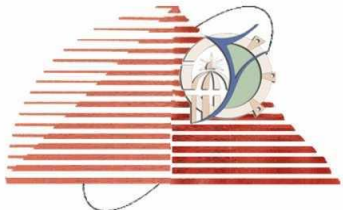


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**Fayoum University**



**Faculty of Engineering  
Mechanical Engineering Dept.**

*Lecture (9)*  
*on*

***Vibration Analysis,  
and Control***

*By*

***Dr. Emad M. Saad***

*Mechanical Engineering Dept.  
Faculty of Engineering  
Fayoum University*

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# Vibration Analysis

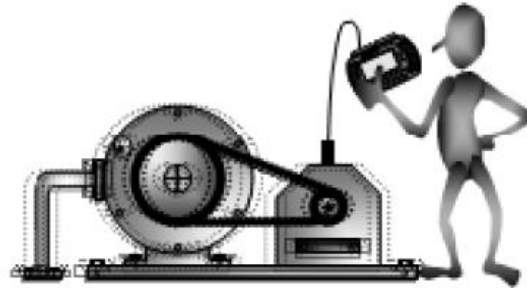
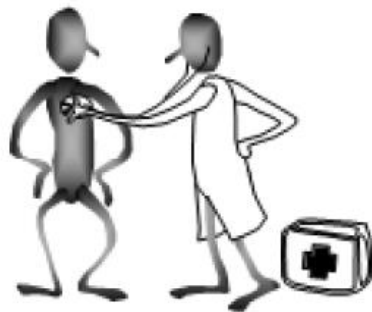
3





# Vibration Analysis

4

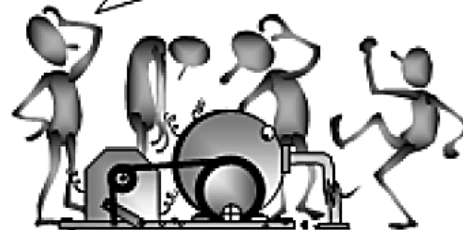


Just as it is costly to detect medical problems at a late stage, it is also the same for machines.

We cover all services and you have a choice: a \$200,000 operation or a \$5000 funeral.

It might be cheaper to replace it!

Now what?

