KISSsoft
Drivetrain Design Solutions

# KISSsoft Training

# Cylindrical Gear Design, Analysis and Optimization

4 days

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Sharing Knowledge

# Cylindrical Gear Design, Analysis and Optimization

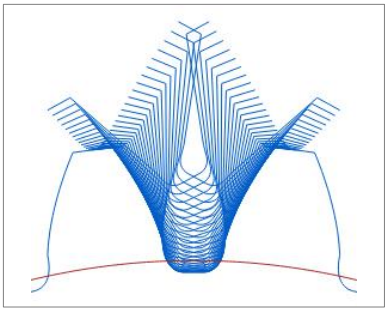
The objective of this training is to understand the fundamental theories for cylindrical gear design and analysis, and to learn the application usages of KISSsoft.

The training starts with the geometric definition and properties, manufacturing and inspection techniques of cylindrical gears in the first day.
The second day explains in-depth knowledge on gear failure modes and strength rating methods.
The third day explores the contact analysis regarding tooth load and stress, stiffness, transmission error, vibration and noise, and other important results under actual operating condition.
The last day focuses on how to apply the knowledge built in the previous days on gear design and optimization. Strategies to achieve optimal gear design in various criteria will be explored by using KISSsoft sizing functionalities.
Various exercises during the training will help to deepen knowledge and learning experience.

After successful completion of the training, participants will have gained knowledge on how to interpret the gear rating, analyze results properly and how to apply the software to improve gear design from the conceptual to the final design phases.

This training course is designed for engineers who are already familiar with cylindrical gear calculations and basic functionalities of KISSsoft. If a participant has a lack of knowledge on gears or KISSsoft usages and user interface, we highly recommend going through the KISSsoft tutorials posted on the KISSsoft website before the training. Interested engineers may also ask for a test version to help with the preparation.

## Day 1: Geometry of Cylindrical Gears with Involute Profile

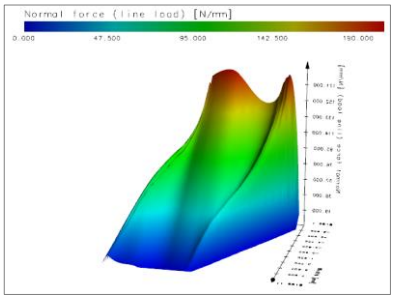


- Gearing law, Involute tooth form
- Reference profile and tool geometry
- Tooth form for spur and helical gears, external and internal gears
- Profile shift, Grinding stock allowance, Manufacturing profile shift
- Sizing profile shift coefficient and deep tooth form
- Path of contact, Specific sliding
- Definition of various circles
- Backlash (Theoretical and Operating), Tip clearance
- Operating backlash calculation
- Tolerances and allowances, Quality and deviation
- Various methods for inspection
- Tooth flank modifications (Profile and tooth trace)
- Profile and tooth trace diagram (K chart)
- Measurement grid report
- Most frequent errors found in the geometric design of gear pairs
- Exercises

## Day 2: Strength Rating and Failure Mode Analysis

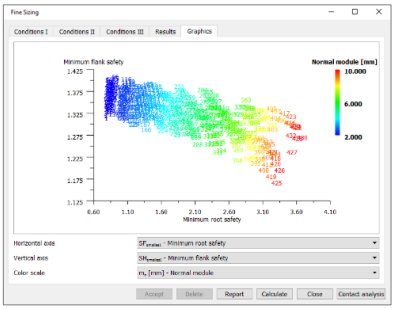
- Calculation of safety factors, Identifying required safety factors
- Definition of material data and Woehler Line (S-N curve)
- Calculation of the flank safety (pitting resistance)
- Calculation of the root safety (bending strength)
- Root stress calculation by graphical method
- Root stress calculation by FEM (2D and 3D)
- Root stress calculation for internal gears
- Static strength calculation
- Calculation of scuffing (flash temperature and integral temperature)
- Micropitting (On request)
- Tooth flank fracture (On request)
- Safety of hardened layer (On request)
- Load spectrum analysis
- Reliability, lifetime, and damage calculation
- Effect of profile and flank modifications on strength
- Interpretation of failure modes and strategies to prevent the failure
- Exercises

## Day 3: Loaded Tooth Contact Analysis




- Basic principle of loaded tooth contact analysis (LTCA)
- Tooth stiffness according to Weber/Banaschek
- Assumptions in analysis of helical gear teeth
- Actual path of contact and identification of entry and exit impact
- Effective transverse contact ratio and overlap ratio
- Actual normal force and stress distribution
- Transmission error and it's relation with vibration and noise
- Effect of the deviation and inclination error of axis
- Combining the shaft calculation
- Combining the gear body deformation by FEM
- Calculation of face load factor according to ISO 6336-1 Annex E
- Micropitting by contact analysis
- Analytical model for planetary gear contact analysis
- Effect of planet carrier deformation
- Calculation of planet carrier deformation by FEM
- Load sharing among planets
- Options and limitations of planetary gear contact analysis
- Exercises

## Day 4: Strategies for Gear Design Optimization




- Rough sizing to define raw dimension of gears
- Fine sizing to define macro geometry of gears
- Modification sizing to define micro geometry of gears
- Finding optimal solution well balanced for various criteria
- Incorporating contact analysis results in sizing functions
- Strategies for optimizing tooth flank form for strength and noise
- Sizing modifications considering load spectrum
- Sizing modifications considering manufacturing errors
- Exercises

The training topics can be adapted to the knowledge level of the participants and upon special request from the participants. If you have any question on detailed contents or any interest on special topics, please send us an email to training@KISSsoft.AG.