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PREFACE

This monograph contains the Lectures Notes of an Advanced Summer School on “Friction and Instabilities” that took place in Udine, Italy, in July 3-7, 2000, under the auspices of the International Centre for Mechanical Sciences (CISM) and the International Union of Theoretical and Applied Mechanics (IUTAM). The course had the objective of surveying recent theoretical developments on stability and bifurcation in frictional contact problems, as well as the corresponding computational algorithms.

Stability and bifurcation analyses of rate independent dissipative systems were the object of other CISM courses (). The generalization of that body of theoretical developments to frictional contact problems was the main goal of this course. In fact, the non-associativity of Coulomb’s friction poses delicate questions concerning appropriate stability concepts and criteria, which have much in common with those found in stability analyses of solids whose incremental constitutive moduli do not possess the major symmetry. In addition, the unilaterality of the contact raises important difficulties concerning the appropriate formulation and resolution of dynamic problems.*

With the purpose of presenting an up-to-date view of the theoretical and computational advances in the field, concepts and approaches originating from a variety of areas were put together in the course: contact and impact mechanics, nonlinear dynamics, mathematical theory of variational and quasi-variational inequalities, mathematical programming, bifurcation theory, thermoelasticity, (non-smooth) computational mechanics, and finite element methods. The theoretical concepts and the computational algorithms were applied to a variety of problems involving continuum or discrete systems. Applications to industrial problems and to tribological phenomena were also presented and discussed.

The first chapter of the book contains the lecture notes of Prof. James Barber on instabilities of thermoelastic contact, including the application to a multi-disk clutch. The chapter prepared by Prof. Anders Klarbring addresses stability and critical points in large displacement frictionless contact problems. The lecture of Prof. João Martins is co-authored by Prof. Fernando Simões and Dr. António Pinto da Costa and addresses topics related to instability, bifurcation and non-smoothness in finite dimensional frictional contact problems, as well as instability, ill-posedness and regularization procedures in some infinite dimensional ones. The lecture of Prof. Nguyen Quoc Son is co-authored by Dr. Franck Moirrot and starts with an overview of general concepts of stability of elastic or dissipative media, which are then applied to frictional contact

(*) Nguyen, Q. S. (1993). *Bifurcation and Stability of Dissipative Systems*, CISM Courses and Lectures, Springer-Verlag, Wien, New York, 327.

Petryk, H. (2000). *Material Instabilities in Elastic and Plastic Solids*, CISM Courses and Lectures, Springer, Wien, New York, 414.

problems, in particular to the propagation of stick-slip waves and the study of brake squeal. The lecture of Prof. Zenon Mroz addresses constitutive models of friction, slip and wear at contact interfaces and the stability and post-critical response of frictional contact systems. The lecture of Prof. Michel Raous, co-authored by Dr Serge Barbarin and Dr Didier Vola, is dedicated to the numerical characterization and the computation of dynamic instabilities in frictional contact problems, and includes applications to a tribological experiment and to a squeal phenomenon in the automotive industry.

The organizers of the Course express their sincere gratitude to their colleague lecturers for all their efforts to prepare the lectures and the present notes. The organizers wish to thank CISM and IUTAM for the valuable support provided to the organization of this course. Special thanks are due to the CISM staff for their efficient help, to the Rector of CISM, Prof. S. Kaliszky, for his kind hospitality and support, and to the Editor of the CISM Lecture Notes and Courses series, Prof. C. Tasso, for his encouragement and patience.

João Martins Michel Raous

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