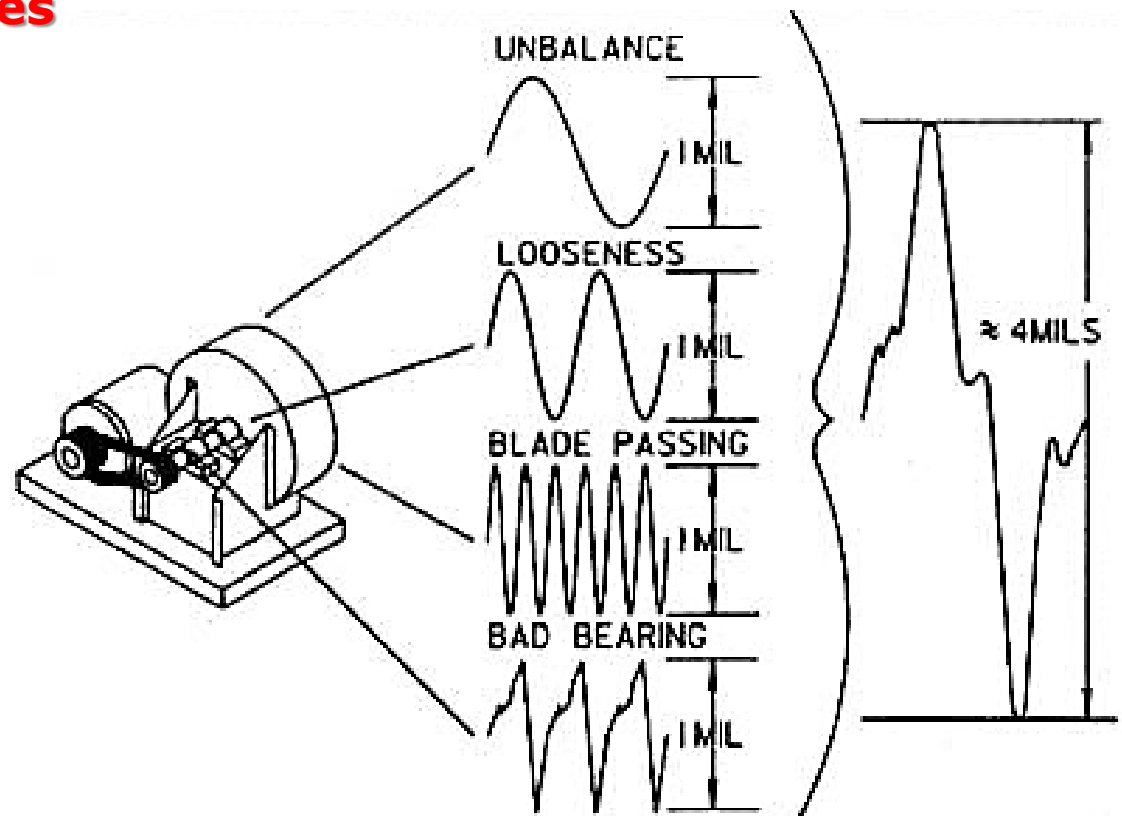




# Vibration Analysis

5

**Main machinery problems occur at specific frequencies**





# Vibration Analysis- Detection mode

6

Vibration analysis is used to determine the operating and mechanical condition of equipment. A major advantage is that vibration analysis can identify developing problems before they become too serious and cause unscheduled downtime. This can be achieved by conducting regular monitoring of machine vibrations either on continuous basis or at scheduled intervals.



## **Regular vibration monitoring can detect :**

- **deteriorating or defective bearings,**
- **mechanical looseness**
- **worn or broken gears.**
- **misalignment and unbalance before these conditions result in bearing or shaft deterioration.**

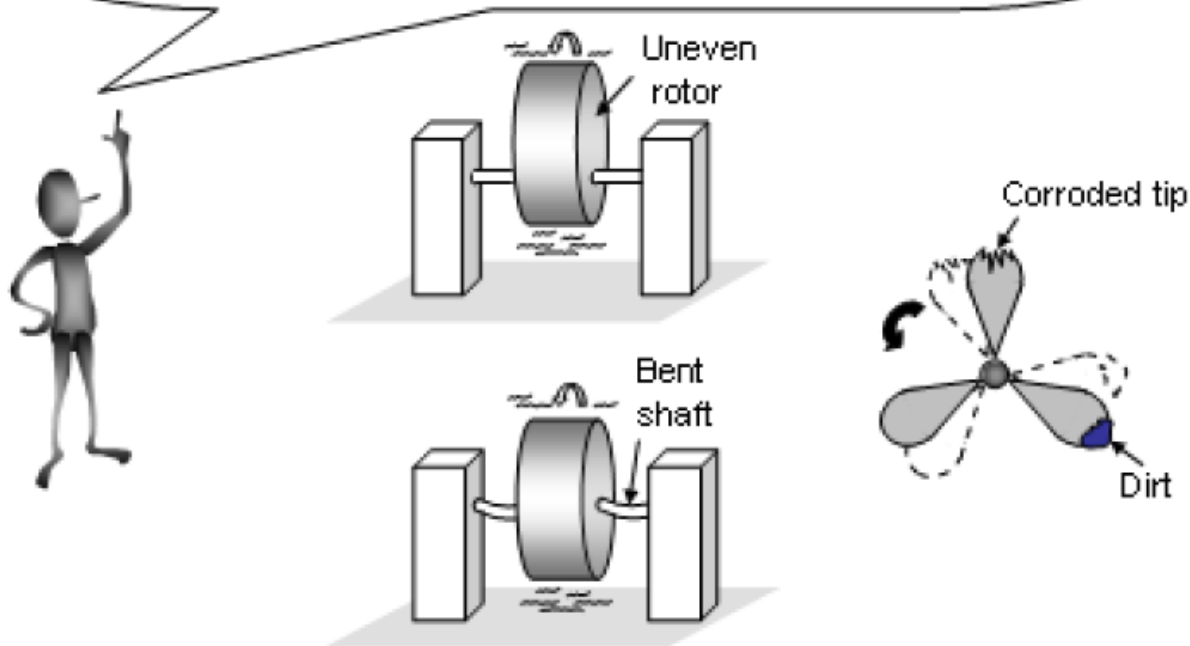




# Vibration Analysis- Detection mode

7

**Imbalanced** machine components contain 'heavy spots' which when rotated, exert a repeating force on the machine. Imbalance is often caused by machining errors, non-uniform material density, variation in bolt sizes, air cavities in cast parts, missing balance weights, incorrect balancing, uneven electric motor windings, and broken, deformed, corroded, or dirty fan blades.



