

BGA Training 2021

BRITISH GEAR
ASSOCIATION

Promoting the technical and commercial interests of manufacturers, distributors, academics and others involved in the Power Transmissions industry in the United Kingdom.

The British Gear Association (BGA) are the leading providers of gear related training in the UK and Europe. All BGA training is developed and delivered by Gear experts from Academia and Industry.

From introductory classes to more in-depth specialist training we have all of your gear training needs covered. Our courses are suitable for all sections of the gearing world. From students and apprentices starting out in their careers to experts wanting to hone their skills or get up to date with the latest developments. Most of our training is CPD Accredited.

During the unprecedented events of 2021 here at the BGA we have been working hard to continue to offer essential Gear Training to support people around the world in an online environment.

Thanks to the continued support of the BGA Membership we can **offer our 2021 online training to members completely free of charge**. If you are not a BGA Member please get in touch to find out how to join.

Please go to the BGA website for course dates www.bga.org.uk/gear-training/

If you would like to register for any of our essential gear training please contact Kirsty in the BGA office admin@bga.org.uk

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VIRTUAL GEAR FOUNDATION

This introductory course is suitable and appropriate for anyone joining the gear industry. We have found this introduction to Gears to be beneficial not just to staff directly working with gears but also those such as HR and Sales departments to **ensure every member of your organisation a broad understanding of Gears and gearing.**

The course will not only equip the delegate with the basic gear knowledge to make a success of their career but also allow them to benefit from the more specialised seminars presented through the year in the BGA's Knowledge Transfer Programme.

This essential Gear training has been produced and will be presented by Gear expert Graham Penning over **three 90-minute sessions**. Each session will be completely interactive allowing delegates to ask questions and have them answered in a live environment. Participating delegates will receive a certificate.

Session 1: 90 minutes including live Q&A.

An Introduction to Gears Part 1: Gear Fundamentals

Law of Gearing; The Involute Form; Power Transmission; Motion Control; Gear Types – Features and Benefits.

Session 2: 90 minutes including live Q&A

An Introduction to Gears Part 2: Noise & Load

Modes of Failure (Bending, Pitting, Micro-Pitting, Scuffing, Wear) Gear Rating methods; Application Factors; Gear Lubrication; Noise & Vibration basics; Transmission Error.

Session 3: 90 minutes including live Q&A

An Introduction to Gears Part 3: Gear Manufacture

Gear Material Specification; Gear Manufacturing Methods (Forming, Moulding, Machining; Hobbing, Shaping, Shaving, Honing, Grinding and Finishing); Heat Treatment and Gear Measurement.

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GEARBOX SYSTEMS: PROBLEMS & SOLUTIONS

Seminar Programme

Many reliability and wear problems in transmission systems are not directly associated with the design of the components themselves but are the result of system dynamics: starting and transient torques, self-excited vibration and the dynamics of the motor or engine and of the driven machine. Particular characteristics of bearings, couplings and gearbox mounting can also significantly affect system performance. Typical problems and solutions are discussed and instrumentation for troubleshooting noise, bearing failures, vibrations and in-service load measurement demonstrated.

The seminar will cover:

- Tackling Unexplained Bearing and Gear Element Failures
- The Dynamics of Gearbox Systems
- Gearbox Noise and Vibration
- Problem Solving using State of the Art Data Acquisition & Analysis Techniques
- Wind Turbine Gearboxes: Type Testing, Instrumentation & Early Stage Troubleshooting
- Gear Alignment Instrumentation ($K_{H\beta}$, K_{γ})
- In-Service Unattended Load (Torque) Data Collection Techniques
- Case Studies in Rail, Marine Propulsion, Renewables, Automotive and Heavy Industries
- State of Art Condition Monitoring Techniques

This is a live interactive session with plenty of opportunity to ask questions and interact with the tutor.

Agenda:

9:30am – Welcome and Part 1

10:30-10:45 – Coffee Break

10:45 – 12:15 – Part 2

12:15 – 13:15 – Lunch Break

13:15 – 14:00 – Part 3

14:00 – 14:15 – Coffee Break

14:15 – 15:30 – Part 4

15:30-16:00 – Q&A

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MECHANICAL POWER TRANSMISSION AND THE JOY OF GEARS

For the last few years, I have delivered a gear foundation course to both young and experienced engineers wanting to understand gear technology, and I always start the day by saying:

“In 1973, I moved to Huddersfield after getting a job as a young engineer with David Brown Gear Industries thinking that, after two years, I will move on knowing everything about gears. Well, here I am, over forty-five years later, still learning something new about gears every week. So, while today I will have no problem introducing all the basics of gears, you will never know everything about gears. That is the joy of gears; they embrace so many technologies that there is always an opportunity to learn something new, and once involved it will be inevitable that you will meet and enjoy working with many different and helpful engineering experts.”

