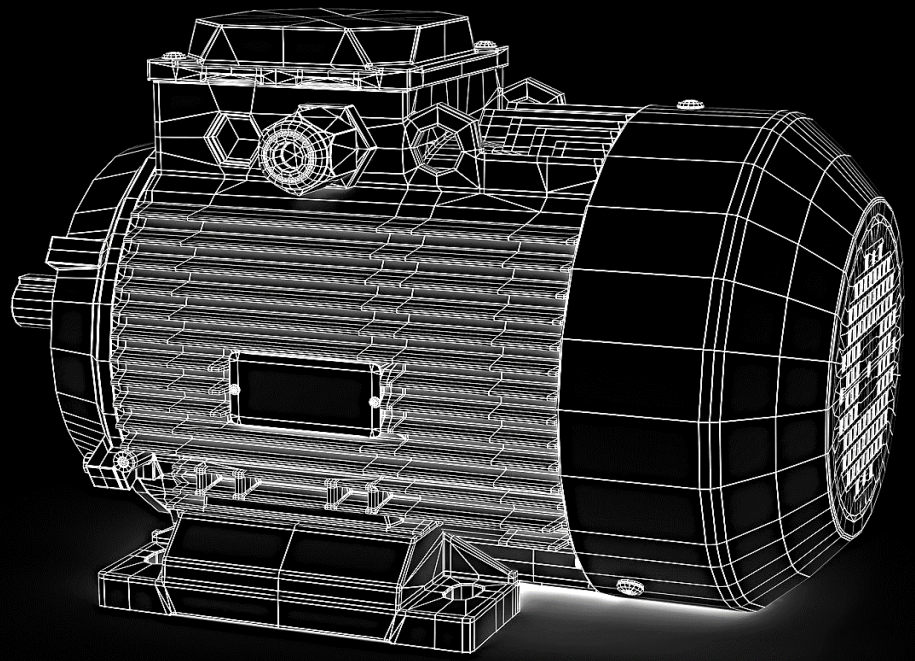

TECHNICAL DIAGNOSTICS

CONDITION MONITORING

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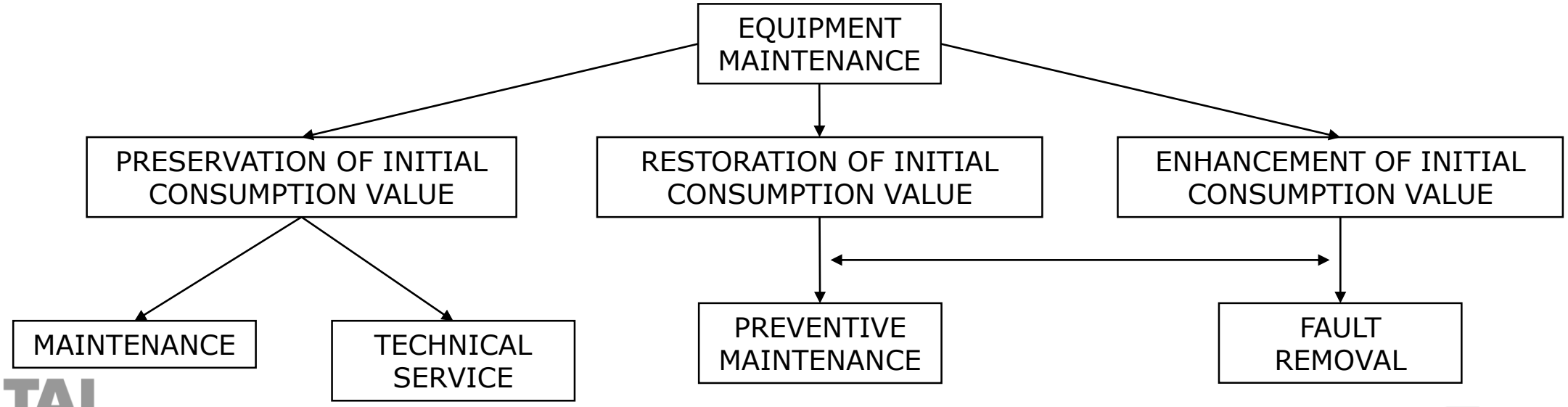
Department of Electrical Power Engineering and Mechatronics

MAINTENANCE OF EQUIPMENT

CONSUMPTION VALUE

- Equipment maintenance encompasses any activity aimed at preserving, restoring, and ideally enhancing the initial consumption value of equipment.
- Maintenance of equipment is of primary importance in its operation.
- Consumption value is determined by the sum of the device's characteristics that make it suitable for satisfying human needs.



