

REAL WORLD EDUCATION. REAL WORLD APPLICATION.



# 2024 EDUCATION CATALOG



# AGMA Classes Approved for CEUs

## THE INTERNATIONAL ACCREDITORS FOR CONTINUING EDUCATION AND TRAINING

American Gear Manufacturers Association (AGMA) is accredited by the International Accreditors for Continuing Education and Training (IACET) and offers IACET CEUs for its learning events that comply with the ANSI/IACET Continuing Education and Training Standard. IACET is recognized internationally as a standard development organization and accrediting body that promotes quality of continuing education and training.

AGMA was originally approved and began active status in December 2017. A renewal occurs every 5 years to ensure compliance with the ANSI/IACET Standards. AGMA went through reaccreditation in 2022 and has been reaccredited through November 2027.

## CONTINUING EDUCATION UNITS

As an IACET Accredited Provider, AGMA offers continuing education units (CEUs) for its programs that qualify under the ANSI/IACET Standard.

One CEU is equal to 10 hours of instruction, not including breaks or lunch. The learning activities allowed to receive CEU awards are face-to-face classes, distance courses, competency-based courses, and other learning events that meet the IACET/ANSI Standards. Partial credit or adjusted CEUs will not be awarded for individuals who do not successfully meet the criteria for achievement of CEUs.



***For more  
information on  
IACET Standard  
Requirements***

**CHECK OUT  
our individual  
course pages**

## LEARNER SUPPORT

***Need detailed information on courses?  
Have a question about the certificate  
program requirements?***

We are here to provide learner support services to assist you in achieving your professional development goals and objectives. Please contact us at **[education@agma.org](mailto:education@agma.org)** to discuss your educational needs.



# AGMA Education Department Mission and Certificate Programs

The AGMA Education Department conducts programs that support the professional development of the gear manufacturing workforce. Classes are available at all levels of experience, from operator to engineer. We provide a variety of learning environments to reach our learners anytime, anywhere, including self-paced on-demand, live online, and in-person courses. We are the leader in gear education in the United States, and are committed to providing relevant opportunities with an emphasis on learning outcomes and the application of knowledge to meet employer and learner needs.

## OUR GOALS ARE TO:

- ▷ Deliver training and education opportunities that build a knowledgeable, skilled workforce to more effectively and efficiently meet critical goals.
- ▷ Continually enhance the quality of the learning environment and the diversity of learning approaches to meet the needs of learners.
- ▷ Ensure that learning opportunities remain relevant.
- ▷ Continually assess and improve courses to ensure desired learning outcomes are met.
- ▷ Attract, develop, and retain highly qualified instructors from diverse backgrounds who are committed to providing supportive learning environments specific to gear manufacturing.

## AGMA HAS ESTABLISHED POLICIES ON:

- ▷ Student Record/Information Privacy
- ▷ Anti-Harassment/Discrimination
- ▷ Intellectual Property
- ▷ Proprietary Interest

For detailed information on such policies, please contact the Education Department at: [education@agma.org](mailto:education@agma.org).

## AGMA Certificate Programs

A leader in gear education, AGMA continues to expand our course offerings to meet the needs of the gear industry. We offer two certificates which include the following:

### GEAR MANUFACTURING CERTIFICATE

- ▷ Basic Training for Gear Manufacturing
- ▷ Fundamentals of Gear Design and Analysis
- ▷ Gear Manufacturing and Inspection
- ▷ Two additional advanced courses in face-to-face or live, instructor-led virtual formats

### ADVANCED GEAR ENGINEERING CERTIFICATE

Any combination of five advanced courses in face-to-face or live, instructor-led virtual formats

### ADVANCED GEAR ENGINEERING CERTIFICATE

*For International Industry Professionals (outside of North America)*

- ▷ Three (3) Online Video Training Courses:
  - Detailed Gear Design
  - Gearbox CSI: Gears Only
  - Gear Failure Analysis
- ▷ Two (2) Additional Advanced Courses of your Choice
  - Face-to-Face or Live, Instructor-Led Virtual Formats

More than 3,000 individuals have completed courses through the AGMA Education Department. For those select students who have completed a certificate program, taking the series of courses required consisted of more than 90 hours of classroom instruction.





The development of AGMA's Workforce Education Series, Operator Level Courses, and Online Video Training Courses—Detailed Gear Design, Gear Failure Analysis, and Gearbox CSI—are made possible through the generous support of the AGMA Foundation.

Over the past 25 years, the Foundation has raised more than \$2.5 million to fulfill its mission of providing support to the gear industry.

Contact Mary Ellen Doran, AGMA Foundation, Executive Director, at [doran@agma.org](mailto:doran@agma.org) for more information and how you can participate in the annual campaign.



AGMA has built a strong partnership with Richard J. Daley College, one of the City Colleges of Chicago. The AGMA National Training Center (NTC) is located on this campus and provides top-notch training, from basic gear manufacturing to advanced engineering courses. Our partnership affords Daley students exposure to gear manufacturing and AGMA students exposure to Daley's resources.

The 10,000 square-foot NTC trains over 600 students per year. Housing machine tools for cutting and inspection, as well as the library of gear failure examples, the NTC provides the unique ability for students to have hands-on experiences in gear manufacturing.

Additionally, the NTC is used to host a variety of other meetings for AGMA and its members. It serves as a place for AGMA to host job fairs for its local companies.



**Leah Lewis**

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Events Coordinator

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@AGMAGear



@agma



American Gear  
Manufacturers  
Association



AGMAvideo



@cheers4gears



# AGMA On-Site Training

AGMA can train your employees at your facility! We understand that training can be costly to your bottom line, but it still remains a necessary component for your company to remain on the cutting edge of gear knowledge in order to implement best practice in your workplace.

