

كلية المأمون الجامعة

قسم هندسة تقنيات القدرة الكهربائية

المرحلة الثانية

الميكانيك الهندسي / ٢

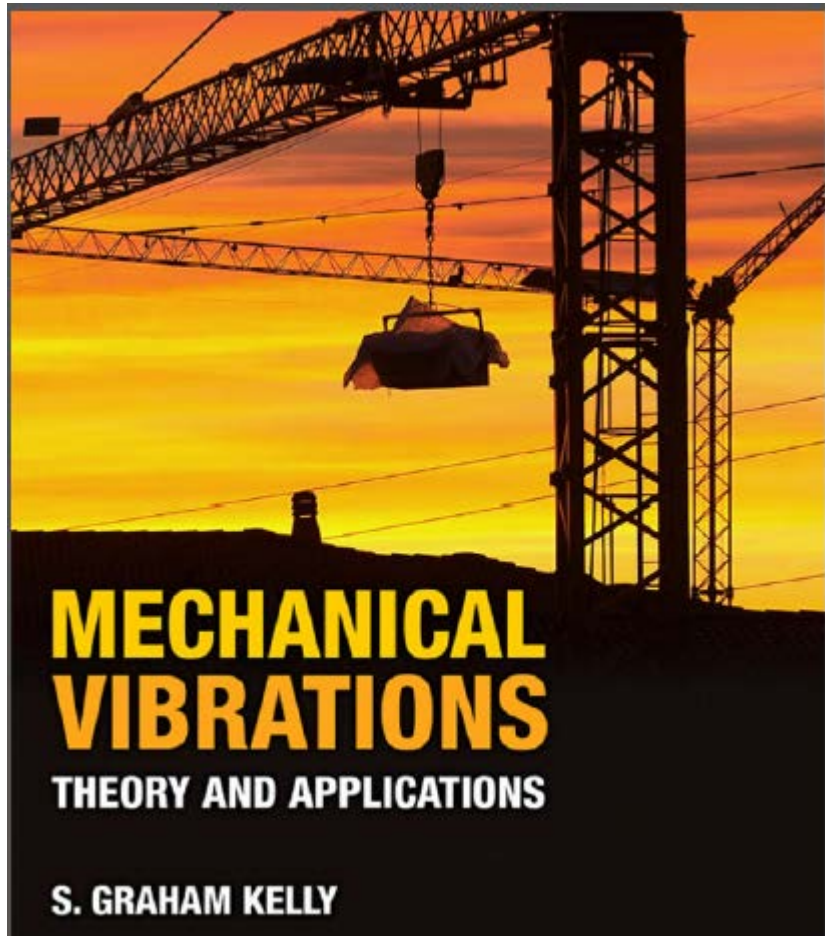
Mechanical engineering / 2

محاضرة -٦-

Topic Outline

- Measurement Vibration Instruments
 - Measuring Instrumentations Types
 - Transducer
 - Vibration Pickups
-

Mechanical Vibrations



Important Notes:

The course notes were compiled mostly from

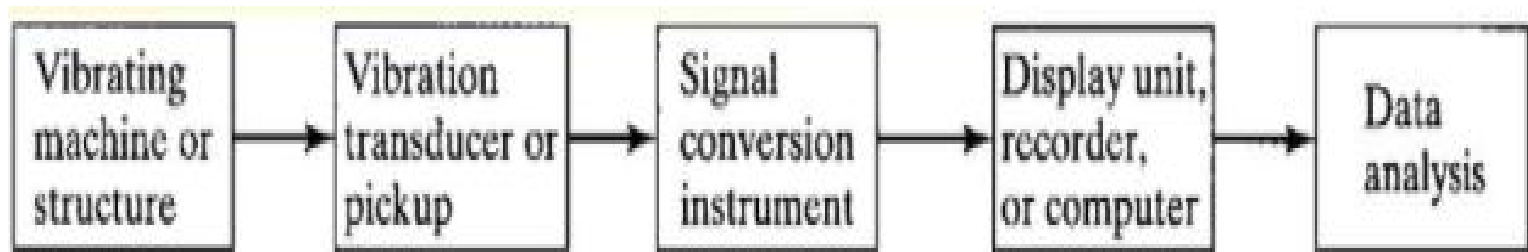
- 1) The book by **Graham Kelly**, “**Mechanical Vibrations, Theory and Applications**”, 2012.
- 2) **Bruel Kjaer** Technical notes,
- 3) **Dan Russel’s** webpage:
<http://www.acs.psu.edu/drussell>

Therefore, they are gratefully acknowledged.