MAINTENANCE OF EQUIPMENT

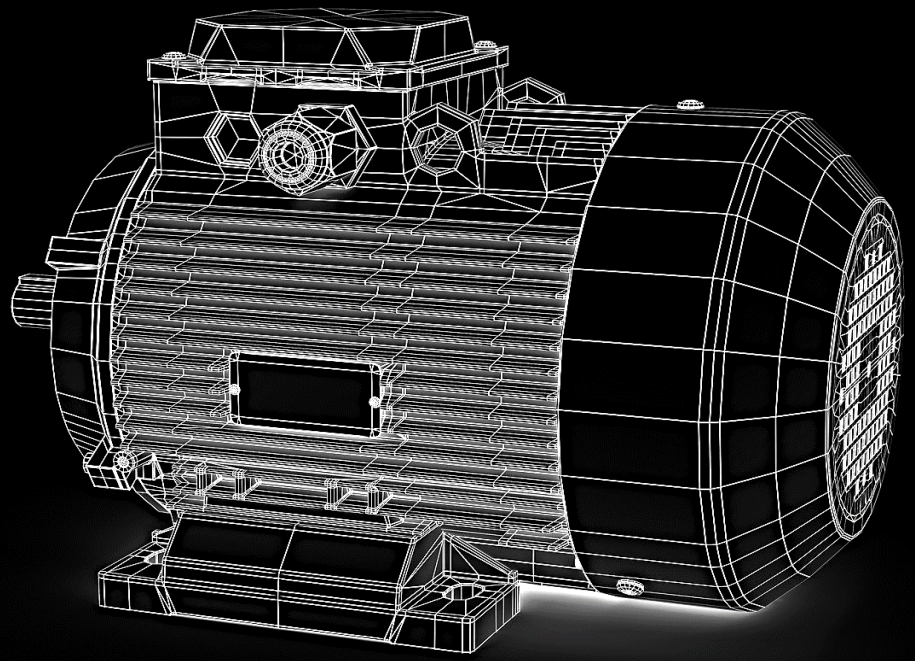
MAINTENANCE AND SERVICE

- Maintenance:
  - Checking oil flow
  - Restoring tire air pressure
  - Cleaning terminals, etc
- Technical service:
  - Oil and oil filter replacement
  - Engine valve adjustment
  - Lubrication of bearings, etc
- The purpose of these operations is to preserve the machine's consumption value

MAINTENANCE OF EQUIPMENT

REPAIR

- To restore the consumption value, equipment is repaired.
  - Parts and components that have lost their functionality are replaced with new or refurbished ones.
- It is advisable to do this preventively before the component goes completely out of service.
  - Preventive maintenance can be organized systematically only if the reliability parameters of the equipment are predictably accurate.
  - In the case of planned maintenance, some parts that have not fully exhausted their technical resource will inevitably be replaced.
  - For unique and expensive equipment, such behavior is not always justified, and technical diagnostics are used to decide on the need for equipment or individual element repairs.
- If the repair is not carried out preventively, it is considered fault removal.



