Timoshenko Vibration Problems In Engineering

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the fifth edition of this classic work retains the most useful portions of timoshenko s book on vibration theory and introduces powerful modern computational techniques the normal mode method is emphasized for linear multi degree and infinite degree of freedom systems and numerical methods dominate the approach to nonlinear

systems a new chapter on the finite element method serves to show how any continuous system can be discretized for the purpose of simplifying the analysis includes revised problems examples of applications and computer programs

authors hugo bachmann walter j ammann florian deischl josef eisenmann ingomar floegl gerhard h hirsch günter k klein göran j lande oskar mahrenholtz hans g natke hans nussbaumer anthony j pretlove johann h rainer ernst ulrich saemann lorenz steinbeisser large structures such as factories gymnasia concert halls bridges towers masts and chimneys can be detrimentally affected by vibrations these vibrations can cause either serviceability problems severely hampering the user s comfort or safety problems the aim of this book is to provide structural and civil engineers working in construction and environmental engineering with practical guidelines for counteracting vibration problems dynamic actions are considered from the following sources of vibration human body motions rotating oscillating and impacting machines wind flow road traffic railway traffic and construction work the main section of the book presents tools that aid in decision making and in deriving simple solutions to cases of frequently occurring normal vibration problems complexer problems and more advanced solutions are also considered in all cases these guidelines should enable the engineer to decide on appropriate solutions expeditiously the appendices of the book contain fundamentals essential to the main chapters

authors hugo bachmann walter j ammann florian deischl josef eisenmann ingomar floegl gerhard h hirsch günter k klein göran j lande oskar mahrenholtz hans g natke hans nussbaumer anthony j pretlove johann h rainer ernst ulrich saemann lorenz steinbeisser large structures such as factories gymnasia concert halls bridges towers masts and chimneys can be detrimentally affected by vibrations these vibrations can cause either serviceability problems severely hampering the user s comfort or safety problems the aim of this book is to provide structural and civil engineers working in construction and environmental engineering with practical guidelines for counteracting vibration problems dynamic actions are considered from the following sources of vibration human body motions rotating oscillating and impacting machines wind flow road traffic railway traffic and construction work the main section of the book presents tools that aid in decision making and in deriving simple solutions to cases of frequently occurring normal vibration problems complexer problems and more advanced solutions are also considered in all cases these guidelines should enable the engineer to decide on appropriate solutions expeditiously the appendices of the book contain fundamentals essential to the main chapters

this book offers professionals working at power plants guidelines and best practices

for vibration problems in order to help them identify the respective problem grasp it and successfully solve it the book provides very little theoretical information which is readily available in the existing literature and doesn t assume that readers have an extensive mathematical background rather it presents a range of well documented real world case studies and examples drawn from the authors 50 years of experience at jobsites vibration problems don t crop up very often thanks to good maintenance and support but if and when they do most power plants have very little experience in assessing and solving them accordingly the case studies discussed here will equip power plant engineers to quickly evaluate the vibration problem at hand by deciding whether the machine is at risk or can continue operating and find a practical solution

vibration problems in engineering by s timoshenko professor of theoretical and engineering mechanics stanford university second editionfifth printing new york d van nostrand company inc 250 fourth avenue preface to the second edition in the preparation of the manuscript for the second edition of the book the authors desire was not only to bring the book up to date by including some new material but also to make it more suitable for teaching purposes with this in view the first part of the book was entirely re written and considerably enlarged a number of examples and problems with solutions or with answers were included and in many places new material was added the principal additions are as follows in the first chapter a discussion of forced vibration with damping not proportional to velocity is included and an article on self excited vibration in the chapter on non linear sys tems an article on the method of successive approximations is added and it is shown how the method can be used in discussing free and forced vibra tions of systems with non linear characteristics the third chapter is made more complete by including in it a general discussion of the equation of vibratory motion of systems with variable spring characteristics the fourth chapter dealing with systems having several degrees of freedom is also considerably enlarged by adding a general discussion of systems with viscous damping an article on stability of motion with an application in studying vibration of a governor of a steam engine an article on whirling of a rotating shaft due to hysteresis and an article on the theory of damp ing vibration absorbers there are also several additions in the chapter ontorsional and lateral vibrations of shafts the author takes this opportunity to thank his friends who assisted in various ways in the preparation of the manuscript and particularly professor l s jacobsen who read over the complete manuscript and made many valuable suggestions and dr j a wojtaszak who checked prob lems of the first chapter stephen timoshenko stanford university may 29 1937 preface to the first edition with the increase of size and velocity in modern machines the analysis of vibration problems becomes more and more important in mechanical engineering design it is well known that problems of great practical significance such as the balancing of machines the torsional vibration of