## BENEFITS OF ON-SITE TRAINING

### Cost savings

You are cost-conscious - so are we! By bringing an AGMA course to your location, you can eliminate the cost of sending your staff to another location. Your organization will:

- ▷ Eliminate travel costs.
- ▷ Maximize employee training time.
- ▷ Increase the productivity of your most valuable asset.
- ▷ Boost your employee retention program.
- ▷ Reduce turnover.

### Convenience

- ▷ Choose the best time to learn based on your employees' workloads and schedules.
- ▷ Benefit from courses that fit your needs.
- ▷ Train in your facility or shop.

### Relevance

- ▷ Tailor the courses to incorporate examples and content specific to your company's needs and challenges.

***Ready to bring  
industry-leading gear  
education to your  
workplace?***

**Contact us today**

**+1 703.684.0211  
Education@agma.org**

### Succession Planning

- ▷ Reduce the impact of the knowledge gap as new hires start and seasoned workers retire.
- ▷ Increase cross-training activities to enhance and diversify the skills of your workforce.

### Privacy

Having training at your own facility keeps your training needs and proprietary interests private. This allows your team to speak as freely as needed.

### Accredited

AGMA is accredited by the International Accreditors for Continuing Education and Training (IACET). AGMA complies with the ANSI/IACET Standard, which is recognized internationally as a standard of excellence in instructional practices. As a result of this accreditation, AGMA is accredited to issue the IACET CEU.

## SCHEDULING YOUR ON-SITE TRAINING

1. Choose the course(s).
2. Request a quote by emailing [education@agma.org](mailto:education@agma.org).
3. Schedule your training.
4. Participate in a planning call.
5. Prepare for Training Day.



# ON-DEMAND Education Offerings

## ONLINE ON-DEMAND VIDEO TRAINING COURSES

### DETAILED GEAR DESIGN: BEYOND SIMPLE FACTORS

**MEMBER FEE: \$1,095** | NON-MEMBER FEE: \$1,595

Learn about gear design and examine carefully crafted problems that will demonstrate the practical application of the optimization methods presented in this seminar. Facilitator: Raymond Drago, P.E. of Drive Systems Technology, Inc.

### GEAR FAILURE ANALYSIS

**MEMBER FEE: \$995** | NON-MEMBER FEE: \$1,495

Learn the causes of gear failure and how to prevent it from occurring. You will also see the various types of gear failure, such as overload, bending fatigue, Hertzian fatigue, wear, scuffing and cracking. Possible causes of these failures will be presented, along with some suggested ways to avoid them. Facilitator: Robert Errichello, P.E., of GEARTECH

### GEARBOX CSI: GEARS ONLY

**MEMBER FEE: \$795** | NON-MEMBER FEE: \$1,295

This webinar focuses on the gear part of the Forensic Analysis of Bearings and Gear course. It helps gear designers gain a better understanding of various types of gears. Learn about properly applying the best gear-bearing combination to any gearbox, simple or complex.

### BASICS OF GEARING

**MEMBER FEE: \$795** | NON-MEMBER FEE: \$995

This course provides a solid and fundamental understanding of gear geometry, types and arrangements, and design principles. Basic gear system design process and gear measurement and inspection techniques will also be explained. In addition, the design process to generate a gear pair, design refinement and manufacturing considerations, and interpretation of gear measurement results will be discussed.

## WORKFORCE TRAINING SERIES

**FREE FOR AGMA MEMBERS** | NON-MEMBER FEE: \$395/COURSE

This series provides a comprehensive overview of gearing to enhance students' understanding of essential terminology and practices within the industry.

### FUNDAMENTALS OF GEARING

### PARALLEL GEAR INSPECTION

### HOBGING

## ARCHIVED WEBINARS

**FREE FOR AGMA MEMBERS** | NON-MEMBER FEE: \$159/COURSE

### LIVE WEBINARS

AGMA has many options for webinars - from emerging technology and marketing, to the economy and state of the gear industry. Join us for a topic that interests you!

### FOR PREVIOUSLY RECORDED WEBINARS

All sessions are recorded and sessions and handouts are available as on demand downloads.

***For more  
information  
on AGMA's  
ON-DEMAND  
opportunities  
VISIT [agma.org](http://agma.org)***



AGMA | ABMA

# Annual Meeting 2024

*March 14-16, 2024*



**Meritage Resort & Spa**

*Napa Valley*  
**California**



American  
Gear Manufacturers  
Association®

[agma.org](http://agma.org)



American Bearing  
Manufacturers Association

[americanbearings.org](http://americanbearings.org)

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# OPERATOR LEVEL Course Offerings



## OPERATOR PRECISION GEAR GRINDING

0.6 CEUs

**July 24-25, 2024**

LIVE Online

Instructor: Terrance Klaves

**MEMBER FEE \$600 | NON-MEMBER FEE \$700**

Explore precision gear grinding processes, machine input variables, kinematics in Part A, Grinding simulation, machine alignment, setup errors, pitfalls, common gear fatigue failures and expectations related to finish ground gearing will be covered in Part B. Learn definitions of gearing component features, application loads and process steps from blanking, through heat treatment to finished part ready to ship. Study aspects of Quality Assurance, Inspection Documentation and corrective actions for measured non-conformances. Understand pre-heat treat, heat treatment distortion and post heat treatment operations, including the how's and why's to produce finished gears that conform and perform to end user expectations. Calculate gear form grinding cycle times for real life examples at various accuracy levels on commercially available software.

### LEARNING OBJECTIVES

- ▷ Review and challenge control of part datums for pre-heat treatment operations, use datums consistently through finishing operations given part prints.
- ▷ Anticipate and correct for part distortion during heat treatment knowing the actual heat treatment process used.
- ▷ Understand gear grinding kinematics for both form and generating machines along with allowable metal removal rates and wheel dressing intervals based on type of grinding wheels being used.
- ▷ Ask questions of gear designers and manufacturing engineers to acquire all information required to produce conforming finished gears.
- ▷ Accurately apply and inspect pre-calculated micro-geometry modifications derived from complex contact analysis software.



