

iLearnVibration Subjects

This document has been created to show you which subjects are covered in iLearnVibration, and for iLearnInstructor users, to illustrate the basic order, structure and content of our courses.

We hope that this material will help you to prepare your courses.

Maintenance practices

- Introduction to maintenance practices

- Why do we perform vibration analysis?
- What costs can be reduced?
- Why do machines fail?
- How can you achieve the best results?

- Common maintenance practices

- Introduction
- Breakdown Maintenance
- Preventive Maintenance
- Predictive Maintenance
- Proactive Maintenance
- In conclusion

Condition monitoring

- An introduction to condition monitoring

- Introduction
- Why do we do it?
- How do we do it?

- Condition monitoring technologies

- Vibration analysis
- Oil analysis
- Wear particle analysis
- Infrared thermography

- The future of condition monitoring

- The future
- Technology integration
- Merger between maintenance and process monitoring

- Automation and on-line monitoring
- On-line monitoring and automated diagnostics
- The Internet

- Review

- In review

Vibration fundamentals

- Getting started

- Let's get started

- What is vibration?

- What is vibration?
- Where it all began
- Understanding vibration

- Introducing the time waveform

- The time waveform
- Introducing "period" and "frequency"
- Period and frequency
- Introducing "CPM"
- Introducing "Hertz"
- Introducing "RPM"
- Speed and the waveform
- Introducing "amplitude"
- Introducing "peak-to-peak"
- Introducing "peak"
- A real signal
- Introducing the "average"
- Introducing "rms"
- The rms
- Going into greater depth
- Do you need to know this?

- Understanding phase

- Let's learn about phase
- Phase is an important diagnostic tool

- Sensing vibration

- Sensing vibration
- A new simulator

- Displacement, velocity and acceleration

- Introducing "displacement"
- Introducing "velocity"
- Velocity and displacement
- Velocity
- Introducing "acceleration"
- Acceleration and displacement
- Acceleration, velocity and displacement
- Acceleration
- Displacement

- A review of the time waveform

- Review the waveform
- Waveforms can be very complex
- Looking for change
- Increased out-of-balance
- Increasing rub

- *Introducing the spectrum*

- Introducing the spectrum
- A new unit of frequency: orders
- A review

- *Forcing frequencies*

- Introducing forcing frequencies
- Calculating forcing frequencies
- General forcing frequency calculations
- Rolling element bearings
- Gearbox forcing frequencies
- Transmission components
- Gearbox forcing frequencies revisited
- Multi-stage gearboxes
- Belt drives
- Putting it all together
- Review of forcing frequencies

- *Signals*

- The wonders of signals
- Quick tour of the tutorial control panel
- Sine wave
- Square wave and harmonics
- Clipped wave
- Transients
- Modulation and sidebands
- Beat frequencies
- Mixing signals, and phase

- *Overall readings*

- Overall readings

- *An introduction to vibration analysis*

- Introduction to analysis

Measuring vibration

- *Introduction to vibration measurement*

- Introduction
- The basics
- Converting between acceleration, velocity and displacement
- Why do I need to know this?

- *Transducer types*

- Transducer types
- Displacement transducers
- Velocity transducers
- Accelerometers
- Transducer settling time

- When isn't displacement actually displacement?
- Triaxial accelerometers
- Calibration

- *Selecting a transducer*

- Selecting a transducer

- *Vibration units*

- Vibration units

- *Positioning the sensor*

- Positioning the sensor

- *Mounting the sensor*

- Mounting the sensor
- Temporary mounting
- Probe tip summary
- Using magnets
- Target pads
- Quick connect pads
- Permanent stud mounting
- Threaded stud
- Cement pad

- *Collecting routine measurements*

- Collecting routine measurements

- *Recognizing bad data*

- Recognizing bad data
- Power-on settling time
- Thermal transients
- Dirty surface causes loss of high frequency content
- Harmonics due to poor contact
- Sensor problems
- Harmonics due to poor contact
- Recognizing bad data
- Thermal transients

- *Measuring phase*

- Measuring phase
- Relative phase readings
- What happens inside the data collector?
- Operating deflection shapes
- Conclusion

Data processing

- *Introduction*

- Introduction

- *Collecting data*

- Collecting data: A brief history of time

- *Sampling*

- Understanding sampling and the FFT

- Aliasing

- Understanding aliasing
- Anti-alias filters and sigma-delta sampling

- Sampling revisited

- A closer look at sampling

- Windowing

- Understanding windowing
- Window factor and resolution

- Window types

- The Hanning window
- The flat top window
- The Hamming window
- Rectangular and uniform window
- Experiment with windowing
- Why is this important?