shafts and of geared systems the vibrations of turbine blades and turbine discs the whirling of rotating shafts the vibrations of railway track and bridges under the action of rolling loads the vibration of foundations can be thoroughly understood only on the basis of the theory of vibration only by using this theory can the most favorable design proportions be found which will remove the working conditions of the machine as far as possible from the critical conditions at which heavy vibrations may occur in the present book the fundamentals of the theory of vibration are developed and their application to the solution of technical problems is illustrated by various examples taken in many cases from actual experience with vibration of machines and structures in service in developing this book the author has followed the lectures on vibration given by him to the mechanical engineers of the westinghouse electric and manufacturing company during the year 1925 and alsocertain chapters of his previously published book on the theory of elasticity the contents of the book in general are as follows the first chapter is devoted to the discussion of harmonic vibrations of systems with one degree of freedom the general theory of free and forced vibration is discussed and the application of this theory to balancing machines and vibration recording instruments is shown

vibration problems in machines explains how to infer information about the internal operations of rotating machines from external measurements through methods used to resolve practical plant problems second edition includes summary of instrumentation methods for establishing machine rundown data relationship between the rundown curves and the ideal frequency response function the section on balancing has been expanded and examples are given on the strategies for balancing a rotor with a bend with new section on instabilities it includes case studies with real plant data matlab scripts and functions for the modelling and analysis of rotating machines

the last thing one settles in writing a book is what one should put in first pascal s pensees classical vibration theory is concerned in large part with the infinitesimal i e linear undamped free vibration of various discrete or continuous bodies one of the basic problems in this theory is the determination of the natural frequencies eigen frequencies or simply eigenvalues and normal modes of the vibrating body a body which is modelled as a discrete system of rigid masses rigid rods massless springs etc will be governed by an ordinary matrix differential equation in time t it will have a finite number of eigenvalues and the normal modes will be vectors called eigenvectors a body which is modelled as a continuous system will be governed by a partial differential equation in time and one or more spatial variables it will have an infinite number of eigenvalues and the normal modes will be functions eigen functions of the space variables in the context of this classical theory inverse problems are concerned with the construction of a model of a given type e g a mass

spring system a string etc which has given eigenvalues and or eigenvectors or eigenfunctions i e given spec tral data in general if some such spectral data is given there can be no system a unique system or many systems having these properties

the book presents the theory of free forced and transient vibrations of single degree two degree and multi degree of freedom undamped and damped lumped parameter systems and its applications free and forced vibrations of undamped continuous systems are also covered numerical methods like holzers and myklestads are also presented in matrix form finite element method for vibration problem is also included nonlinear vibration and random vibration analysis of mechanical systems are also presented the emphasis is on modelling of engineering systems examples chosen even though quite simple always refer to practical systems experimental techniques in vibration analysis are discussed at length in a separate chapter and several classical case studies are presented though the book is primarily intended for an undergraduate course in mechanical vibrations it covers some advanced topics which are generally taught at postgraduate level the needs of the practising engineers have been kept in mind too a manual giving solutions of all the unsolved problems is also prepared which would be extremely useful to teachers

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