## GEAR HEAT TREATMENT OPERATOR / OPERATIONS

1.6 CEUs

**August 6-8, 2024**

Cleveland, OH

Instructor: William Andreski

**FIRST MEMBER FEE \$1,750; ADDITIONAL  
MEMBERS \$1,550 | FIRST NON-MEMBER FEE  
\$2,250; ADDITIONAL NON-MEMBERS \$2,050**

This course provides the heat treat operator and operations team the means to perform the heat treatment of steel gears in a manner that meets the AGMA and customer requirements in a safe and efficient manner. The course identifies the key requirements for proper processing. Sufficient metallurgical background is provided to allow the student to identify how this information relates to the required processing and properties of the gear.

### LEARNING OBJECTIVES

- ▷ Identify and locate the required information for material, process, and equipment for gear heat treatment.
- ▷ Recognize how the various heat treatment processes apply to the relevant AGMA documents.
- ▷ Perform preparation to product and equipment for heat treatment in an efficient and safe manner.
- ▷ Operate and monitor heat treat equipment, and perform quality control processes.
- ▷ Perform post-heat treatment processes, Go/No-Go material inspections and cycle documentation reviews.

**SIGN UP  
for courses at  
*agma.org***





## OPERATOR HOBBING & SHAPER CUTTING

1.3 CEUs

**August 12-13, 2024**

Chicago, IL - AGMA  
National Training Center

Instructor: Peter Grossi

**FIRST MEMBER FEE \$1,150; ADDITIONAL MEMBERS \$950 | FIRST NON-MEMBER FEE \$1,650; ADDITIONAL NON-MEMBERS \$1,450**

Learn and understand fundamentals of gear manufacturing. Acquire knowledge and understanding of gear nomenclature, hobbing and shaping of spur and helical gears, and splines. Learn and understand hobber and shaper machine set-up, as well as gear tooth element inspection. Understand the manufacturing process before gear tooth cutting, as well as post cutting processes. Apply concepts to further finishing processes, including heat treat, skiving, and gear tooth shaving and grinding. Gain knowledge to establish a solid foundation for all basic gear manufacturing.

*This course is taught at AGMA National Training Center.*

### LEARNING OBJECTIVES

- ▷ Identify gear blank inaccuracies.
- ▷ Establish proper machine set-up procedures and practices.
- ▷ Define gear tooth element nomenclature.
- ▷ Identify gear tooth errors resulting from hobber and shaper machine set-up errors, as well as cutter sharpening errors.
- ▷ Interpret gear inspection charts for quality level.



## BASIC GEAR INSPECTION FOR OPERATORS

1.3 CEUs

**August 14-15, 2024**

Chicago, IL - AGMA  
National Training Center

Instructor: William 'Mark' McVea, PhD, P.E.

**FIRST MEMBER FEE \$1,150; ADDITIONAL MEMBERS \$950 | FIRST NON-MEMBER FEE \$1,650; ADDITIONAL NON-MEMBERS \$1,450**

This course will provide a solid foundation for anyone going into gear inspection. Learn the common and current and basics of the tools and techniques used to measure and inspect gears. Understand the four main categories by which a gear is evaluated and classified. Gain proficiency in understanding gear quality by learning the numerical scale on which gear design, manufacture and inspection are based, and more.

*This course is taught at AGMA National Training Center.*

### LEARNING OBJECTIVES

- ▷ Describe the differences between measurement and inspection.
- ▷ Thorough review of measurement techniques.
- ▷ Thorough review of inspection results.
- ▷ Use means and methods to interpret and use the outcomes of both measurements and inspection to guide better gear production.
- ▷ Describe of manufacturing and process cause and effect as defined by the results of gear inspection.
- ▷ Explain the correlation between manual measurement techniques and how automated GMM (Gear Measurement Machine systems) perform the same task.
- ▷ Be able to explain the automated processes used by GMM systems to assess gear quality.
- ▷ Review of applicable standards.



# BASIC LEVEL Course offerings

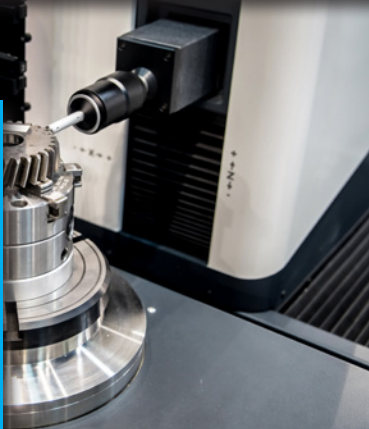
## ANALYTICAL GEAR CHART INTERPRETATION

0.3 CEUs

**January 23, 2024**

**May 16, 2024**

LIVE Online



Instructor: Dwight Smith

**MEMBER FEE \$350 | NON-MEMBER FEE \$450**

This course is an introduction to the methodology of analytical gear inspection and the evaluation and interpretation of the resulting data. The application of this information to identify and correct manufacturing errors will begin to be explored. Additionally, it reviews chart interpretation and applies inspection data to understand the causes and cures of manufacturing errors. Many chart examples are used to understand cause and effect.

### LEARNING OBJECTIVES

- Identify major gear characteristics measured and methods used.
- Evaluate pitch, profile and helix. Use AGMA ANSI ISO analysis methods.
- Compare and contrast 2008-A88 with the current standard AGMA ANSI ISO 1328-1-B14.
- Understand errors from various gear manufacturing processes: hobbing, shaping, shaving, and grinding.
- Understand the relationship between inspection charts and manufacturing kinematics.
- Use inspection chart information to determine the root causes of errors.

