



Valentin L. Popov

# Contact Mechanics and Friction

Physical Principles  
and Applications

Second Edition

 Springer

# Contact Mechanics And Friction Physical Principles And Applications

**S Ben Porath**



## **Contact Mechanics And Friction Physical Principles And Applications:**

**Contact Mechanics and Friction** Valentin L. Popov, 2010-03-10 The English edition of Contact Mechanics and Friction lying before you is for st the most part the text of the 1 German edition Springer Publishing 2009 The book was expanded by the addition of a chapter on frictional problems in ear quake research Additionally Chapter 15 was supplemented by a section on elasto hydrodynamics The problem sections of several chapters were enriched by the addition of new examples This book would not have been possible without the active support of J Gray who translated it from the German edition I would like to thank Prof G G charyan and Prof S Sobolev for discussions and critical comments on the chapter over earthquake dynamics Dr R Heise made significant contributions to the velopment and correction of new problems I would like to convey my affecti ate thanks to Dr J Starcevic for her complete support during the composition of this book I want to thank Ms Ch Koll for her patience in creating figures and Dr R Heise M Popov M He S K rscher and B Grzempa for their help in pro reading Berlin November 2009 V L Popov Preface to the German Edition

**Contact Mechanics and Friction** Valentin L. Popov, 2017-03-10 This application oriented book introduces readers to the associations and relationships between contact mechanics and friction providing them with a deeper understanding of tribology It addresses the related phenomena of contacts adhesion capillary forces friction lubrication and wear from a consistent point of view The author presents 1 methods for rough estimates of tribological quantities 2 simple and general methods for analytical calculations and 3 the crossover into numerical simulation methods the goal being to convey a consistent view of tribological processes at various scales of magnitude from nanotribology to earthquake research The book also explores the system dynamic aspects of tribological systems such as squeal and its suppression as well as other types of instabilities and spatial patterns It includes problems and worked out solutions for the respective chapters giving readers ample opportunity to apply the theory to practical situations and to deepen their understanding of the material discussed The second edition has been extended with a more detailed exposition of elastohydrodynamic lubrication an updated chapter on numerical simulation methods in contact mechanics a new section on fretting in the chapter on wear as well as numerous new exercises and examples which help to make the book an excellent reference guide

**Contact Mechanics and Friction : Physical Principles and Applications**

Valentin L. Popov, 2010 Dry Friction Friction induced Vibrations Thermal Effects in Contacts Lubricated Systems Viscoelastic Properties of Elastomers Rubber Friction and Contact Mechanics of Rubber Wear Friction under the Influence of Ultrasound Numerical Simulation Methods in the Physics of Friction Earthquakes and Friction Appendix Further Reading Index of Figures Index of Subjects

*Review of "Contact Mechanics and Friction: Physical Principles and Applications" by Valentin L. Popov*, 2011

**Method of Dimensionality Reduction in Contact Mechanics and Friction** Valentin L. Popov, Markus Heß, 2014-08-19 This book describes for the first time a simulation method for the fast calculation of contact properties and friction between rough surfaces in a complete form In contrast to existing simulation methods the method of dimensionality

reduction MDR is based on the exact mapping of various types of three dimensional contact problems onto contacts of one dimensional foundations Within the confines of MDR not only are three dimensional systems reduced to one dimensional but also the resulting degrees of freedom are independent from another Therefore MDR results in an enormous reduction of the development time for the numerical implementation of contact problems as well as the direct computation time and can ultimately assume a similar role in tribology as FEM has in structure mechanics or CFD methods in hydrodynamics Furthermore it substantially simplifies analytical calculation and presents a sort of pocket book edition of the entirety contact mechanics Measurements of the rheology of bodies in contact as well as their surface topography and adhesive properties are the inputs of the calculations In particular it is possible to capture the entire dynamics of a system beginning with the macroscopic dynamic contact calculation all the way down to the influence of roughness in a single numerical simulation model Accordingly MDR allows for the unification of the methods of solving contact problems on different scales The goals of this book are on the one hand to prove the applicability and reliability of the method and on the other hand to explain its extremely simple application to those interested