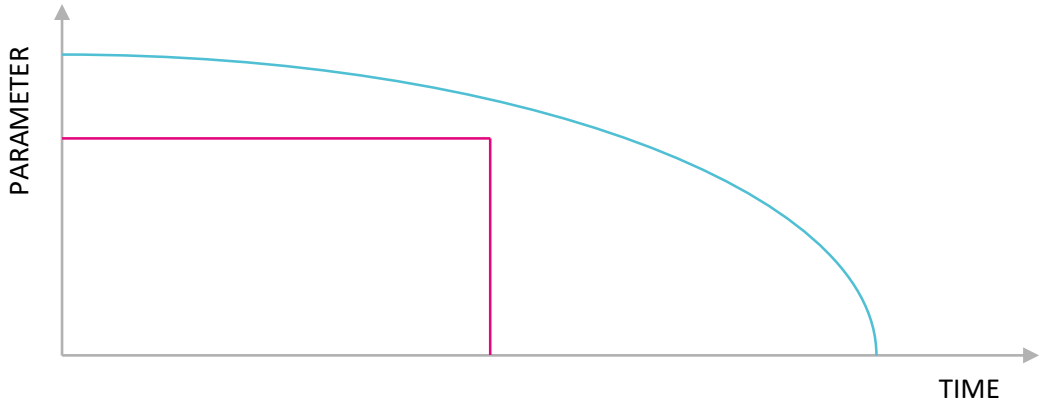
TAL TECH EMG

DESCRIPTION OF FAILURES

DESCRIPTION OF FAILURES

SLOW AND SUDDEN FAILURE

- Any failure is preceded by the deterioration process or damage to the malfunctioning element.
- The progression of damage can be predictable or unpredictable depending on the situation.
- Processes causing slow failures are generally predictable, such as fatigue, wear, corrosion, and aging signs.
- Predicting random sudden failures is practically impossible, for instance, pixel failure, water damage, incorrect connection, etc.



In the figure:

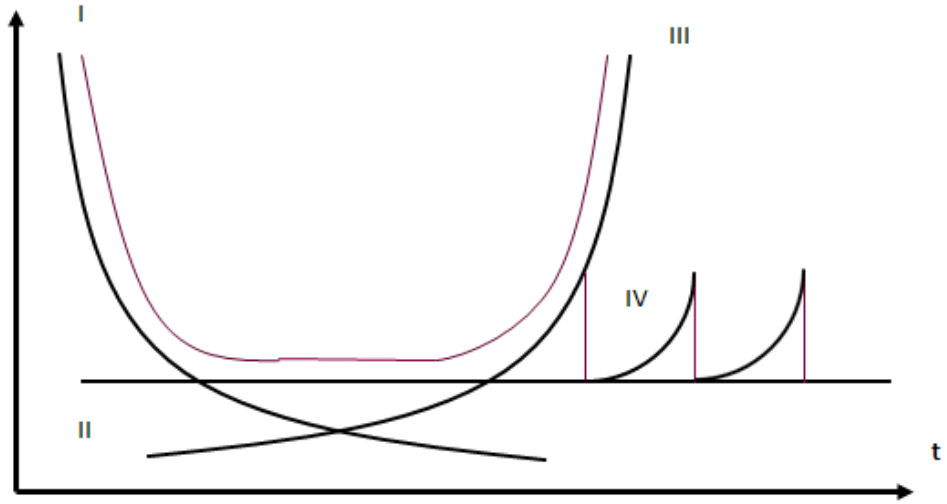
Sudden failure – for example, the filament burning out in an incandescent light bulb.

Slow failure – for example, a decrease in compression in a car engine due to the wear of piston rings and cylinder surfaces.

DESCRIPTION OF FAILURES

UNPREDICTABLE FAILURE

- Having sufficient statistical data collected from the use or testing of specific types of equipment allows for predicting the probability of failure occurrence.
- Unpredictable failures characterize equipment during the normal operation period (II), where it doesn't make sense to replace parts preventively.



The change in failure intensity (λ) over time (t):

I – the curve of failures during the initial operation period

II – the line of failures during the normal operation period

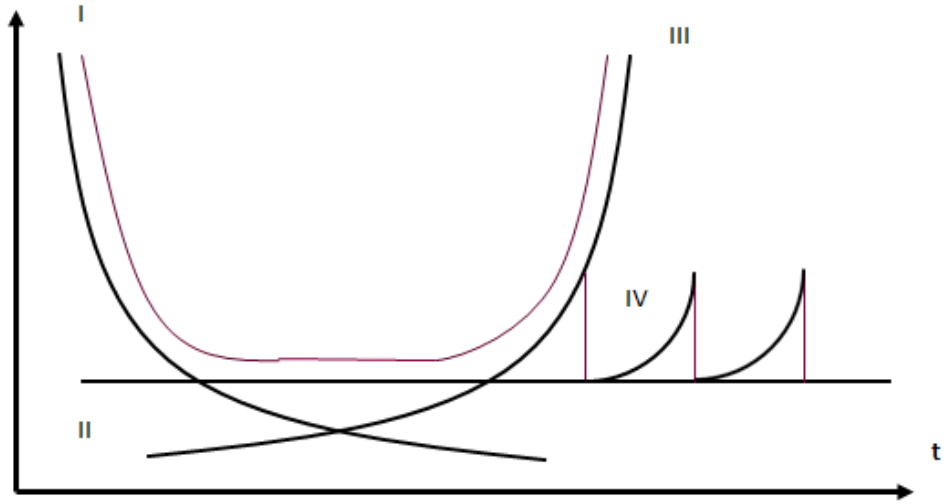
III – the curve of the period of increased failure intensity