Webinar Content.

This webinar outlines how mechanical power transmission has been used throughout history to create and develop the machines that have now become essential to our civilization and way of life.

Many transmissions exploit gears and gearboxes to both control motion and allow the prime mover and driven machine to run at their ideal conditions.

The critical role gears play is explained and how for more than 2000 years, gear engineers have had to embrace and understand all aspects of mechanical engineering. As new technologies emerge this challenge continues, providing exciting opportunities for all engineers involved with gears and gearboxes.

Whilst the inescapable truth is that gears are used, not because we want them, but because we need them, hidden within is the secret joy associated with gears and this will be revealed during the course.

Attendees will

- Better understand how they can use these technologies to improve their engineering applications
- Recognise how one of the most enduring engineering technologies is embracing the latest technology developments and innovations.
- Be introduced to the vast range of technologies apparently simple mechanisms like gears embrace to provide one of the most fulfilling career paths an engineer can follow.

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VIRTUAL GEAR GEOMETRY

This course is split into 4 sessions. The sessions will include a short introduction on Teams before you access some video presentations individually and try some easy quizzes to test your knowledge. We then get back together on Teams later in the morning to run through the quiz answers and discuss any questions you have and summarise what we have covered. PDFs of the PowerPoint presentations and supporting training information will be sent prior to the event. Also, you will have access to the video sessions for 24 hours to run over things again if needed.

CYLINDRICAL GEAR GEOMETRY PART 1- HOW INVOLUTE GEARS WORK

Gear geometry is thought to be complex and often considered a 'black art'. This short on-line session will dispel this myth and provide delegates with a basic knowledge of how gears work and cylindrical gear geometry. No prior gear knowledge is required.

It is applicable to gear designers, manufacturing staff, machine operators, inspectors and those who are new to the gear industry and want to understand what all the fuss is about.

The session will:

- Remind us why we use gears.
- Introduce us to the requirements of gears and the involute curve.
- Show how gears work.
- Show why gears need to be precise.
- Explain why gears are noisy and how we make them quiet.
- However, we won't look at gear design or gear calculations- that's for later sessions.
- We have included plenty of time for questions and discussion.

Key skills and knowledge: At the end of the seminar you will understand how gears work and understand what is important to make gears work properly. Designing, manufacturing and inspection processes make much more sense when you understand basic gear geometry. You will be ready to develop your knowledge further in the next gear geometry sessions from the BGA.

CYLINDRICAL GEAR GEOMETRY PART 2- AN INTRODUCTION TO BS ISO 21771:2007

Gear geometry is complicated, but this short on-line session will build on the part 1 of this series and introduce you to ISO 21771 on cylindrical gear geometry. The standard provides gear geometry calculations and is daunting, but this session will start your introduction to it, step by step.

It is applicable to gear designers, manufacturing staff, machine operators, inspectors and those who are new to the gear industry. Many of us use commercial software or spreadsheets to perform gear calculations developed by others, but each of us needs to know what the values mean and where they come from.

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VIRTUAL GEAR GEOMETRY CONTINUED

The session will:

- Remind us how easy it is to specify gear geometry.
- Explain why it's more complicated in practice (spoiler alert- its due to how we make gears).
- Introduce us to ISO terms and more importantly to the symbols used in ISO gear standards. ISO symbols can be considered the international language of gears.
- Introduce some basic geometry calculations and diagrams from ISO 21771. We will show you how to interpret these.
- Include some basic gear calculations which require a scientific calculator.
- We will go through the answers at the end of the session.
- We have included plenty of time for questions and discussion.

Key skills and knowledge: Designing, manufacturing and inspection processes make much more sense when you understand basic gear geometry. You will be familiar with some common gear terms and symbols be able to understand and perform basic gear calculations with BS ISO 21771 (which is available for BGA members via the BGA website). You'll be ready to develop your knowledge further in the next gear geometry sessions available from the BGA.

CYLINDRICAL GEAR GEOMETRY PART 3- GEAR PAIRS AND THEIR RELATED GEAR GEOMETRY

This short on-line session will build on parts 1 & 2 of this series to develop your expertise and introduce you to profile shift coefficient, a subject that often causes confusion, gear pair geometry and tooth thickness calculations. The sessions will be based around ISO 21771:2007 standard and show you how to interpret the confusing gear pair drawings so you can confidently use the standard.

It is applicable to gear designers, manufacturing staff, machine operators, inspectors and those who are new to the gear industry. Many of us use commercial software or spreadsheets to perform gear calculations developed by others, but each of us needs to know what the values mean and where they come from.

