Wind Turbine Condition Monitoring Training Course

Professional Development Training Course Outline

Category	Renewable Energy	**Duration**	5 Days
Base Fee	$1,500 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

Wind Turbine Condition Monitoring Training Course is designed to develop advanced capabilities in wind turbine health monitoring, predictive maintenance, fault detection, fault diagnosis, reliability engineering, SCADA analytics, vibration analysis, machine learning, and digital twin technology. As wind farms expand and operations and maintenance (O&M) becomes increasingly data-driven, condition monitoring is becoming essential for improving turbine availability, reducing unplanned downtime, optimizing maintenance costs, and extending asset life. Current industry research highlights SCADA-based monitoring, high-frequency vibration analysis, machine learning, acoustic analysis, and digital twins as major areas of development in wind turbine drivetrain monitoring.

This course provides participants with an integrated understanding of online condition monitoring, anomaly detection, predictive diagnostics, remaining useful life (RUL), condition indicators, sensor technologies, data preprocessing, AI-enabled maintenance, and asset performance management. Learners will work through realistic industry case studies involving gearbox, bearing, generator, main-shaft, and other turbine-system faults, while exploring how SCADA data, vibration signals, digital twins, IoT, edge analytics, and artificial intelligence can support proactive maintenance decisions. Recent 2026 research also emphasizes the growing role of digital twins in connecting real-time asset data, physics-based models, AI analytics, diagnostics, prognostics, and maintenance decision-making.

Programme Curriculum

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5 days

Course Objectives

By the end of the course, participants will be able to:

1. Understand the principles of wind turbine condition monitoring and predictive maintenance.
2. Identify common failure mechanisms affecting gearboxes, bearings, generators, shafts, and other drivetrain components.
3. Apply SCADA analytics to establish turbine performance and health baselines.
4. Interpret vibration analysis and frequency-domain indicators for machinery diagnostics.
5. Apply fault detection and anomaly detection techniques to turbine operating data.
6. Develop practical condition indicators and health indices for turbine assets.
7. Understand machine learning and AI-enabled condition monitoring approaches.
8. Apply digital twin concepts to real-time turbine health assessment.
9. Evaluate remaining useful life (RUL) and prognostics concepts for maintenance planning.
10. Integrate sensor, SCADA, vibration, temperature, and other multisource condition-monitoring data.
11. Reduce false alarms through effective data preprocessing, feature engineering, and threshold selection.
12. Translate monitoring results into risk-based maintenance and asset management decisions.
13. Design an integrated condition-based maintenance strategy for improved reliability, availability, and O&M performance.

Target Audience

1. Wind Farm Operations & Maintenance Managers
2. Wind Turbine Maintenance Engineers
3. Reliability and Asset Performance Engineers
4. Condition Monitoring and Predictive Maintenance Specialists
5. Mechanical, Electrical, and Control Engineers
6. SCADA, Data Analytics, and Industrial AI Professionals
7. Renewable Energy Project and Asset Managers
8. Engineering Consultants, Researchers, and Technical Trainers

Course Modules

Module 1: Fundamentals of Wind Turbine Condition Monitoring

- **Condition monitoring fundamentals** and the role of proactive maintenance in wind energy.
- Wind turbine architecture
- Failure modes, degradation mechanisms, **failure signatures**, and criticality assessment.
- Online versus offline monitoring and the evolution from corrective to **condition-based maintenance**.
- **Case Study:** Developing a monitoring strategy for a wind farm experiencing recurring drivetrain failures.

Module 2: Sensors, Data Acquisition, and Monitoring Technologies

- Accelerometers, temperature sensors, oil sensors, strain gauges, acoustic sensors, electrical measurements, and other **condition-monitoring technologies**.
- Sensor placement, sampling rates, signal quality, calibration, and measurement uncertainty.
- Vibration, temperature, lubrication, acoustic emission, electrical, and operational data.
- IoT-enabled monitoring, remote diagnostics, edge computing, and **real-time asset intelligence**.
- **Case Study:** Selecting a multisensor monitoring architecture for an offshore wind turbine.

Module 3: SCADA Data Analytics for Wind Turbines

- Understanding **SCADA systems**, operational variables, alarms, events, and historical turbine datasets.
- Data cleaning, synchronization, missing-data treatment, outlier detection, and **data preprocessing**.
- Normal operating envelopes, baseline modeling, power-curve analysis, and performance deviation.
- **Anomaly detection** using statistical and data-driven approaches.
- **Case Study:** Using SCADA trends to identify an emerging generator or drivetrain abnormality before major failure.

