits
- Hybrids (HEV, PHEV, Etc.)
- Electric Vehicles (EV)
- Lubricant discussion from a mechanical point of view
- Lubrication systems
- Lubricant conductivity and interaction with electrical systems on-board
- Bearing specification and selection criteria
- Shaft design considerations and operational parameters
- Seal specification and selection criteria
- Cooling system architecture, objectives and issues
- Thermal management
- Market assessment
- Full energy analysis / EV spread sheet comparison

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

Plagiarism¹, cheating and other types of misconduct are unacceptable.

Students with Disabilities

Students requiring assistance and accommodation should complete the [Special Accommodation](#)

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."

[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/>