IV – the curve characterizing the effect of preventive maintenance

DESCRIPTION OF FAILURES

BREAK-IN PERIOD

- Predictable are not the so-called "infantile" failures that occur during the break-in period (I) and depend on design, manufacturing, and assembly errors and deficiencies.
- Also, unpredictable are sudden failures caused by hidden defects in the details.
- The most important measure is to enhance technical control and conduct a break-in of equipment before putting it into operation. This is usually addressed through testing, during which defective parts and inaccuracies are replaced with functional solutions.



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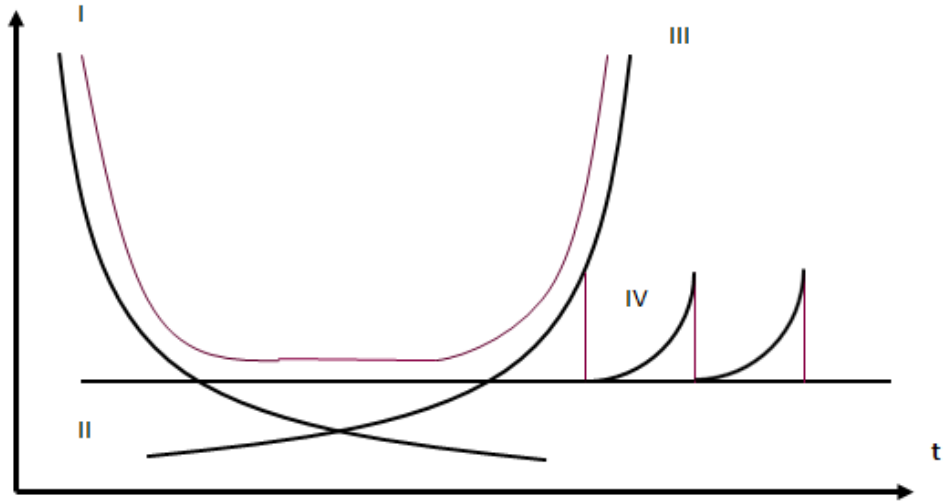
DESCRIPTION OF FAILURES

PREDICTABLE FAILURE AND PREVENTIVE MAINTENANCE

- In the third period, slow failures dominate, resulting from the wear, fatigue, corrosion, and aging of components. These failures are predictable when the laws of these processes are understood.
- Prophylactic measures related to the replacement of "critical" components help enhance reliability (IV).



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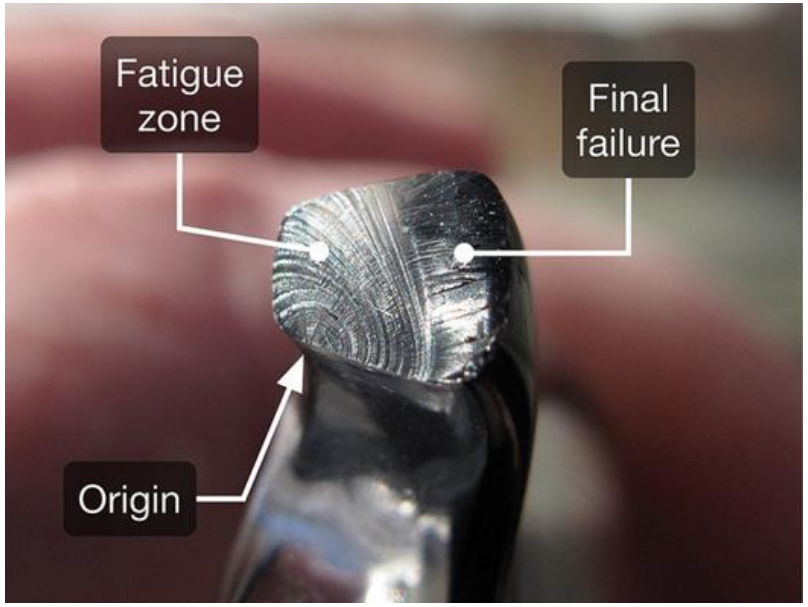
DESCRIPTION OF FAILURES

