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**Mechanical vibration — Rotor  
balancing —**

**Part 2:  
Vocabulary**

*Vibrations mécaniques — Équilibrage des rotors —  
Partie 2: Vocabulaire*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

The committee responsible for this document is Technical Committee ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 2, *Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures*.

This first edition of ISO 21940-2 cancels and replaces ISO 1925:2001, which has been technically revised. All terms and definitions formerly contained in different balancing standards have been reviewed and compiled in this document.

A list of all parts in the ISO 21940 series can be found on the ISO website.

# Mechanical vibration — Rotor balancing —

## Part 2: Vocabulary

### 1 Scope

This document defines terms on balancing. It complements ISO 2041, which is a general vocabulary on mechanical vibration and shock.

### 2 Normative references

There are no normative references in this document.

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

NOTE An illustrated terminology for balancing machines is provided in [Annex A](#).

#### 3.1 Mechanics

##### 3.1.1

##### **principal axis of inertia**

one of three mutually perpendicular axes intersecting each other at a given point about which the products of inertia of a solid body are zero

Note 1 to entry: In *balancing* ([3.4.1](#)), the term principal axis of inertia is used to designate the central principal axis of inertia (of the three such axes) most nearly coincident with the *shaft axis* ([3.2.7](#)) of the rotor.

[SOURCE: ISO 2041:2009, 1.34, modified — converted to singular and the notes to entry have been changed.]

##### 3.1.2

##### **speed**

angular velocity of a rotor

Note 1 to entry: Speed is measured in revolutions per unit time or in angle (in radians) per unit time. Note 2 to entry: The quantities most frequently used for specifying speed are

- $n$  rotational speed measured in revolutions per minute;
- $f$  rotational frequency measured in revolutions per second;
- $\Omega$  angular velocity measured in radians per second.

### 3.1.3

#### **resonance speed**

DEPRECATED: critical speed

DEPRECATED: resonant speed

characteristic speed at which resonances of a system are excited

Note 1 to entry: In the context of *balancing* (3.4.1), a resonance speed is related only to the once-per-revolution component of vibration.

[SOURCE: ISO 2041:2009, 2.85, modified — the notes to entry have been changed.]

### 3.1.4

#### **rigid-body-mode resonance speed**

*resonance speed* (3.1.3) of a rotor at which flexure of the rotor can be neglected

### 3.1.5

#### **flexural resonance speed**

*resonance speed* (3.1.3) of a rotor at which flexure of the rotor cannot be neglected

### 3.1.6

#### **service speed**

angular velocity at which a rotor operates in its final installation or environment

### 3.1.7

#### **balancing speed**

angular velocity at which rotor *balancing* (3.4.1) is performed

### 3.1.8

#### **axis of rotation**

instantaneous line about which a body rotates

### 3.1.9

#### **rigid body mode**

mode shape of a rotor corresponding to a *rigid-body-mode resonance speed* (3.1.4) for a given support system

### 3.1.10

#### **flexural mode**

mode shape of a rotor corresponding to a *flexural resonance speed* (3.1.5) for a given support system

### 3.1.11

#### **shape function of the $n$ th flexural mode**

$\phi_n(z)$

mathematical expression for the deflection shape of the rotor in the corresponding *flexural mode* (3.1.10) normalized so that the maximum deflection is unity

Note 1 to entry: Frequently, it is assumed that the modes are mutually orthogonal and the system is axially symmetric. This is not applicable in all cases.

### 3.1.12

#### **modal amplification factor**

$M_n$

ratio of the magnitude of the modal vibration displacement vector to the magnitude of the modal eccentricity for the  $n$ th *flexural mode* (3.1.10)

Note 1 to entry: Modal amplification factor is a non-dimensional quantity. It is expressed for the  $n$ th mode as

$$M_n = \frac{(\Omega/\omega_n)^2}{\sqrt{\left[1 - (\Omega/\omega_n)^2\right]^2 + 4\zeta_n^2 (\Omega/\omega_n)^2}}$$

where

- $\Omega$  is the angular velocity expressed in radians per second;
- $\omega_n$  is the undamped natural angular frequency expressed in radians per second;
- $\zeta_n$  is the *modal damping ratio* (3.1.13).

Note 2 to entry: The modal amplification factor at the *flexural resonance speed* (3.1.5) is called “modal sensitivity”.

### 3.1.13

#### **modal damping ratio**

$\zeta_n$

measure of the damping effect on the *nth flexural mode* (3.1.10)

## 3.2 Rotor systems

### 3.2.1

#### **rigid behaviour**

rotor where the flexure caused by its *unbalance* (3.3.1) distribution can be neglected with respect to the agreed *unbalance tolerance* (3.4.12) at any speed up to the maximum *service speed* (3.1.6)

Note 1 to entry: A rotor that behaves as rigid under one set of conditions [e.g. *service speed* (3.1.6), *initial unbalance* (3.3.10) and *unbalance tolerances* (3.4.12)] may not behave as rigid under another set of conditions.

### 3.2.2

#### **flexible behaviour**

rotor where the flexure caused by its *unbalance* (3.3.1) distribution cannot be neglected with respect to the agreed *unbalance tolerance* (3.4.12) at any speed up to the maximum *service speed* (3.1.6)

Note 1 to entry: Flexible behaviour includes *shaft-elastic behaviour* (3.2.3), settling behaviour (i.e. unbalance indication irreversibly changes after the first run-up) and component-elastic behaviour (i.e. unbalance indication reversibly changes with speed due to displacement of rotor components other than the shaft).

### 3.2.3

#### **shaft-elastic behaviour**

rotor where the elastic flexure due to *modal unbalances* (3.3.16) cannot be neglected with respect to the agreed *unbalance tolerances* (3.4.12)

Note 1 to entry: Shaft-elastic behaviour of a rotor is a subset of *flexible behaviour* (3.2.2).

### 3.2.4

#### **journal**

part of a rotor that is supported radially or guided by a bearing in which it rotates

### 3.2.5

#### **journal axis**

mean straight line joining the centroids of cross-sectional contours of a *journal* (3.2.4)

### 3.2.6

#### **journal centre**

intersection of the *journal axis* (3.2.5) and the radial plane of the *journal* (3.2.4) where the resultant transverse bearing force acts

### 3.2.7

#### **shaft axis**

line joining the *journal centres* (3.2.6) which follows the deflected shape of the rotor due to gravity or any other constant force

### 3.2.8

#### **inboard rotor**

rotor that has its centre of mass located between the *journals* (3.2.4)