Method of Dimensionality Reduction in Contact Mechanics Valentin L. Popov, Markus Hess, Emanuel Willert, 2018-08-08 The present book is a collection of open access papers describing the foundations and applications of the Method of Dimensionality Reduction MDR first published in the Journal Facta Universitatis Series Mechanical Engineering in the years 2014 2018 The Method of Dimensionality Reduction MDR is a method of calculation and simulation of contacts of elastic and viscoelastic bodies It consists essentially of two simple steps a substitution of the three dimensional continuum by a uniquely defined one dimensional linearly elastic or viscoelastic foundation Winkler foundation and b transformation of the three dimensional profile of the contacting bodies by means of the MDR transformation As soon as these two steps are done the contact problem can be considered to be solved For axial symmetric contacts only a small calculation by hand is required which does not exceed elementary calculus and will not be a barrier for any practically oriented engineer Alternatively the MDR can be implemented numerically which is almost trivial due to the independence of the foundation elements In spite of its simplicity all results are exact The present book brings together papers covering the most important aspects of the MDR and providing a practical guide for its use

Principles of Engineering Tribology Ahmed Abdelbary, Li Chang, 2023-05-26 Principles of Engineering Tribology Fundamentals and Applications introduces readers to the core theories and fundamentals of the field its basic terminology and concepts as well as advanced topics such as the tribological properties of various engineering surfaces roughness measurements and the mechanics of surface contact The fundamentals of friction and wear of metallic and non metallic materials such as polymers ceramics rubbers and composites are discussed as are fluidic gaseous grease and solid media lubrication techniques In addition the properties of lubricants and various types of additives incorporated are discussed along with a methodology for conducting friction wear and lubrication laboratory testing and an overview of simulation and modeling methods for various

tribosystems Case studies and applications are featured throughout with a particular emphasis on analyzing failure modes of tribosystems Introduces the basic concepts of tribology building a comprehensive understanding for readers and then covering more advanced topics Discusses tribological properties of various engineering surfaces roughness measurements and mechanics of surface contact Covers more advanced topics such as fluidic gaseous grease and solid media lubricants methods for conducting friction and wear laboratory tests and more Includes a wide range of both traditional and state of the art applications and case studies

**Tribology in Materials and Applications** Jitendra Kumar Katiyar,P. Ramkumar,T. V. V. L. N. Rao,J. Paulo Davim,2020-05-23 This book broadens the knowledge of tribology This book is evolved out of current research trends on tribological performance of systems related to nano tribology rheology engines polymer brushes composite materials erosive wear and lubrication The book deals with enhancing the ideas on tribological properties the different types of wear phenomenon and lubrication enhancement Further the tribological performance of systems whether nano micro or macro scale depends upon a large number of external parameters and important among them are temperature contact pressure and relative speed Thus the book focus on the theoretical aspects to industrial applications of tribology

Contact Mechanics and Friction of Elastic Solids on Hard and Rough Substrates Boris Lorenz,2012 *Proceedings of China Modern Logistics Engineering* Logistics Engineering Institution,2014-10-11 *Proceedings of China Modern Logistics Engineering* covers nearly all areas of logistics engineering technology focusing on the latest findings and the following theoretical aspects Logistics Systems and Management Research Green Logistics and Emergency Logistics Enterprise Logistics Material Handling Warehousing Technology Research Supply Chain Management Logistics Equipment Logistics Packaging Technology Third party Logistics etc The book will help readers to grasp the relevant aspects of the theory involved research and development trends while also offering guidance for their work and related studies It is intended for researchers scholars and graduate students in logistics management logistics engineering transportation business administration E commerce and industrial engineering