FATIGUE

- Fatigue refers to the weakening of material strength under the influence of alternating loads.
- Characteristic of alternating loads is that the component breaks due to the gradual development of a fatigue crack.
- At the fracture site, two distinct regions can be observed:
  - A smooth, polished area where the crack developed gradually.
  - A rough, granular area where the final fracture occurred.
- The occurrence and progression of fatigue cracks are influenced not only by structural defects in the material (such as cracks, inclusions) but also by defects in the surface treatment of the component (scratches, tool or abrasive marks, etc).



DESCRIPTION OF FAILURES

CORROSION

- Corrosion is the chemically or electrochemically induced damage to a material originating from the surface, often influenced by mechanical or biological processes. According to the laws of thermodynamics, metals strive to move towards a less energy-intensive state from a more energy-intensive state (for example, into an oxide state).
- Chemical corrosion is the direct reaction between the material and another substance.
  - For example, the reaction between iron or steel and atmospheric oxygen at high temperatures, resulting in the formation of a scale on the surface.
- In addition to the presence and action of an electrolyte, electrochemical corrosion requires the presence of an electrolyte.
  - For example, metal objects in seawater, aggressive solutions, molten electrolytes, humid air, soil, at the contact points of different metals, and under the influence of external electrical currents.
- Stress corrosion is a special form of electrochemical corrosion that can also cause unexpected cracking. Its formation requires the presence of persistent tensile stresses and a corresponding reagent (alkali, nitrate, etc.).

DESCRIPTION OF FAILURES

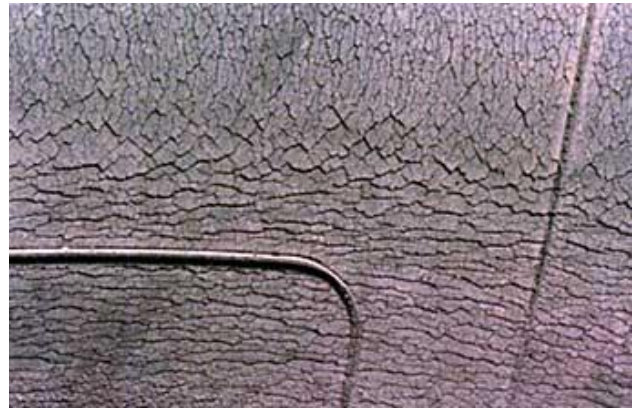
WEAR

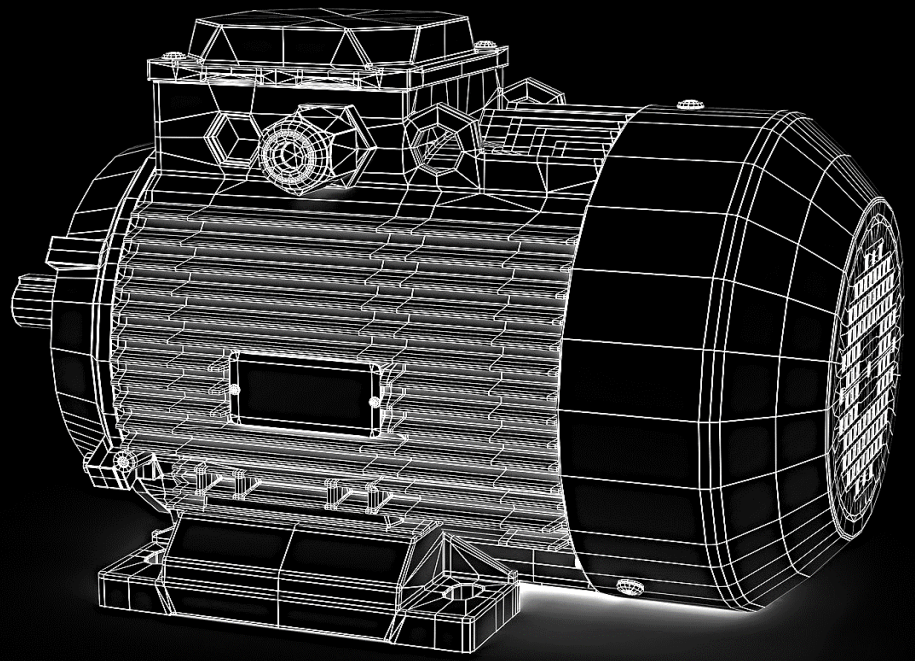
- Wear is the gradual process of a solid body's dimensions and/or shape changing due to the breaking of protrusions associated with friction, resulting in the detachment of material and/or residual deformation on the surface.