## DESIGN BASICS OF SPUR AND HELICAL GEARS

0.3 CEUs

**February 13, 2024**

**September 10, 2024**

LIVE Online



Instructor: Terrance Klaves

**MEMBER FEE \$350 | NON-MEMBER FEE \$450**

Learn how to develop and understand customer gear drive application specifications and target performance expectations. Review, calculate and select basic gear terminology variables and design parameters which define tooth bending and contact rating safety factors using two real-life examples. Learn how to optimize gear fatigue safety factors for a given target design life and fit new gear designs and ratios into existing center distance using profile shift. Use commercially available software to develop gear geometry factors, calculate and optimize gear set power density and performance. Review common gear failure modes if the design or final accuracy does not meet application requirements. Discuss time and cost of more than 20 other gear drive component functions and drive development steps through prototypes to shipment of compliant assembled production drives. There will be an opportunity to discuss gear design challenges which may be unique to participant industries.

### LEARNING OBJECTIVES

- Discuss aspects of gear tooth fatigue loading and typical failure modes as a basis for gear designs which exceed target design fatigue life.
- Understand the various forms of drive loads.
- Ability to start with customer supplied gear drive application specification and develop an optimized gear design which meets or exceeds application and performance requirements.
- Review gear geometry terminology and design optimization variables beyond information available in Machinery's Handbook, apply optimization tools currently used in industry.
- Calculate contact and bending safety factors as (material and design allowable loads) divided by (application loads) for a target design life.
- Learn how to fit a new gear ratio into existing housing and center distance.





## BASIC TRAINING FOR GEAR MANUFACTURING

2.7 CEUs

**April 8-12, 2024**

**September 16-20, 2024**

Chicago, IL - AGMA

National Training Center

Instructors: Dwight Smith, Allen Bird and Peter Grossi

**FIRST MEMBER FEE \$1,995; ADDITIONAL  
MEMBERS \$1,795 | FIRST NON-MEMBER FEE  
\$2,495; ADDITIONAL NON-MEMBERS \$2,295**

Learn the fundamentals of gear manufacturing in this hands-on course. Gain an understanding of gearing and nomenclature, principles of inspection, gear manufacturing methods, and hobbing and shaping. Utilizing manual machines, develop a deeper breadth of perspective and understanding of the process and physics of making a gear as well as the ability to apply this knowledge in working with CNC equipment commonly in use.

*This course is taught at AGMA National Training Center.*

## LEARNING OBJECTIVES

- ▷ Demonstrate understanding of the evolution, history, and function of gears.
- ▷ Show and describe 14 gear tooth features.
- ▷ Describe six typical gear characteristics that are measured.
- ▷ Demonstrate knowledge of gauging vs. measurement.
- ▷ Utilize and describe a variety of analysis methods.
- ▷ Understand processes to troubleshoot problems.



## LOADED TOOTH CONTACT ANALYSIS

0.3 CEUs

**June 13, 2024**

LIVE Online

Instructor: Terrance Klaves

**MEMBER FEE \$350 | NON-MEMBER FEE \$450**

Evaluate loaded tooth contact and develop tooth modifications using commercially available software to improve Khb and optimize power density. Two real life gearing examples will be presented in the course: one will have a cantilever mounted pinion, the other a shaft pinion straddled non-symmetrically by bearings. Both examples demonstrate component deflections under load which significantly reduce tooth mesh contact which is then corrected with developed helix and profile modifications. Other gear performance optimization tools will also be briefly discussed, profile shift, isotropic finishing, shot peening, accuracy, material selection.

## LEARNING OBJECTIVES

- ▷ Identify the need for contact analysis and describe the theory behind the contact analysis process.
- ▷ Model the loaded gear mesh shafts, bearings and gear geometry in commercially available dedicated gearing “FEA” software to calculate magnitude and direction of tooth deflections and deformations.
- ▷ Develop tooth profile and helix modifications that compensate for tooth deflections, reducing transmission error and optimizing power density.
- ▷ Describe the tools and processes of contact analysis.
- ▷ Review cantilever pinion example of contact analysis and corrective action.
- ▷ Review non-symmetrical bearing mounted shaft pinion example of contact analysis and corrective action.
- ▷ Present contact analysis Do’s and Don’ts.
- ▷ Review other gear performance optimization tools.



## FUNDAMENTALS OF GEAR DESIGN AND ANALYSIS

2.0 CEUs

**June 25-27, 2024**

Rosemont, IL



Instructor: William 'Mark' McVea, PhD, P.E.

**FIRST MEMBER FEE \$2,150; ADDITIONAL MEMBERS \$1,950 | FIRST NON-MEMBER FEE \$2,650; ADDITIONAL NON-MEMBERS \$2,450**

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 interrelation 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.

### LEARNING OBJECTIVES

- ▷ Develop a full appreciation for the meaning and correct use of gear nomenclature.
- ▷ Appreciate and be able to 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.

## HOW TO READ AND INTERPRET A GEAR INSPECTION CHART

0.3 CEUs

**August 20, 2024**

**December 3, 2024**

LIVE Online



Instructor: William 'Mark' McVea, PhD, P.E.

**MEMBER FEE \$350 | NON-MEMBER FEE \$450**

This half-day, online seminar is intended to provide you with a thorough understanding of the information contained within a typical gear inspection report. Specifically, we will look at the contents and meaning of the information contained within the gear charts, as well as the techniques used by the gear measurement system to assess gear quality. 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 be covered. We will also discuss how to interpret the results and what corrective actions may be considered if the quality of a particular gear is unsatisfactory.

### LEARNING OBJECTIVES

- ▷ Describe the measurement and inspection techniques used to qualify a gear.
- ▷ Explain the major contributing factors to gear quality.
- ▷ Describe in detail the practical gear measurement and inspection techniques.
- ▷ Categorize the common tools and equipment used to measure and inspect gears.
- ▷ Discuss some of the new and automated gear design systems.



# CONTINUING EDUCATION

FROM AGMA MEDIA

## gear TECHNOLOGY®

The Gear Industry's Information Source. Eight times per year, we bring you technical content related to gear design, manufacturing, inspection, heat treating and much more, along with the latest news, insights and trends affecting the gear industry.