Module 4: Vibration Analysis and Drivetrain Diagnostics

- Time-domain and frequency-domain analysis of **wind turbine vibration signals**.
- FFT, spectral analysis, envelope analysis, order analysis, and condition indicators.
- Bearing, gearbox, shaft, coupling, and generator fault signatures.
- Misalignment, imbalance, looseness, resonance, bearing degradation, and gear-mesh abnormalities.
- **Case Study:** Diagnosing a developing gearbox bearing fault from vibration trends and spectral features.

Module 5: Fault Detection, Diagnosis, and Prognostics

- **Fault detection vs. fault diagnosis vs. prognosis** and their roles in maintenance decision-making.
- Thresholds, alarms, trend analysis, statistical process monitoring, and change-point detection.
- Root-cause analysis and fault classification.
- **Remaining Useful Life (RUL)**, degradation modeling, and maintenance-window estimation.
- **Case Study:** Building a fault-diagnosis workflow for early identification of a turbine generator problem.

Module 6: Artificial Intelligence and Machine Learning for Condition Monitoring

- **Machine learning for predictive maintenance**
- Feature engineering, dimensionality reduction, clustering, classification, and regression.
- Autoencoders, anomaly detection, time-series analytics, and health-index development.
- Model validation, false positives, false negatives, explainability, and **trustworthy AI**.
- **Case Study:** Developing an AI-based health indicator to distinguish healthy turbine behavior from abnormal drivetrain conditions.

Module 7: Digital Twins, Predictive Maintenance, and Intelligent O&M

- Digital Twin architecture for **wind turbine health monitoring**.
- Linking physical assets, sensors, SCADA, analytics, simulation, and maintenance systems.
- Physics-based, data-driven, and hybrid **Digital Twin models**.
- Predictive, prescriptive, and increasingly autonomous maintenance concepts.
- **Case Study:** Creating a Digital Twin-based workflow for monitoring a 3 MW-class wind turbine.

Module 8: Integrated Condition-Based Maintenance Strategy

- Converting monitoring outputs into **maintenance recommendations and work priorities**.
- Risk-based maintenance, criticality ranking, failure consequences, and maintenance optimization.
- KPI development: availability, reliability, downtime, mean time between failures, and maintenance cost.
- Integrating **SCADA + vibration + AI + Digital Twin + asset management** workflows.
- **Case Study:** Designing an end-to-end condition-based maintenance program for a multi-turbine wind farm.

Training Methodology

- Interactive lectures and presentations.
- Group discussions and brainstorming sessions.
- Hands-on exercises using real-world datasets.
- Role-playing and scenario-based simulations.
- Analysis of case studies to bridge theory and practice.
- Peer-to-peer learning and networking.
- Expert-led Q&A sessions.
- Continuous feedback and personalized guidance.

Register as a group from 3 participants for a Discount

Send us an email: info@fineskilltrainingcenter.org or call *+254769199797*

Certification

Upon successful completion of this training, participants will be issued with a globally- recognized certificate.

Tailor-Made Course

We also offer tailor-made courses based on your needs.

Key Notes

a. The participant must be conversant with English.

b. Upon completion of training the participant will be issued with an Authorized Training Certificate

c. Course duration is flexible and the contents can be modified to fit any number of days.

d. The course fee includes facilitation training materials, 2 coffee breaks, buffet lunch and A Certificate upon successful completion of Training.

e. One-year post-training support Consultation and Coaching provided after the course.

f. Payment should be done at least a week before commence of the training, to Fineskill Training Center account, as indicated in the invoice so as to enable us prepare better for you.

Upcoming Scheduled Sessions

Start Date	End Date	Location	Price
21 Sep 2026	25 Sep 2026	Online	$1,000
21 Sep 2026	25 Sep 2026	Physical	$1,500
21 Sep 2026	25 Sep 2026	Physical	$0
21 Sep 2026	25 Sep 2026	Physical	$0
21 Sep 2026	25 Sep 2026	Physical	$0
21 Sep 2026	25 Sep 2026	Physical	$0
21 Sep 2026	25 Sep 2026	Physical	$0
21 Sep 2026	25 Sep 2026	Physical	$0

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