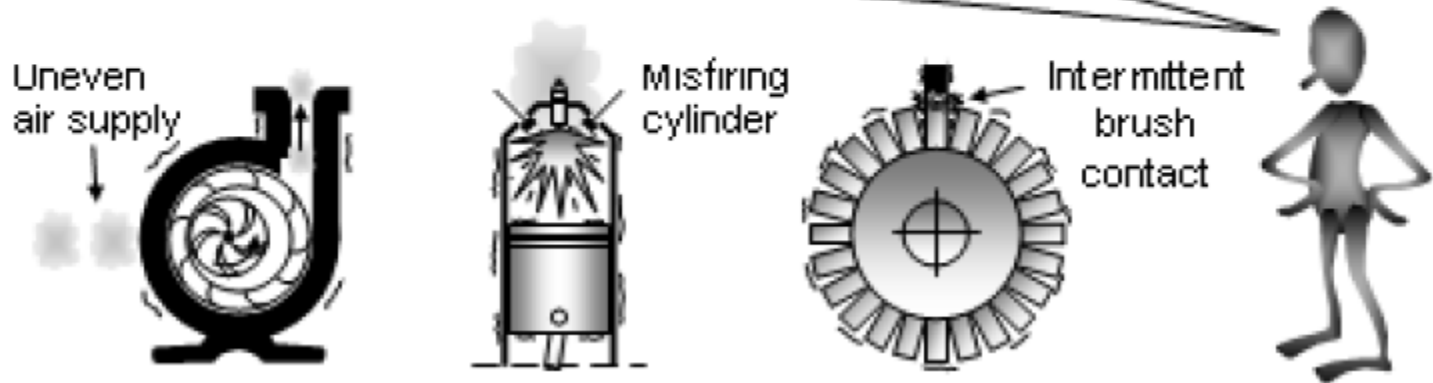




# Vibration Analysis- Detection mode

8

**Improperly driven** machine components exert a repeating force on the machine because of intermittent power supply. Examples include pumps receiving air in pulses, internal combustion engines with misfiring cylinders, and intermittent brush-commutator contact in DC motors.