[geartechnology.com/subscribe.htm](http://geartechnology.com/subscribe.htm)

SCAN ME



## Power Transmission Engineering®

The Magazine of Mechanical Components, written for design engineers, maintenance professionals and end users who are the designers, specifiers and buyers of gears, bearings, motors, gear drives and other mechanical power transmission devices. Eight times per year, we bring you everything from the basics to the latest technology in power transmission and motion control.

[powertransmission.com/subscribe.htm](http://powertransmission.com/subscribe.htm)



SCAN ME

**You can choose to receive either magazine in print or digital format (or both!), and you can also opt-in to receive our weekly e-mail newsletters.**

**FREE  
KNOWLEDGE  
SERVED  
DAILY**



# ADVANCED LEVEL Course Offerings

## EV AUTOMOTIVE TRANSMISSION DEVELOPMENT

2.0 CEUs

**April 23-25, 2024**

Ann Arbor, MI



***Come check out  
AGMA's FIRST  
Electric Vehicle  
(EV) course!***

Instructor: William 'Mark' McVea, PhD, P.E.

**FIRST MEMBER FEE \$2,150; ADDITIONAL MEMBERS \$1,950** | FIRST NON-MEMBER FEE \$2,650;  
ADDITIONAL NON-MEMBERS \$2,450

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. We will develop a workable set of requirements that will then be used as the design basis. An internal combustion engine driving into a typical gearbox provides a great deal of NVH masking. Thus, we 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.

### 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.

# SAVE THE DATES 2024



**Strategic  
Networking &  
Leadership Forum**

**May 1-3, 2024**  
Milwaukee, WI

**Fall Technical  
Meeting**

**October 7-9, 2024**  
Chicago, IL





## INVOLUTE SPLINE DESIGN AND RATING

0.6 CEUs

**January 17-18, 2024**  
**June 17-18, 2024**

LIVE Online

Instructor: Raymond J. Drago, P.E.

**MEMBER FEE \$600 | NON-MEMBER FEE \$700**

This course will address both geometry and rating of involute splines of various types. The types of spline joints and their applications will be discussed. Spline configuration variations, including half depth, full depth, and special function designs, will be addressed. Both fixed and flexible spline configurations will be examined in terms of usage and design. Lubrication methods, including grease, oil bath, and flowing oil, as well as coatings appropriate for various spline applications, are examined. Shear and compressive stress rating methods are discussed with analyses methodology presented in both equation and graphical methodology via various rating charts.

### LEARNING OBJECTIVES

- ▷ Explain involute splines and the various types.
- ▷ Compare and contrast spline configuration variations.
- ▷ Apply various lubrication methods to splines and spline applications.
- ▷ Apply rating methods and analyze methodology.



## GEAR MATERIALS

2.0 CEUs

**January 30 -**  
**February 1 &**  
**February 6-8, 2024**

LIVE Online

Instructor: Raymond J. Drago, P.E. & Dale Weires

**FIRST MEMBER FEE \$1,950; ADDITIONAL  
MEMBERS \$1,750 | FIRST NON-MEMBER FEE  
\$2,450; ADDITIONAL NON-MEMBERS \$2,250**

Learn what is required for the design of an optimum gear set and the importance of the coordinated effort of the gear design engineer, the gear metallurgist, and the bearing system engineer. Investigate gear-related problems, failures and improved processing procedures.

### LEARNING OBJECTIVES

- ▷ 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.

**Watch FREE  
webinars at  
*agma.org***

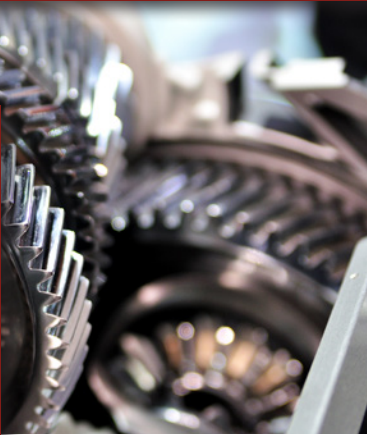


## GEARBOX CSI

2.0 CEUs

**February 27-29 &  
March 5-7, 2024**

LIVE Online



Instructors: Raymond J. Drago, P.E. & Joseph W. Lenski, Jr.

**FIRST MEMBER FEE \$1,950; ADDITIONAL MEMBERS \$1,750 | FIRST NON-MEMBER FEE \$2,450; ADDITIONAL NON-MEMBERS \$2,250**

A good understanding of individual failure modes and the failure scenarios that led to the actual system failure is an essential skill to designing gear and bearing systems that will operate properly for their full design life. In this course, we will define and explain the nature of many gear and bearing failures, as well as describing various actual failure scenarios. In addition, a detailed primer on bearing technology prefaces the failure scenario discussions. You will gain a better understanding of various types of gears and bearings. Learn about the limitation and capabilities of rolling element bearings and the gears that they support. Grasp an understanding of how to properly apply the best gear-bearing combination to any gearbox from simple to complex.

### LEARNING OBJECTIVES

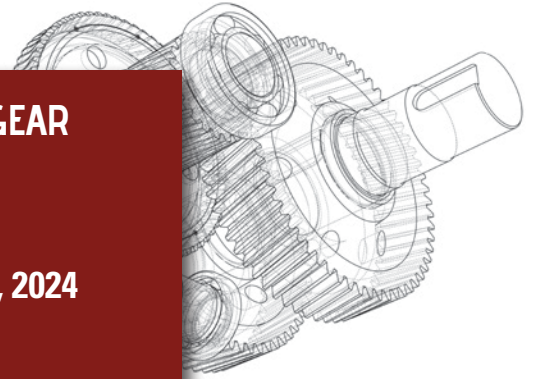
- ▷ Apply understanding of forensic analysis of gearbox failures in future gearbox designs.
- ▷ Discuss bearing and gear types.
- ▷ Explain how bearing selection is influenced by gear type and loading.
- ▷ Select appropriate bearing types and configurations as influenced by gear type and loading.
- ▷ Explain how to optimize bearing and gear combination.
- ▷ Identify seven materials and manufacturing related defects.