- Dynamic range

- Understanding dynamic range

- Averaging

- Understanding averaging
- Overlap averaging
- Peak hold averaging
- Run-up and coast-down tests
- Speed variation tests
- The bump test
- Time synchronous averaging

Vibration analysis

- Introduction

- Introduction

- The four phases of vibration analysis

- The four phases - a summary
- The "analysis pyramid"

- The detection phase

- The detection phase
- The exception report
- Setting alarm limits
- Fixed alarm limits
- ISO Standards
- Calculated alarm limits
- What are the calculations?
- Statistics
- Statistics with a twist
- Detection techniques
- Band alarms
- Envelope alarms
- Expert systems
- Artificial intelligence systems

- Dealing with speed variation
- Summary of the detection phase

- The Analysis phase

- Analysis phase
- Trending
- Spectrum analysis
- Validate the data
- Checking for transducer faults
- Checking for correct test conditions
- Checking for the correct point
- Identifying the running speed peak
- A quick scan of the data
- Recognizing the pattern
- Analyzing harmonics
- Analyzing sidebands
- Two approaches to analyzing sidebands
- Noise floor and humps
- The importance of vibration amplitude
- Spectral comparison overview
- Spectral comparisons to reference data
- Introducing stacked plots
- Introducing waterfall plots
- Reference spectra and averaging
- Logarithmic displays
- Understanding machine vibration - the big picture
- Compare to other axes
- Introducing the triaxial plot
- Compare data to another location
- Compare data to another location
- Compare data to another machine
- Time waveform analysis
- The importance of transducer type
- The importance of the measurement setup
- Measurement axes and storage
- Performing the analysis
- Analysis techniques

- The root cause analysis phase

- Root cause analysis
- Check the history of data
- Look at the big picture

- The verification phase

- Verification phase

Machinery Fault Diagnosis

- Introduction to machinery fault diagnosis

- Introduction to fault diagnosis
- Understand the spectrum
- Understand the machine
- Play the odds

- Imbalance

- Diagnosing imbalance
- Imbalance
- Assessing the severity of imbalance
- The importance of imbalance
- Understanding imbalance
- Vibration analysis
- Vertically oriented machines
- Overhung rotors
- The causes of imbalance
- Analyzing the data
- Example One:
- Example Two:

- Eccentricity

- Understanding eccentricity

- Misalignment

- Diagnosing misalignment
- Understanding angular misalignment
- Understanding parallel misalignment
- Common Misalignment
- Confusing misalignment with imbalance
- Temperature affects on misalignment
- The importance of misalignment
- Causes of misalignment
- Vibration analysis
- Example:

- Bent shaft

- Diagnosing bent shaft

- Cocked bearing

- Diagnosing a cocked bearing

- Looseness

- Diagnosing looseness
- Rotating looseness
- Example:
- Structural looseness (foundation flexibility)
- Loose pillow block (pedestal) bearings
- Example One:
- Example Two:
- Example Three:

- Rotor rub

- Diagnosing rotor rub
- Example:

- Journal bearings

- Wear/clearance problems
- Oil Whirl
- Oil Whip

- Resonance

- Diagnosing resonance conditions

- Bump tests
- Run up or coast down tests
- Variable speed test
- Diagnosing resonance

- Rolling element bearings

- Diagnosing rolling element bearing faults
- Rolling element bearings
- Spectrum and time waveform analysis
- Forcing frequency calculations
- Forcing frequencies visualized
- The nine stages of bearing failures
- Stage One
- Stage Two
- Stage Three
- Stage Four
- Stage Five
- Stage Six
- Stage Seven
- Stage Eight
- Stage Nine
- Example

- Demodulation

- Using and understanding demodulation
- Other applications for demodulation

- Hydraulic and Aerodynamic forces

- Blade pass
- Blade faults
- Flow turbulence
- Cavitation
- Example:

- Pumps

- Diagnosing problems associated with pumps

- Fans

- Diagnosing problems associated with fans

- Compressors

- Diagnosing problems associated with centrifugal compressors
- Centrifugal compressors

- Reciprocating machines

- Diagnosing problems with reciprocating machines
- Reciprocating engines

- Electric motors

- Diagnosing faults associated with electric motors
- Synchronous motors
- Induction motors
- Sources of vibration in electric motors
- Stator problems
- Soft foot

- Eccentric rotors
- Rotor problems
- Rotor bow
- Cracked rotor bars
- Loose rotor bars
- Loose rotor
- Loose stator windings
- Lamination problems
- Loose connections
- Measuring motor current

- Steam and Gas Turbines

- Diagnosing Steam and Gas Turbines
- Journal bearings
- Orbit plots

- Gearbox analysis

- Gearbox analysis
- Time waveform analysis of gears
- Detecting tooth wear
- Tooth load
- Gear backlash
- Eccentric gears
- Misaligned gears
- Cracked or broken tooth
- Hunting tooth frequency

- Couplings

- Diagnosing coupling faults

- Belt drivers

- Diagnosing faults associated with belt drives
- Worn belts
- Example:
- Eccentric sheaves
- Sheave misalignment
- Belt resonance
- Example:

- Conclusion

- Conclusion

Running a successful condition monitoring program

- Introduction

- Introduction
- Perform a plant survey
- Financial issues
- Physical issues
- How many machines to test?
- Know your machine
- Standard test conditions
- Where do you measure?

- What do you measure?
- Setting up the database
- Setting and maturing alarms
- Day-to-day work
- The detection phase
- The analysis phase
- Making the recommendation
- The root cause analysis phase
- The verification phase
- Report your successes
- Don't be a statistic!
- In conclusion