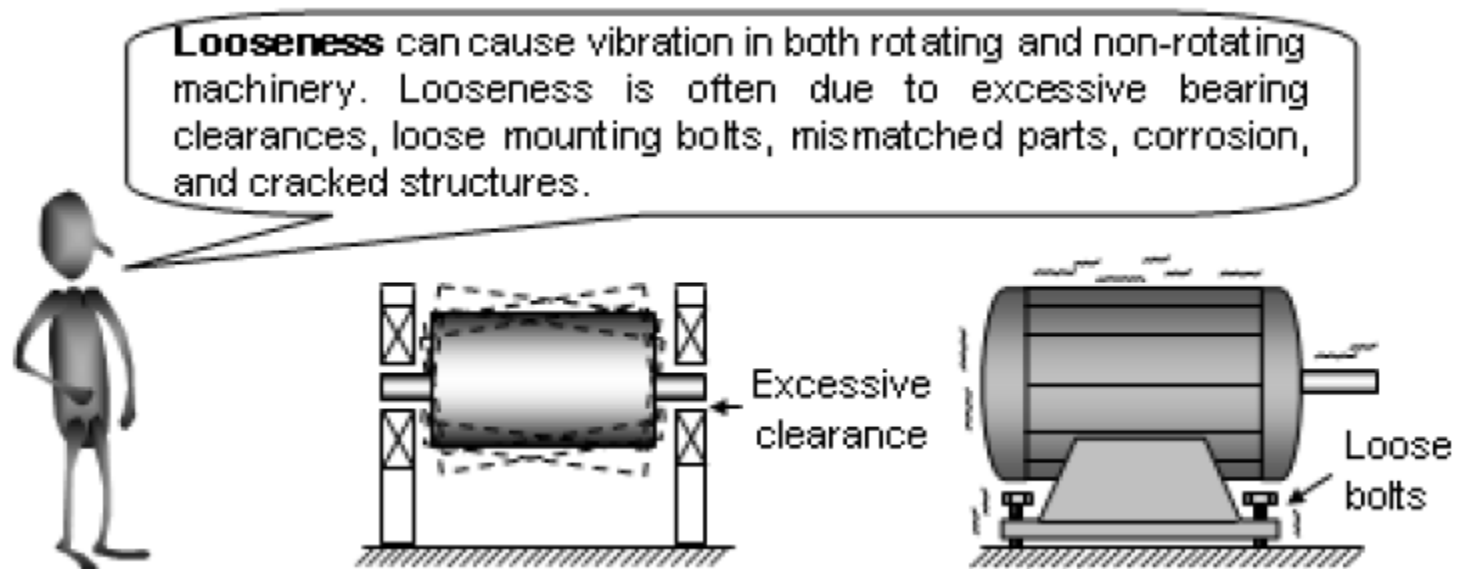






# Vibration Analysis- Detection mode

9



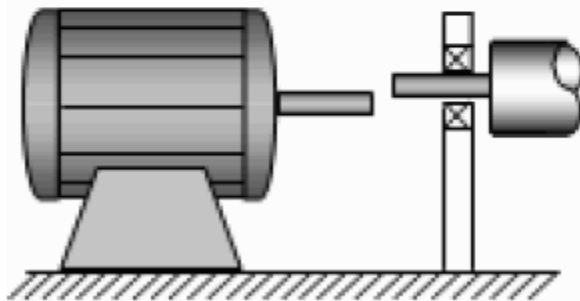


# Vibration Analysis- Detection mode

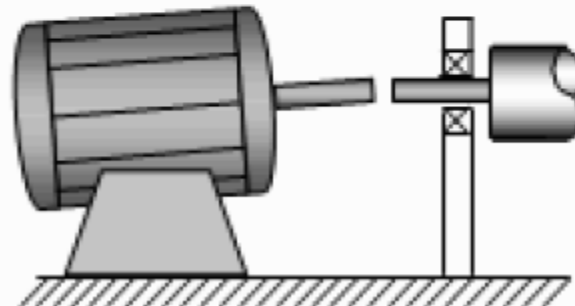
10

**Misaligned** machine components create "bending moments" which when rotated, exert a repeating force on the machine. Misalignment is often caused by inaccurate assembly, uneven floors, thermal expansion, distortions due to fastening torque, and improper mounting of couplings.

Parallel misalignment



Angular misalignment

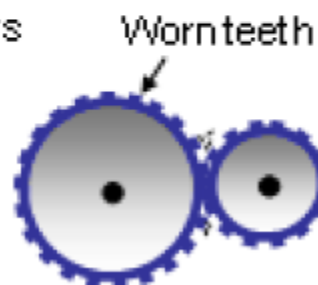




# Vibration Analysis- Detection mode

11

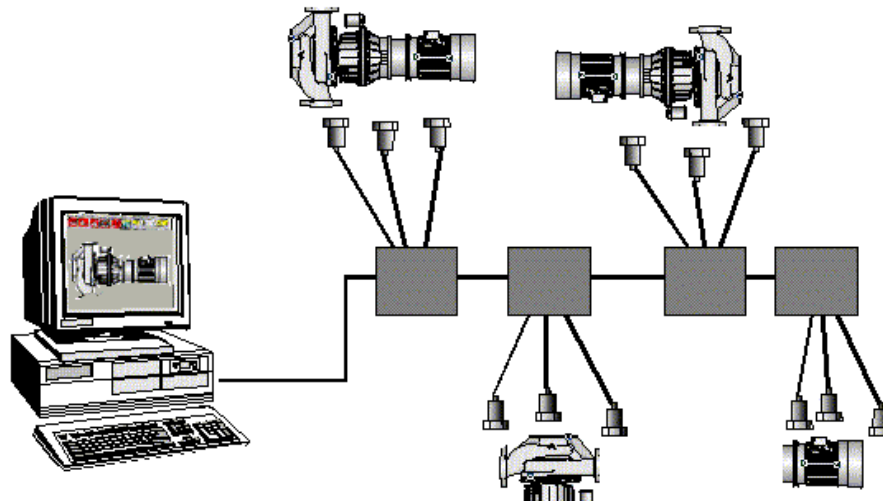
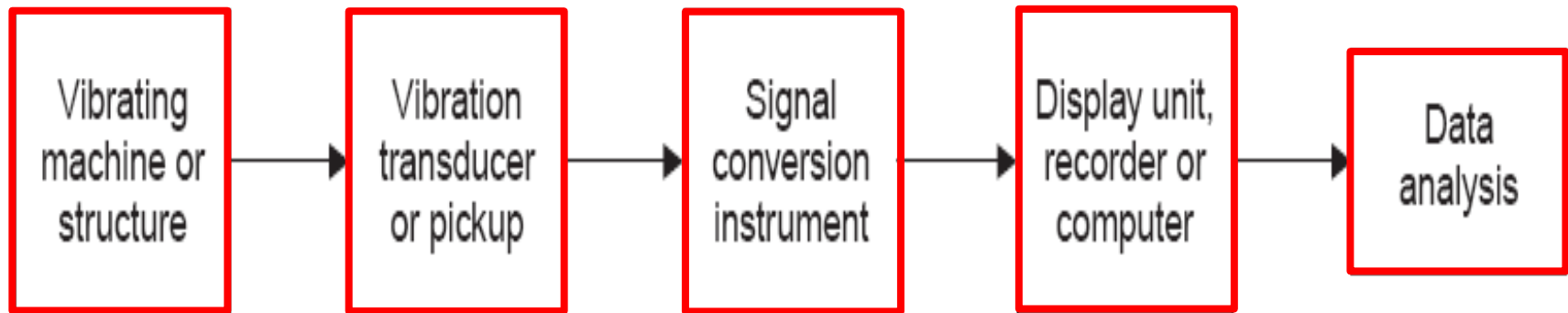
**Worn** machine components exert a repeating force on the machine because of the rubbing of uneven worn surfaces. Wear in roller bearings, gears, and belts is often due to improper mounting, poor lubrication, manufacturing defects, and overloading.





