ME4000 Predictive Maintenance Techniques
Midterm Exam

1. Briefly describe predictive maintenance and condition monitoring (25P). [PÇ3, %50, PÇ4,%50]

2. Provide examples of sensor types used in predictive maintenance and give a brief overview of piezoelectric accelerometers (25P). [PÇ3, %50, PÇ4,%50]

3. Explain data acquisition systems briefly (25P). [PÇ3, %50, PÇ4,%50]

4. Draw the curve for failure rates over time and briefly explain the regions on the curve (25P). [PÇ3, %50, PÇ4,%50]

Best wishes…   Dr. Y. Emre KARABACAK

ANSWERS

1. _Predictive maintenance_ is a proactive maintenance strategy that involves predicting when equipment failure is likely to occur based on data analysis, monitoring, and machine learning algorithms. By analyzing equipment data such as temperature, vibration, or performance metrics, predictive maintenance aims to anticipate issues before they occur, allowing for timely maintenance or repairs to prevent unplanned downtime.

Condition monitoring, on the other hand, is the process of continuously monitoring the condition of equipment or machinery to detect any changes or abnormalities that may indicate potential faults or failures. It involves collecting and analyzing real-time data from sensors, meters, or other monitoring devices to assess the health and performance of the equipment. Condition monitoring helps in identifying issues early on, allowing for proactive maintenance actions to be taken before they escalate into more significant problems.

2. _Vibration Sensors_: These sensors detect abnormal vibrations in machinery, which can indicate misalignment, bearing wear, or other mechanical issues.

Temperature Sensors: They monitor the temperature of equipment to detect overheating, which could be a sign of impending failure.

Pressure Sensors: These sensors monitor pressure levels in hydraulic systems, air compressors, or other systems to detect leaks or other abnormalities.

Flow Sensors: They measure the flow rate of liquids or gases in pipes or systems, helping to identify issues such as blockages or leaks.

Current Sensors: These sensors monitor electrical currents in motors or other equipment to detect abnormalities such as overloading or phase imbalances.

Piezoelectric accelerometers are a specific type of vibration sensor commonly used in predictive maintenance. They work based on the piezoelectric effect, which converts mechanical stress into electrical charge. When the accelerometer is subjected to vibration or acceleration, it generates a proportional electrical signal. This signal is then processed to analyze the frequency, amplitude, and other characteristics of the vibration, providing valuable insights into the health and condition of the machinery.

3. _Data acquisition systems_ are hardware and software setups designed to collect, process, and store data from various sensors and sources. These systems are commonly used in industrial, scientific, and engineering applications to monitor and control processes, conduct experiments, and gather information for analysis.

A typical data acquisition system consists of three main components:

Sensors: These are devices that measure physical quantities such as temperature, pressure, voltage, current, or flow rate and convert them into electrical signals.

Signal Conditioning: The electrical signals from sensors often need to be conditioned or modified before they can be accurately measured and analyzed. Signal conditioning may involve amplification, filtering, isolation, or other processes to improve signal quality and accuracy.

Data Acquisition Hardware: This component includes analog-to-digital converters, which convert the analog signals from sensors into digital data that can be processed by a computer or microcontroller. Data acquisition hardware also typically includes input/output modules, connectors, and other components to interface with sensors and other devices.

In addition to these hardware components, data acquisition systems also rely on *software* to control the acquisition process, configure sensor settings, display real-time data, and store collected data for further analysis. Modern data acquisition systems often include advanced features such as real-time data visualization, remote monitoring and control capabilities, and integration with other systems and software platforms. Overall, data acquisition systems play a crucial role in acquiring and processing data from the physical world, enabling informed decision-making and optimization of processes and systems.

4. *The first region* has a decreasing failure rate due to early failures. *The middle region* is a constant failure rate due to random failures. *The last region* is an increasing failure rate due to wear-out failures.