**Contact mechanics perspective of tribology** Irina Goryacheva,Marco Paggi,Valentin L. Popov,2021-06-04 **Tribology Across Scales: Theory, Simulation and Experiment** Jasminka Starčević,Markus Heß,2025-05-01 This book is dedicated to Prof Dr rer nat Valentin L Popov who has become an internationally recognized leading figure in the field of tribology within the past 35 years He has collaborated with numerous scientists and researchers all over the world His countless publications cover not only research contributions to classical tribology in mechanical engineering but also to more modern fields such as nanotribology or biotribology They include experimental investigations theoretical approaches and numerical simulations from the nanoscale to the macroscale In tribute to the outstanding work of Prof Popov this book brings together advanced contributions in the field of tribology written by more than 40 distinguished scientists and researchers MP4 File via app download the SN More Media app for free scan a link with play button and access MP4 File directly on your smartphone or tablet

**Tribology in Materials and**

**Manufacturing** Amar Patnaik, Tej Singh, Vikas Kukshal, 2021-02-03 Tribology in Materials and Manufacturing Wear Friction and Lubrication brings an interdisciplinary perspective to accomplish a more detailed understanding of tribological assessments friction lubrication and wear in advanced manufacturing Chapters cover such topics as ionic liquids non textured and textured surfaces green tribology lubricants tribolayers and simulation of wear      **Introduction to**

**Computational Contact Mechanics** Alexander Konyukhov, Ridvan Izi, 2015-06-15 Introduction to Computational Contact Mechanics A Geometrical Approach covers the fundamentals of computational contact mechanics and focuses on its practical implementation Part one of this textbook focuses on the underlying theory and covers essential information about differential geometry and mathematical methods which are necessary to build the computational algorithm independently from other courses in mechanics The geometrically exact theory for the computational contact mechanics is described in step by step manner using examples of strict derivation from a mathematical point of view The final goal of the theory is to construct in the independent approximation form so called covariant form including application to high order and isogeometric finite elements The second part of a book is a practical guide for programming of contact elements and is written in such a way that makes it easy for a programmer to implement using any programming language All programming examples are accompanied by a set of verification examples allowing the user to learn the research verification technique essential for the computational contact analysis Key features Covers the fundamentals of computational contact mechanics Covers practical programming verification and analysis of contact problems Presents the geometrically exact theory for computational contact mechanics Describes algorithms used in well known finite element software packages Describes modeling of forces as an inverse contact algorithm Includes practical exercises Contains unique verification examples such as the generalized Euler formula for a rope on a surface and the impact problem and verification of the percussion center Accompanied by a website hosting software Introduction to Computational Contact Mechanics A Geometrical Approach is an ideal textbook for graduates and senior undergraduates and is also a useful reference for researchers and practitioners working in computational mechanics      *Tumor Organoids* Shay Soker, Aleksander Skardal, 2017-10-20 Cancer cell biology research in

general and anti cancer drug development specifically still relies on standard cell culture techniques that place the cells in an unnatural environment As a consequence growing tumor cells in plastic dishes places a selective pressure that substantially alters their original molecular and phenotypic properties The emerging field of regenerative medicine has developed bioengineered tissue platforms that can better mimic the structure and cellular heterogeneity of in vivo tissue and are suitable for tumor bioengineering research Microengineering technologies have resulted in advanced methods for creating and culturing 3 D human tissue By encapsulating the respective cell type or combining several cell types to form tissues these model organs can be viable for longer periods of time and are cultured to develop functional properties similar to native tissues This approach recapitulates the dynamic role of cell cell cell ECM and mechanical interactions inside the tumor

Further incorporation of cells representative of the tumor stroma such as endothelial cells EC and tumor fibroblasts can mimic the in vivo tumor microenvironment Collectively bioengineered tumors create an important resource for the in vitro study of tumor growth in 3D including tumor biomechanics and the effects of anti cancer drugs on 3D tumor tissue These technologies have the potential to overcome current limitations to genetic and histological tumor classification and development of personalized therapies

*Combined Discrete and Continual Approaches in Biological Modelling* Alexander E. Filippov, Stanislav N. Gorb, 2020-06-30 Basic laws of nature are rather simple but observed biological structures and their dynamic behaviors are unbelievably complicated This book is devoted to a study of this strange relationship by applying mathematical modeling to various structures and phenomena in biology such as surface patterns bioadhesion locomotion predator prey behavior seed dispersal etc and revealing a kind of self organization in these phenomena In spite of diversity of biological systems considered two main questions are 1 what does self organization in biology mean mathematically and 2 how one can apply this knowledge to generate new knowledge about behavior of particular biological system We believe that this kind of biomimetics in computer will lead to better understanding of biological phenomena and possibly towards development of technical implications based on our modeling