## DETAILED GEAR DESIGN

2.7 CEUs

**April 16-19, 2024**

Arlington, VA



Instructor: Raymond J. Drago, P.E.

**FIRST MEMBER FEE \$2,850; ADDITIONAL MEMBERS \$2,650 | FIRST NON-MEMBER FEE \$3,150; ADDITIONAL NON-MEMBERS \$2,950**

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 bending 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.

### LEARNING OBJECTIVES

- ▷ Improve 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.





## INTEGRATIONS AND TRADE-OFFS IN GEAR AND BEARING SYSTEMS

1.3 CEUs

**April 23-24, 2024**

Ann Arbor, MI

Instructor: Michael Berhan

**FIRST MEMBER FEE \$1,450; ADDITIONAL MEMBERS \$1,250 | FIRST NON-MEMBER FEE \$1,950; ADDITIONAL NON-MEMBERS \$1,750**

The purpose will be to cover the concurrent design and analyses of gears and bearings in integrated systems like gearboxes, transmissions, and electric motor drives, so as to allow for good integration and faster optimization of the overall system.

This will help gear engineers and suppliers better determine the trade-offs with the bearings, help bearing engineers and suppliers similarly with the gears, and system engineers better understand both.

The examples covered are generic but should be useful both within and across industries that use these components and systems.

### LEARNING OBJECTIVES

- ▷ Describe basic gear and bearing terminology, functional properties, and how these concepts can help better design integrated gear and bearing systems.
- ▷ Analyze integrated gear and bearing systems through the lenses of differing design properties, such as between ball vs. roller bearings and spur vs. helical gears, and through specific applications and pairings of gears and bearings used in various systems and operating environments.
- ▷ Explain four real-world systems trade-offs – efficiency, durability, noise, size – and how to consider these factors when designing and analyzing gears and bearings.
- ▷ Identify where improvements can be made earlier in the design process for better optimization through at least four areas, including materials, stresses, standards ratings, and basic reliability statistics.



## GEAR MANUFACTURING & INSPECTION

2.0 CEUs

**May 7-9, 2023**

Wilmington, DE

Instructor: Raymond J. Drago, P.E.

**FIRST MEMBER FEE \$2,150; ADDITIONAL MEMBERS \$1,950 | FIRST NON-MEMBER FEE \$2,650; ADDITIONAL NON-MEMBERS \$2,450**

While function and rating are important factors in a successful gear design, to be truly optimal and successful, the gear designer must also design the gears to be manufactured and inspected. This course will address key factors in a wide variety of manufacturing and inspection processes to enable the gear designer to better design optimal gears considering both rating and the necessary manufacturing and inspection processes to produce the gears as designed. We will also help the designer to understand how to interpret inspection data so that they can ensure that the gears meet the design. To be clear, this is not a course in how to operate the various machines. Rather it addresses the design provisions that are required to allow the gears to be optimally manufactured and inspected.

*This course includes a tour of the Chalmers & Kubek facility in Philadelphia, PA. Transportation will be provided.*

### LEARNING OBJECTIVES

- ▷ Identify methods of manufacturing external and internal spur, single and double helical, and bevel and worm gears.
- ▷ Discuss the features associated with each manufacturing method regarding their impact upon and their ability to refine, guide and optimize the design process.
- ▷ Specify the data required to control both the manufacturing and inspection processes on an engineering drawing.
- ▷ Discuss the possibilities for misunderstanding between purchaser and supplier.

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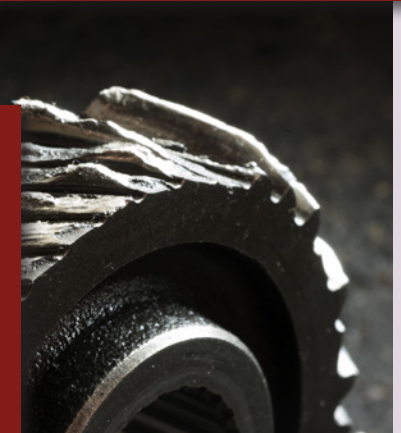


## GEAR FAILURE ANALYSIS

2.0 CEUs

**May 21-23, 2024**  
**October 22-24, 2024**

Chicago, IL - AGMA  
National Training Center



Instructor: Terrance Klaves & Andrew Milburn

**FIRST MEMBER FEE \$2,150; ADDITIONAL MEMBERS \$1,950 | FIRST NON-MEMBER FEE \$2,650; ADDITIONAL NON-MEMBERS \$2,450**

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.

*This course is taught at AGMA National Training Center.*

## LEARNING OBJECTIVES

- ▷ 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.





## GEARBOX SYSTEMS DESIGN

2.0 CEUs

**June 4-6, 2024**

Clearwater Beach, FL

Instructors: Raymond J. Drago, P.E. & Steve Cymbala

**FIRST MEMBER FEE \$2,150; ADDITIONAL MEMBERS \$1,950 | FIRST NON-MEMBER FEE \$2,650; ADDITIONAL NON-MEMBERS \$2,450**

This course focuses on the supporting elements of a gearbox that allow gears and bearings to do their jobs most efficiently. Learn about seals, lubrication, lubricants, housings, breathers, and other details that go into designing gearbox systems.

### LEARNING OBJECTIVES

- ▷ Understand types of housing construction, housing elements (covers, inspection ports, sump, mounting, etc.).
- ▷ Apply drawing practices for housings and related components.
- ▷ Learn about bearing mounting, retention and sealing.
- ▷ Understand election and role of gearbox accessories, such as breathers, filters, screens, sight gages, and other level indication devices.
- ▷ Apply the appropriate lubricant selection.
- ▷ Apply the lubricant to the rotating elements.
- ▷ Describe the selection criteria concerning the basic lubricant chemistry (since the best design is only as good as its implementation, drawing practices and tolerancing will also be addressed from the designers' perspective).
- ▷ Learn about translating the general design from the design manual to the individual component drawings.