The session will:

- Remind us how gears work
- Introduce gear pair geometry and lines of contact.
- Introduce the concepts of working pressure angle and show you how we work out where gears start to contact on the tooth flank.
- Introduce you to profile shift coefficient, 'x', why we use it, and what effects it has on gear geometry.
- Introduce you to basic tooth thickness calculations.
- Introduce the relevant geometry calculations and diagrams from ISO 21771.
- Allow you to test your knowledge with quizzes but don't worry, we will go through the answers

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VIRTUAL GEAR GEOMETRY CONTINUED

Key skills and knowledge:

Designing, manufacturing and inspection processes make much more sense when you understand gear geometry. You will be familiar with common gear terms and symbols be able to understand and be confident using gear calculations in BS ISO 21771 (which is available for BGA members via the BGA website). You'll be ready to develop your knowledge further in the next sessions available from the BGA looking at gear geometry that relates to gear performance.

CYLINDRICAL GEAR GEOMETRY PART 4- PERFORMANCE RELATED GEAR GEOMETRY.

- to contact on the tooth flank.
- Introduce you to profile shift coefficient, 'x', why we use it, and what effects it has on gear geometry.
- Introduce you to basic tooth thickness calculations.
- Introduce the relevant geometry calculations and diagrams from ISO 21771.
- Allow you to test your knowledge with quizzes but don't worry, we will go through the answers at the end of the session.
- We have Included plenty of time for questions and discussion.

Key skills and knowledge: Designing, manufacturing and inspection processes make much more sense when you understand gear geometry. You will be familiar with common gear terms and symbols be able to understand and be confident using gear calculations in BS ISO 21771 (which is available for BGA members via the BGA website). You'll be ready to develop your knowledge further in the next sessions available from the BGA looking at gear geometry that relates to gear performance.

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VIRTUAL INTRODUCTION TO ROLLING ELEMENT BEARINGS.

This online course is fully interactive with detailed examples and plenty of time for questions and discussion.

Bearings are an integral part of all mechanical power transmissions and rolling element bearings are often the most accurate component on the transmission. A good understanding of how they work is essential to those involved in transmission design, manufacture and assembly activities.

We will be examining both as run and damaged bearings which illustrate common failure modes.

The Seminar will cover:

- How rolling element bearings work and the history of their development.
- Common radial and thrust bearing types and their application, Benefits and limitations of each type of bearing.
- Lubrication considerations.
- Calculation of bearing loads caused by the gears and discuss good design practice.
- Common bearing failure modes and an introduction to BS ISO 15243:2017 – Rolling bearings – Damage and failures – Terms, characteristics and causes.
- Basic bearing life calculation to BS ISO 281:2007 – Rolling bearings – Dynamic load ratings and rating life, for L10 life calculation and the modified life calculation L_{mn} considering endurance limit, lubrication and lubricant contamination. How do you use them?
- Miners sum cumulative damage analysis methods to account for varying load conditions.
- Examination of failed bearings and typical witness marks on bearings in service.

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VIRTUAL Design of Experiments (DOE)

This online course is fully interactive with detailed examples and plenty of time for questions and discussion.

Why learn about DOE?

Properly designed experiments will improve

- Understanding of the Cause and Effect relationship in any process
- Predictive knowledge of the process, in order to improve it
- Control process costs, while meeting or exceeding customer requirements.

The course will cover:

- Background to DOE in understanding the cause and effect relationship
- Understanding data types, and the wide range of experimental tools.
- Planning an experiment (including gear measurement considerations)
- Determine if any factor or combination of factors is significant
- Screening trials and observations
- Replication and Repetition
- Statistical control and stability
- Analysis of Results via ANOVA and define prediction equations
- Process optimisation to reduce costs
- Case studies
- Software options

Module 1. Introduction to DoE Theory.

By the end of this module, the participant will:

- Understand the strategy behind Design of Experiments (DoE/DoX)
- Understand the types of experiments
- Understand the goals of an experimental strategy
- Understand the concept of “between group” variation to “within group” variation.
- Understanding the within group randomness assumptions and the experimental methods to test these assumptions

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VIRTUAL Design of Experiments (DOE) Continued.

- Understand Coding
- Understand the limitations of One-Factor-At-a-Time (OFAT) experiments

Module 2. Methods of Data Analysis:

By the end of this module, the participant will:

- Understand the importance of control charts as analytical tools in DoE, and how to interpret them.
- ANOM, ANOR, and ANOME
- Understanding multi-level factors.
- Understand the concept of interaction.
- ANOVA for graphical and numerical analysis.
- Testing Results via “SPC for Excel®” and “Minitab®”
- General measurement issues.
- Evaluating the Measurement Process (EMP) studies

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