**Handbook of Research on Evolving Designs and Innovation in ICT and Intelligent Systems for Real-World Applications** Sarma, Kandarpa Kumar, Saikia, Navajit, Sharma, Mridusmita, 2022-06-24 The relentless advances in all areas of information and communication technology intelligent systems and related domains have continued to drive innovative research Most of these works have attempted to contribute in some form towards improving human life in general and have become indispensable elements of our day to day lives The evolution continues at an accelerated pace while the world faces innumerable challenges and rapid advances in artificial intelligence wireless communication sensors cloud and edge computing and biomedical sciences These advances must be documented and studied further in order to ensure society's continual development The Handbook of Research on Evolving Designs and Innovation in ICT and Intelligent Systems for Real World Applications disseminates details of works undertaken by various groups of researchers in emerging areas related to information and communication technology electronics engineering intelligent systems and allied disciplines with real world applications Covering a wide range of topics such as augmented reality and wireless sensor networks this major reference work is ideal for industry professionals researchers scholars practitioners academicians engineers instructors and students

*Tribology on the Small Scale C.* Mathew Mate, Robert W. Carpick, 2019 Friction lubrication adhesion and wear are prevalent physical phenomena in everyday life and in many key technologies This book explains how these tribological phenomena originate from atomistic and microscale physical phenomena and shows how this understanding can be used to solve macroscale tribology problems

Contact Dynamics Nikolay Goloshchapov, 2019-02-08 This volume describes the application of the method of the differential specific forces MDSF By using this new method the solutions to the problems of a dissipative viscoelastic and

elastic plastic contacts between curvilinear surfaces of two solid bodies can be found The novelty is that the forces of viscosity and the forces of elasticity can be found by an integration of the differential specific forces acting inside an elementary volume of the contact zone This volume shows that this method allows finding the viscoelastic forces for any theoretical or experimental dependencies between the distance of mutual approach of two curvilinear surfaces and the radiuses of the contact area Also the derivation of the integral equations of the viscoelastic forces has been given and the equations for the contact pressure have been obtained The viscoelastic and elastic plastic contacts at impact between two spherical bodies have been examined The equations for work and energy in the phases of compression and restitution and at the rolling shear have been obtained Approximate solutions for the differential equations of movement displacement by using the method of equivalent work have been calculated This new method of differential specific viscoelastic forces allows us to find the equations for all viscoelastic forces It is principally different from other methods that use Hertz's theory the classical theory of elasticity and the tensor algebra This method will be useful in research of contact dynamics of any shape of contacting surfaces It also can be used for determination of the dynamic mechanical properties of materials and in the design of wear resistant elements and coverings for components of machines and equipment that are in harsh conditions where they are subjected to the action of flow or jet abrasive particles This volume will be useful for professional designers of machines and mechanisms as well as for the design and development of new advanced materials such as wear resistant elastic coatings and elements for pneumatic and hydraulic systems stop valves fans centrifugal pumps injectors valves gate valves and in other installations

**Engineering Applications of Discrete Element Method** Xuewen Wang, Bo Li, Rui Xia, Haozhou Ma, 2020-09-10 This book introduces the engineering application of the discrete element method DEM especially the simulation analysis of the typical equipment scraper conveyor coal silos subsoiler in the coal and agricultural machinery In this book the DEM is applied to build rigid and loose coupling model and the kinematic effect of the bulk materials the mechanical effect of the interaction between the bulk materials and the mechanical equipment in the operation process of the relevant equipment are studied On this basis the optimization design strategy of the relevant structure is proposed This book effectively promotes the application of DEM in engineering analyzes the operation state failure mechanism and operation effect of related equipment in operation and provides theoretical basis for the optimal design of equipment The book is intended for undergraduate and graduate students who are interested in mechanical engineering researchers investigating coal and agricultural machinery and engineers working on designing related equipments



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