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## BEVEL GEAR SYSTEMS DESIGN

2.0 CEUs

**July 30 - August 1,  
2024**

Rosemont, IL

Instructor: Raymond J. Drago, P.E.

**FIRST MEMBER FEE \$2,150; ADDITIONAL MEMBERS \$1,950 | FIRST NON-MEMBER FEE \$2,650; ADDITIONAL NON-MEMBERS \$2,450**

Learn how to design and apply bevel gears systems from the initial concept through manufacturing and quality control and on to assembly, installation and maintenance. Engage in a practical hands-on guide to the bevel gear design, manufacture, quality control, assembly, installation rating, lubrication and, most especially, application.

### LEARNING OBJECTIVES

- ▷ Apply the selection process required to determine which type of bevel gear is best for a particular application.
- ▷ Integrate both the manufacturing and quality control processes in the initial design process.
- ▷ Draw upon how bevel gears are manufactured to design these gears for manufacturability and good quality control.
- ▷ Discuss best practices for mounting, assembling and installing bevel gears.
- ▷ Discuss requirements and practices for lubrication and maintenance.
- ▷ Draw upon the relationship between standard rating practices and actual bevel gear tooth stresses as a means of optimum design.
- ▷ Describe in-service lubrication and maintenance required to support long term operation.

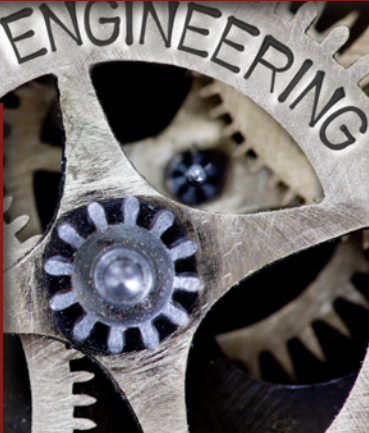


## REVERSE ENGINEERING

0.6 CEUs

**August 14-15, 2024**

LIVE Online



Instructor: Raymond J. Drago, P.E.

**MEMBER FEE \$600 | NON-MEMBER FEE \$700**

We will discuss the basic types of reverse engineering projects. The need for understanding the operation of the system in which the gears will be used, the conditions that led to the need for the project and especially, the specific nature of the failure that occurred, if that is the reason for the project, are key, often ignored, elements of the process. In some cases, no drawings are available at all; thus, a design must be developed that will yield gears that provide equivalent load capacity, life, noise performance and smoothness of operation. This scenario will be discussed with recommended analyses resented. In other cases, where no drawings are available, the correct procedures to follow in developing a reverse engineered gear that truly meets the system requirements will be discussed in detail with cautionary procedures outlined.

### LEARNING OBJECTIVES

- ▷ Understand the difference between designing from scratch and designing to duplicate an existing part and its function.
- ▷ Consider the reasons why reverse engineering an existing gear set, or, especially, a single gear can often be considerably more difficult than designing a new gear or gear set from scratch.
- ▷ Discuss the possibilities for misunderstanding, which are legion, between purchaser and supplier.
- ▷ Apply an understanding of forensic analysis of gearbox failures to avoid simply duplicating the original failure.
- ▷ Understand the difference between a temporary replacement and a duplicate of the original gear.

## CONDITION MONITORING

0.6 CEUs

**October 16-17, 2024**

LIVE Online



Instructors: Raymond J. Drago, P.E.

**MEMBER FEE \$600 | NON-MEMBER FEE \$700**

In this course we will examine each of the following questions and the interrelation of each with a primary focus on how this information can be used to define the actions required to keep the gearbox running properly and to allow maintenance planning.

**What:** There are many parameters that provide information about the condition of an operating gearbox, some are lubrication centric while others are operationally centric. **Why:** Each parameter, individually and in combination, can provide insight into the condition of the gearbox and its individual components.

**How:** There are a variety of ways we can collect the data required to estimate remaining operational time and risk of premature failure. Even more importantly, however, our discussion of the “how” will address the relation of the function of the gearbox and the risks associated with parameters evaluated.

### LEARNING OBJECTIVES

- ▷ Recognize the specific parameters that need to be monitored.
- ▷ Understand the hardware and data interpretation required for each monitored parameter.
- ▷ Discuss relative importance of each parameter and significance of data obtained with respect to the operational capability of the gear system.
- ▷ Discuss potential actions required based on data obtained by each monitoring method.
- ▷ Understand the best techniques for obtaining data from an operating gear system that can be used to predict the operational performance of the system.
- ▷ Understand that data collected does not necessarily provide a “yes” or “no” decision point but rather can support rational judgements relative to maintenance scheduling.
- ▷ Review how data collected is used to determine specific lubricant replacement scheduling.





## GEAR SYSTEMS DESIGN FOR MINIMUM NOISE

1.3 CEUs

**November 12-13 &  
November 19-20, 2024**

LIVE Online

Instructor: Raymond J. Drago, P.E.

**FIRST MEMBER FEE \$1,250; ADDITIONAL  
MEMBERS \$1,050 | FIRST NON-MEMBER FEE  
\$1,750; ADDITIONAL NON-MEMBERS \$1,550**

The general nature of noise and its measurement will be examined, with particular emphasis on terminology standards, and units of measurement appropriate to gear technology. The mechanism by which observer-noticed noise is generated and transmitted will be defined, described, discussed. Before attempting to solve a noise problem with an existing unit or beginning the design of a new unit, the nature of the noise must be defined. Both experimental and analytical methods will be covered, with particular emphasis on application rather than theory. The factors that influence the noise produced by a gear system and the effects of each will be discussed. Various techniques that can reduce the noise level of existing gear systems without requiring major hardware replacement will be presented and discussed.

