Preface

This book represents the natural evolution of the lecture notes of the course "Dynamics and Vibrations of Machines" held at the Politecnico di Milano in the academic years 1981–1992 and of a book already published for the course "Simulation and modelling of mechanical systems" (academic years 1993–2014).

These collected works can be considered as a natural extension of the didactic work carried out in this area, initially by Prof. O. Sesini and later by Profs. A. Capello, E. Massa and G. Bianchi. The contents of this book also sum up decades of experience gained by the research group which is part of the Section of Mechanical Systems at the Politecnico di Milano (former Institute of Applied Mechanics). It also draws upon the research topics developed by a research group of the Department of Mechanics, to which the authors belong. Said research was generally based on problems encountered in the industrial world, performed in collaboration with organizations and research centres including ABB, ENEL (Italian General Electricity Board), FS (Italian Railways), Bombardier, Alstom, Ansaldo, ENEL-CRIS, ISMES, Fiat, Ferrari and Pirelli, as well as countless others. In this context, the following research topics were considered of prime importance:

- analytical and experimental investigations on the vibration of power lines;
- slender structures—wind interaction;
- aeroelastic behaviour of suspension bridges;
- dynamic behaviour of structures subjected to road and rail traffic;
- rail vehicle dynamics, pantograph—catenary interaction, train—railway infrastructure interaction, etc.;
- ground vehicle dynamics; and
- rotor dynamics.

These themes impacted significantly on the development of this book.

The educational content of this volume is primarily addressed to students of engineering taking courses in mechanics, aerospace, automation and energy, disciplines introduced recently by the Italian Ministry of Education in compliance with the New Italian University Order. However, given its organic structure and the

comprehensive overview of the subjects dealt with, the book could also serve as a useful tool to professionals in the industry.

In this book, an engineering approach for the schematization of a generic mechanical system, applicable both to rigid and deformable bodies, is introduced. Such an approach is necessary to identify the behaviour of a mechanical system subject to different excitation sources. In addition to the traditional aspects associated with the dynamics and vibrations of mechanical systems, the engineering approach illustrated herein allows us to reproduce the interaction of mechanical systems with different force fields acting on its various components (e.g. action of fluids and contact forces), i.e. forces dependent on system motion, and, consequently, its state.

This concept, dealing with the interaction of force fields and mechanical systems, gives rise to a new system on which the dynamic behaviour is considered, focusing, in particular, on the analysis of motion stability.

Controlled systems, in which the action of the actuator, controlled in a closed loop, defines forces as a function of the state of the system, can also be assimilated to systems interacting with force fields and, for this reason, dealt with in a similar way.

Traditionally, however, there are typical approaches in this area that cannot be ignored and, for this reason, controlled systems are treated in a separate text.[1]

In this text, however, an effort has been made to reference the symbols and main techniques used in control engineering, in order to create an easy interface for mechanical engineers dealing with electronic control.

More specifically, in the first part of this book, we will analyse mechanical systems with 1 or more degrees of freedom (d.o.f.), generally in large motion and, subsequently, the small motion of systems in the neighbourhood of either the steady-state motion or the static equilibrium position. In this phase, we will analyse both discrete and continuous systems, for which certain discretization procedures will be discussed (modal approach, finite elements).

Conversely, the second part of this text deals with the study of mechanical systems subjected to force fields, with many examples such as fluid–elastic interaction, train and railway interaction, rotor dynamics, experimental techniques related to parameter identification and random excitations.

The first part of the text can be a useful tool for undergraduate courses to approach the dynamics and the vibration problems in the mechanical systems.

The second part is more suitable for graduate and Ph.D. students to analyse many real problems due to the interaction of mechanical systems with different surrounding fields of forces. The main problems related to the behaviour and stability of these systems are fully described in the last part of the book and will be very useful for the students.

[1]Diana and Resta [1].

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The authors would also like to express their gratitude especially to Professor Bruno Pizzigoni for his hard and excellent work for the audit and the check of the English text. It goes without saying that, as always, there are likely to be omissions and errors for which we hope you will forgive us.

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Reference

1. Diana G, Resta F (2006) Controllo dei sistemi meccanici. Polipress, Milano

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