DESCRIPTION OF FAILURES

AGING

- Aging primarily characterizes non-metallic materials.
- Depending on the type of material and environmental conditions, changes may occur over time, ultimately leading to the loss of the elements' functionality.
- In addition to the factor of time, weakening of materials can be contributed to by chemical, mechanical, thermal, radiation, and other influences.





TAL TECH EMG

TECHNICAL DIAGNOSTICS

TECHNICAL DIAGNOSTICS

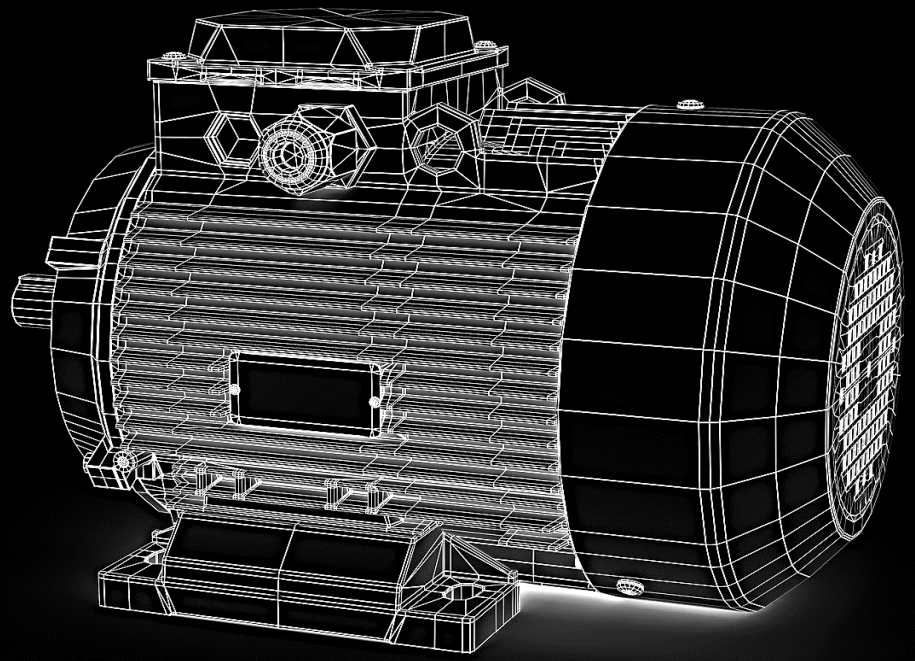
IDEA

- Technical diagnostics plays a crucial role in detecting and preventing failures.
- The object of diagnosis can be an entire system or one of its components.
- Technical diagnosis serves as the basis for decision-making regarding the necessity of repair or maintenance.
- Practically any parameter of a device or its part can be used for diagnostics.
- In the case of complex and critical equipment, checking individual components may often be insufficient, and it is advisable to use diagnostic systems.

DIAGNOSIS FEATURES

PARAMETERS

- Output parameters determine the operational capability of the device according to technical conditions.
  - Output power, efficiency, productivity, quality
- Damages that have caused or may cause faults are often predictable:
  - Wear, deformation, corrosion
- Checking indirect indicators is particularly effective when measuring output parameters is challenging.
- Continuous monitoring during operation is known as monitoring or monitoring.



TAL TECH EMG

THANK YOU!