### LEARNING OBJECTIVES

- Understand the need for gearbox system noise control.
- Become familiar with the nature of noise and its measurement as well as terminology standards, and units of measurement appropriate to gear technology.
- Learn the mechanisms by which observer noticed noise is generated and transmitted.
- Explain the importance of equal planet/star gear spacing and how a system can be designed with unequal planet spacing.
- Understand the various design and manufacturing factors that influence gear system noise.

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# AMERICAN BEARING MANUFACTURERS ASSOCIATION Course Offerings



*Founded in 1917, the American Bearing Manufacturers Association (ABMA) has long and rich history, which includes aiding in the production of bearings in World War I and fighting counterfeit bearings around the world. ABMA provides leadership, advocacy and education on issues impacting the global bearing industry. ABMA's members include manufacturers of bearings and finished components as well as suppliers to the bearing industry. Participants from member companies are CEOs and senior executives—the key decision-makers and the most successful and forward thinking leaders in the bearing industry. Engage with ABMA to gain access to membership opportunities, receive updates on industry news, attend courses, or become a key partner.*

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## ADVANCED CONCEPTS OF BEARING TECHNOLOGY

**June 24-27, 2024**

Rosemont, IL



Instructors: Daniel Snyder, Timothy Ovaert, Vern Wedeven, and Brian Werner

**MEMBER FEE \$2,550 | NON-MEMBER FEE \$2,850**


This course builds on the foundations of the essential course and challenges the experienced engineer in areas such as failure modes, friction and wear, fatigue life calculation methods and load distribution. This is an exceptional course for engineers with two to three years work experience in bearings or past attendees of the Essential Concepts of Bearing Technology.

### LEARNING OBJECTIVES

- ▷ Bearing Macrogeometry: Osculation, Internal Clearances, Contact Angles.
- ▷ Load Contacts, Ball/Roller Loading: Static/Inertial.
- ▷ Contact Stresses, Deflection, Surface & Subsurface Stresses.
- ▷ Internal Load Distribution – Loaded Zones, Speed & Motion.
- ▷ Concepts of Friction & Wear: Surface Topography and Measurement.
- ▷ Fundamentals of Fatigue Life Theory, Dynamic Capacity.
- ▷ Contact Friction, Traction Effects.
- ▷ Bearing Friction & ISO Reference Speed Ratings.
- ▷ Permanent Deformations & Static Capacity.
- ▷ Fatigue Life Prediction: Standards & Advanced Calculation Methods.
- ▷ Testing Methods & Statistical Test Data Analysis.
- ▷ Lubricants & Rheology & EHL Calculations.
- ▷ Shaft-Bearing Systems & Performance Analysis.
- ▷ Determining Preload.



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## ADVANCED CONCEPTS OF LUBRICATION AND WEAR

**July 9-11, 2024**

University of Notre Dame

Instructors: Timothy Ovaert and Vern Wedeven

**MEMBER FEE \$2,000 | NON-MEMBER FEE \$2,200**

This course is designed for engineers and scientists in the rolling element bearing, gear, and power transmission industries who desire a more fundamental knowledge of component-relevant topics in the field of tribology. The science behind lubrication and wear continues to evolve. This course introduces attendees to important terminology; surface topography measurement, characterization, and application; the mechanics of surfaces in contact; the development of lubricant films; lubricant functionality; and failure of rolling element bearings and mechanical components in motion. The purpose of this course is to bridge the gap between component design and component failure, as a result of relative motion between surfaces in contact.

### LEARNING OBJECTIVES

- ▷ Basic terminology and introduction to tribology.
- ▷ Regimes of lubrication.
- ▷ 2-D and 3-D surface roughness and topographical characterization.
- ▷ 2-D and 3-D contact mechanics.
- ▷ Asperity contact models.
- ▷ 2-D and 3-D elastohydrodynamic lubrication (EHL).
- ▷ Transient and micro-EHL.
- ▷ Mixed lubrication.
- ▷ Functionality of lubricants.
- ▷ Wear in EHL and mixed lubrication.
- ▷ Bearing life and performance applications.



## ESSENTIAL CONCEPTS OF BEARING TECHNOLOGY

**August 6-8, 2024**

Cleveland, OH

Instructors: Daniel Snyder, Timothy Ovaert, and Vern Wedeven

**MEMBER FEE \$2,350 | NON-MEMBER FEE \$2,650**

The Essentials Course focuses on understanding basic tribology, bearing attributes and applications and explores the basic concepts around manufacturing methods, loads, lubrication and failure. It will give you an overview of the bearing industry as well as basic bearing types and applications. Knowledge of the key players, bearing types and terminology will ensure that everyone has a basic knowledge of the industry upon arrival. This course is specially designed for engineers and others with technical backgrounds that have limited exposure to bearings and need to adapt their technical training to bearings or seek an upgrade to their technical knowledge.

### LEARNING OBJECTIVES

- ▷ Rolling Bearing Types, Attributes, Typical Applications.
- ▷ Macrogeometry & Industry Dimensional Standards.
- ▷ Bearing Loads & Applications: Static and Dynamic.
- ▷ Mounting Arrangements and Fitting Practices, Held/Free, Methods.
- ▷ Contact Stresses – Surface & Subsurface.
- ▷ Fatigue Initiating Stresses.
- ▷ Bearing Load Sharing & Internal Loading.
- ▷ Introduction to Bearing Pre-Load.
- ▷ Materials for Ball & Roller Bearings.
- ▷ Concepts in Friction, Lubrication & Wear.
- ▷ Ball & Roller Bearing Deflections & Stiffness.
- ▷ Bearing Lubricants, EHL & Lubrication Methods.
- ▷ Failure Modes in Rolling Bearings.
- ▷ Bearing Life Standards & Calculation Methods.

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