18ECO133T

Sensors and Transducers

UNIT V

Session 8: SLO – 1

Measuring Vibration with Accelerometers

What is vibration?

- Vibration is the movement or mechanical oscillation about an equilibrium position of a machine or component. It can be periodic, such as the motion of a pendulum, or random, such as the movement of a tire on a gravel road. Vibration can be expressed in metric units (m/s^2) or units of gravitational constant "g," where 1 g = 9.81 m/s^2. An object can vibrate in two ways: free vibration and forced vibration.
- Free vibration occurs when an object or structure is displaced or impacted and then allowed to oscillate naturally. For example, when you strike a tuning fork, it rings and eventually dies down. Natural frequency often refers to the frequency at which a structure "wants" to oscillate after an impact or displacement. Resonance is the tendency for a system to oscillate more violently at some frequencies than others. Forced vibration at or near an object's natural frequency causes energy inside the structure to build. Over time the vibration can become quite large even though the input forced vibration is very small. If a structure has natural frequencies that match normal environmental vibration, then the structure vibrates more violently and prematurely fails.

• Forced vibration occurs when a structure vibrates because an altering force is applied. Rotating or alternating motion can force an object to vibrate at unnatural frequencies. An example of this is imbalance in a washing machine, where the machine shakes at a frequency equal to the rotation of the turnstile. In condition monitoring, vibration measurements are used to indicate the health of rotating machinery such as compressors, turbines, or pumps. These machines have a variety of parts, and each part contributes a unique vibration pattern or signature. By trending different vibration signatures over time, you can predict when a machine will fail and properly schedule maintenance for improved safety and reduced cost.

Figure 1. *Structures may fail if their natural frequencies match environmental vibration.*

How do You measure Vibration?

- Vibration is most commonly measured using a ceramic piezoelectric sensor or accelerometer.
- An accelerometer is a sensor that measures the dynamic acceleration of a physical device as a voltage. Accelerometers are full-contact transducers typically mounted directly on high-frequency elements, such as rolling-element bearings, gearboxes, or spinning blades.
- These versatile sensors can also be used in shock measurements (explosions and failure tests) and slower, low-frequency vibration measurements.
- The benefits of an accelerometer include linearity over a wide frequency range and a large dynamic range.

Figure 1. *Accelerometers are versatile sensors used for high or low frequency vibration as well as shock measurements.*

- Another sensor you can use to measure vibration is the proximity probe.
- Unlike accelerometers, which measure acceleration to determine vibration, proximity probes are noncontacting transducers that measure distance to a target. These sensors are almost exclusively used in rotating machinery to measure the vibration of a shaft.
- An example of a common application is machine monitoring and protection measurements for mechanical systems like turbo machinery. Because of the flexible fluid film bearings and heavy housing, vibrations do not transmit well to the outer casing, so you use proximity probes instead of accelerometers to directly measure shaft motion.