WEEK-9:
Measurement Vibration Instruments

Measurement Vibration Instruments

- The measurement of natural frequencies of structure or machine is useful in the selecting the operational speed of machinery to avoid resonance conditions in the design and operation of activities vibration isolation system.



Measuring Instrumentations Types

Type of vibration measuring instrument used will depend on:

- Expected range of frequencies and amplitudes.
 - Size of machine/structure involved.
 - Conditions of operation of the machine/structure.
 - Type of data processing used.
-

Measuring Instrumentations Types

■ TRANSDUCER

is an electronic device that converts energy from one form to another, as the example the mechanical energy into equivalent electricity signal. Several types of transducers are available such as:



Transducer Types

1- Variable resistance transducer

In these transducers, the mechanical motion produces a change in electrical resistance (rheostat or strain gage) which causes a change in the output voltage or current.

The variable resistance transducer consists of:

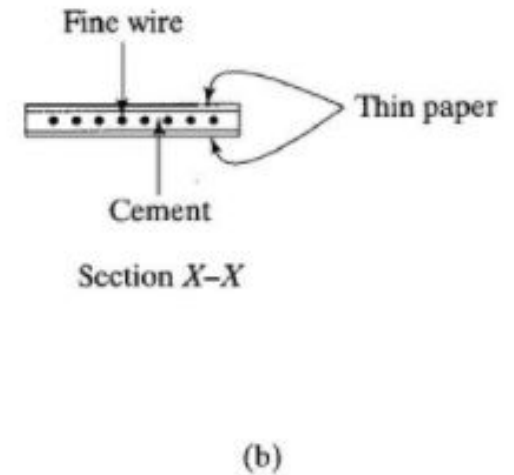
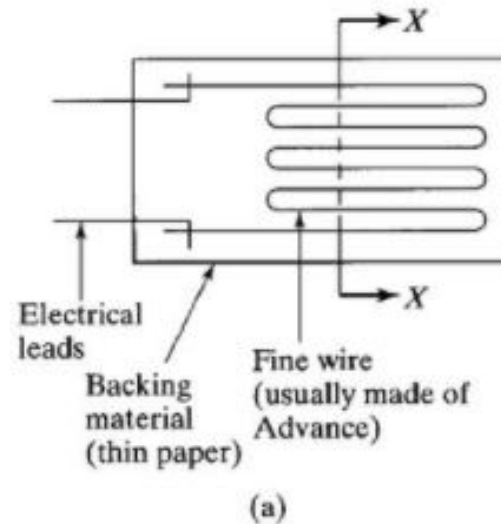
- fine wire: the wire is sandwiched between two sheets of thin paper.
 - strain gage: is bonded to the surface where the strain is to be measured of this paper
-

Transducer Types

when the surface under goes a normal strain (ϵ) the strain gage also under goes the strain and the change in resistance is given by:

$$K = \frac{\Delta R/R}{\Delta L/L} = 1 + 2\nu + \frac{\Delta r}{r} \frac{L}{\Delta L} = 1 + 2V$$

$$\epsilon = \frac{\Delta L}{L} = \frac{\Delta R}{R}$$



Transducer Types

■ Piezoelectric Transducer

Certain materials generate electrical charge when subjected to deformation or stress, the charge generated due acting force. Piezoelectric Transducer are made from Piezoelectric mater such that lithium sulfate, the charge generated in the vibration state due to a force is given by:

$$Q_x = K F_x = K A p_x$$

- Where: -
 - K = Piezoelectric constant.
 - A = is the area on which the force F_x acts
 - P_x = is the pressure due to F_x
-

