Advanced Gear calculation

Gear Design and Optimization

This training course is designed for engineers who are already familiar with cylindrical gear calculations and assumes that the participants already know how to use the KISSsoft user interface. If a participant is neither familiar with KISSsoft nor use the software on a regular basis, we highly recommend to fulfill the basic training course first.

This seminar offers a comprehensive view of the most important geometric properties of cylindrical gears in the first day. The second day offers a more in-depth look at the current state of technology and the latest working practices in the field of gear strength calculation. The third day covers the theoretical foundations of contact analysis, which are required for sizing and optimizing gear units with regard to noise, transmission error, transverse contact ratio and tooth trace modifications and optimization.

More special themes will be covered in which it will be also being shown how complex problems can be solved efficiently using calculation software.
Day 1: Gear Geometry

Geometry of gears (cylindrical) with involute profile

- Reference profiles (normal profile, stubbed and deep tooth forms)
- Profile shift, optimization of profile shift, undercut
- Grinding allowance, manufacturing profile shift
- Backlash, Tip clearance
- Contact line, useable tip circle and useable root circle (SAP characteristics and problems, EAP)
- The most frequent errors found in the design of gear pairs
- Profile modifications
- Internal tooth forms

Manufacturing Tolerances and Inspection

- The various methods for inspection of gears
- Tolerances and allowances
- Calculation with grinding stock allowance

Bevel, Worm, Crossed-Helical, and Face Gears (On Request)

- Geometry and Manufacturing Processes

Day 2: Gear Strength

Strength Calculations (with involute tooth forms)

- Safety factors (theoretical), Identifying required safety factors
- Calculation of the root strength, theory, important formulae
- Calculation of the flank strength, theory, important formulae
- Scuffing (according to flash temperature and integral temperature)
- Micropitting (On request)
- Tooth flank fracture (On request)
- Static strength calculation for gears
- Definition and application of Woehler Line (S-N curve)
- Load spectrum calculation
- Effect of profile and flank modifications
- Measures against gear damage

Bevel, Worm, Crossed-Helical, and Face Gears (On Request)

- Strength calculations

Day 3: Contact Analysis and Gear Optimization

Contact Analysis of Cylindrical Gears

Introduction to the theory of face load calculation

- Face load factor $K_{H|F}$ according to ISO 6336-1, Annex E
- Tooth spring stiffness according to ISO 6336-1
- Tooth pair spring stiffness according to the Weber/Banaschek
- Approximation and effects of helical gear teeth
• Importance of the inclination/deviation error of axis
• Taking the shaft calculation into account
• Analytical model for planetary gear contact analysis
• Effect of planet carrier deformation
• Options and limits of planetary gear contact analysis

**Interpretation of the most important results**

• Interpretation of the transmission error
• Effect of transverse contact ratio and overlap ratio on the transmission error
• Identification of entry and exit impact
• Importance and interpretation of the progressions of normal force, stress, and kinematics
• Load distribution for planets
• Micropitting by contact analysis

**Contact analysis with bevel gear units (On request)**

• Analytical model for bevel gear unit calculation

**Gear Optimization**

**Commonly Used Strategies for Optimization of gears**

• Define raw dimension of gears (Rough sizing)
• Define macro geometry of gears (Fine sizing)
• Define micro geometry of gears (Modification sizing)
• Well balanced root and flank strength
• Strategies for optimizing tooth form for noise reduction
• Deep tooth forms
• Contact stiffness, contact of a gear pair under load
• Transmission error and Impact shock
• Profile and flank modifications
• Sizing and optimizing modifications for load spectra

**Calculation of Gear Drive System by KISSsys (On request)**

Presentation of KISSsys, the extension to KiSSsoft for the calculation of entire systems of machine elements. KISSsys calculates the power transmission and manages the interactions between system elements.