Fundamentals of Machine Design
Volume II

Machine design is part of the broader discipline of Engineering Design. *Fundamentals of Machine Design* is compiled in two volumes. Vol. II is a follow-up to the first volume. Unit 1 of this volume begins by discussing fundamental concepts, types and applications of belt drives, pulleys, rope drives, chain and sprocket drive, spur gears, helical gears, bevel gears, worm gears and gear trains using simple and epicyclic gears in detail. Unit 2 discusses construction aspects, classification, material required, design procedures and selection parameters for hydrodynamic and rolling bearings. The design steps are discussed comprehensively, which helps students and teachers in practical classes. Unit 3 discusses different types and construction processes of important parts of an internal combustion engine including cylinder, piston, connecting rod, crank shaft and valve gears. The final unit 4 comprehensively discusses the design procedure, types and construction of flywheels, clutches, brakes and pressure vessels.

Pedagogical features in the book include solved examples, unsolved exercises, design problems and review questions. The text is primarily a follow-up introductory course on machine design, meant for undergraduate students of mechanical engineering. It is accompanied with teaching resources including a solutions manual for instructors.

Ajeet Singh retired as Professor and Head of the Department of Mechanical Engineering from Motilal Nehru National Institute of Technology (MNNIT), Allahabad. In addition to teaching, he worked in many administrative positions like Dean Academic, Dean Research and Consultancy etc. He has about three decades of teaching experience at undergraduate, graduate and doctoral level in India and 15 years abroad. He taught courses in machine drawing, machine design, internal combustion engines, tribology, computer aided design and engineering processes. He has been consultant to industries like BHEL, TEW etc. Besides publishing several papers in national and international journals, he has published three textbooks: *Working with AutoCAD 2000 with updates to AutoCAD 2000i* (2002), *Machine Drawing: Includes AutoCAD 2005* (2005) and *Machine Drawing; Includes AutoCAD 2010* (2012).

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Dedicated to my parents, wife,

Daughters: Preety, Diljeet and Maneet

Grandchildren: Gaganjit, Karanjit, Ananya, Neha, Tanvi and Simar

Contents

Preface

Fundamentals of machine design considers the concepts of design for each element separately such as shaft, bearing, pulley and gears. Since the number of parts is very large, the book is divided into two volumes. The language is direct and simple, so that every student can understand easily. *Volume 1* of the book describes the basic knowledge needed for designing a part. Various types of stresses that appear due to load and the analysis to calculate the size of a part, which will work satisfactorily, are given. Designs of various types of permanent and temporary joints like riveted, welded, threaded, cotter etc. and some important parts such as shafts, keys, couplings, and springs are described.

Volume 2 has four units; covering design of drives, bearings, I.C. engine parts, and miscellaneous parts such as clutches, brakes, and pressure vessels.

Unit 1 describes different types of drives. Chapter 1 gives the design of belts and pulleys of various types. Chapter 2 is on the design of ropes used for large power transmission and hoisting applications. Chapter 3 describes the design of chain drives. One of the important methods of transmitting power is using gears and is discussed in detail. Chapter 4 describes the fundamentals of the gear design. Various types of gears such as spur, helical, bevel, and worm are described separately in chapters 5 to 8. Design of gear boxes using gear trains and epicyclic gears is explained in Chapter 9.

Unit 2 gives the design of two important types of bearings used in many applications. Design of slide bearings is given in Chapter 10 and rolling element bearings in Chapter 11.

Unit 3 is on the design of I.C. engine parts. Each important part is described as a separate chapter. Chapter 12 is on the design of cylinder, Chapter 13 on piston, Chapter 14 on connecting rod, and Chapter 15 on crank shaft. These engines require valves to control flow of air and exhaust. All parts in valve gear mechanism such as cam, its follower, push rod, rocker arm, and valves are described in Chapter 16. There is large variation in torque in these engines

and hence to reduce the fluctuations in speed, flywheels are required, which are described in Chapter 17.

Unit 4 describes miscellaneous parts in three chapters. Chapter 18 is on the design of various types of clutches, Chapter 19 on the design of various types of brakes, and the last Chapter 20 is on the design of pressure vessels.

Pedagogical features of the book are excellent. At the beginning of each chapter *outcomes* are given, which gives an idea as to what a student is going to learn in that chapter. Every effort has been made to explain the theory with figures. This volume contains *289 figures*. To make the book more illustrative, *122 license-free pictures* are given from the internet. Students face a lot of difficulty in solving design problems; hence a large number of *158 solved examples* are given.

At the end of each chapter a *summary* is given for quick revision of the course and formulas at the time of examination. Each chapter is followed by *theory questions*. To practice for quiz type questions, *216 multiple choice* questions have been given. To practice the design problems, *180 unsolved problems* with the answers are given. Solution to the unsolved examples shall be put in the *solution manual* on the internet in due course of time.
Competition examinations questions of past 3–4 years from Engineering services examinations and *GATE* examinations are given at the end of the chapters to help students preparing for such examinations.

After successful completion of the course, the student shall be able to understand the design process with all stresses on it and shall be able to find a size for its satisfactory working. The mastering of the course is a precondition for a successful design.

Audience: This book can be easily recommended as a *textbook* on the subject of Machine Design for undergraduate students. The book can also be used by practising engineers, students appearing for competition examinations, and for graduate admission tests.

Although every effort is made to minimize the errors, but still a human being is likely to commit mistakes. Also, there is always a possibility of improving the book. Any errors, omissions, or suggestions for the improvement of the book may please be written to the publisher or email to the email address of the author at ajeet41@yahoo.com.

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Many books on the subject of machine design have been consulted and the author would like to thank the publishers and authors of the books referred given in the references at the end of the book.