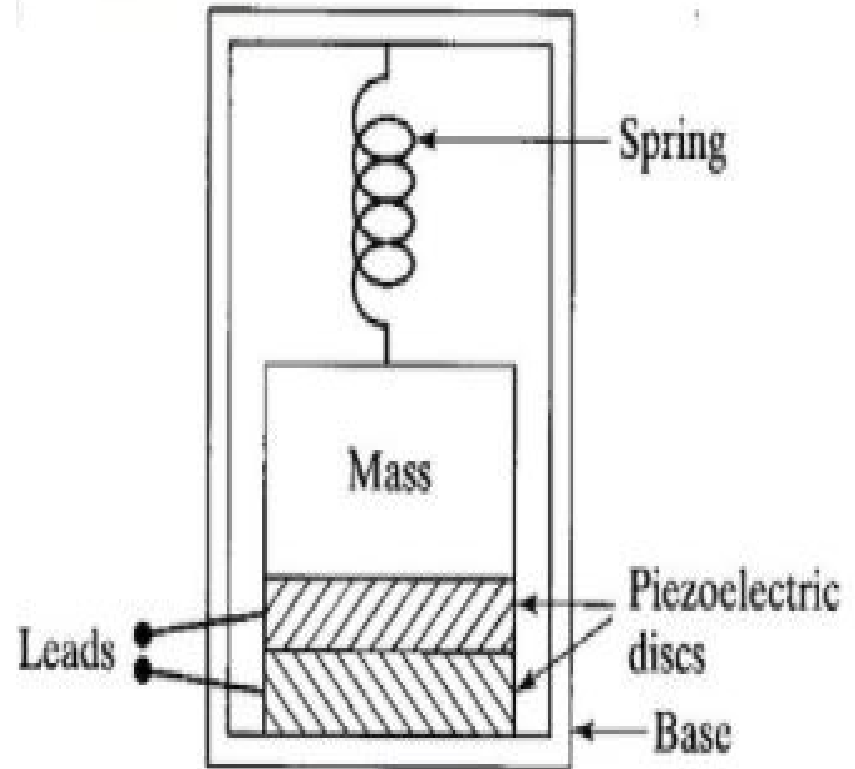
Transducer Types

- the output voltage of the crystal is given by

$$E = v t p_x$$

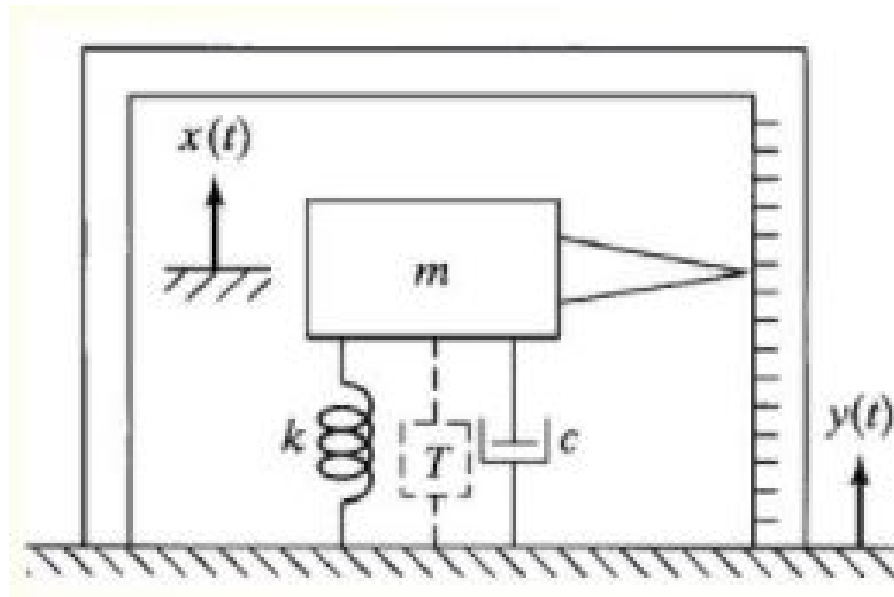
Where :

- v = is the voltage sensitivity
- t = is the thickness the crystal



Vibration Pickups

- Most common pickups are seismic instruments, bottom ends of spring and dashpot have same motion as the cage, where the vibration will excite the suspended mass.



Seismic Instrument

- the seismic instruments are essentially vibratory systems consisting of the support or the base and the mass with a spring attached. the support or the base is attached to the body whose motion is to be measured. the relative motion between the mass and the base, recorded by a rotating drum or some other devices inside the instrument will indicate the motion of the body. for measuring the displacement of a machine part, a vibrometer should be used, whose natural frequency is low compared to the frequency of vibration to be measured. An accelerometer is used to measure acceleration because its natural frequency is high than that of the vibration to be measured. Seismic monographs, the oldest Seismic instruments, are used for the recording of earthquake vibration. the more elaborate modern types of seismic instruments such as the torsigraph are used to record torsional vibration.
-