# Vibration Analysis- Detection mode

## Vibration analysis system

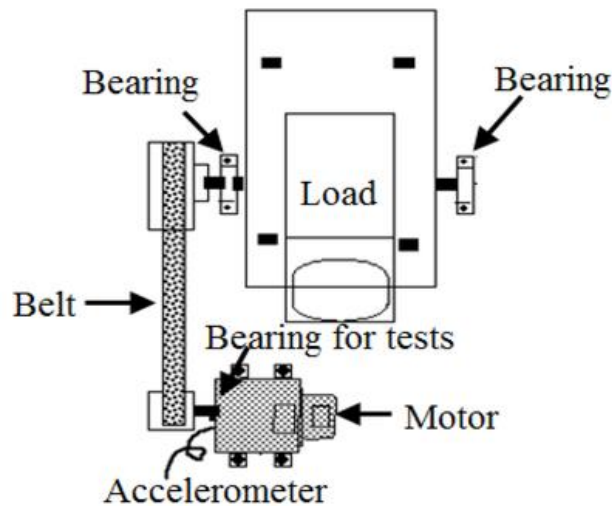




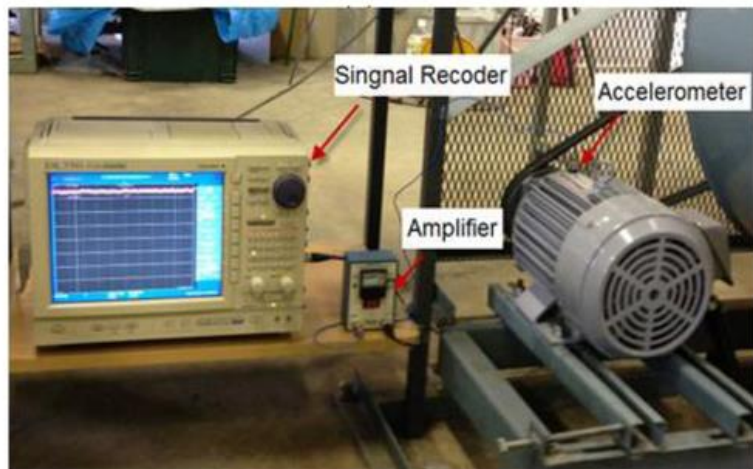
# Vibration Analysis- Diagnosis mode

13

Vibration measurements in analysis (diagnosis) mode can be cost-effective for less critical equipment, particularly if budgets or manpower are limited. Its effectiveness relies heavily on someone detecting unusual noises or vibration levels. This approach may not be reliable for large or complex machines, or in noisy parts of a plant. Furthermore, by the time a problem is noticed, a considerable amount of deterioration or damage may have occurred.



(a)



(b)





# Experimental Model Analysis

14

Experimental model analysis, also known as model analysis or model testing, deals with the determination of:

1. natural frequencies,
2. damping ratios,
3. mode shapes through vibration testing.

Two basic ideas are involved:

1. When a structure, machine, or any system is excited, its response exhibits a sharp peak at resonance when the forcing frequency is equal to its natural frequency when damping is not large.
2. The phase of the response changes by  $180^\circ$  as the forcing frequency crosses the natural frequency of the structure or machine, and the phase will be  $90^\circ$  at resonance.





# Experimental model analysis

15

