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Book Reviews

Fundamentals of Machine Component Design by R. C. Juvinall, Wiley, New York, 1983, 760 pages. Price: $34.95

Reviewed by H. Saunders[1]

A number of books on machine design have appeared on the market, some fair, some good, few excellent. This large volume definitely belongs in the latter category, containing a homogeneous combination of theory, experimental findings and above all, a large number of illustrative examples. As stated by the author, "This book is intended as a text for first courses in mechanical engineering design and as a reference for practicing engineers." Juvinall fulfills his intention.

Chapter 1 introduces mechanical engineering design in a broad perspective. Safety, ecological and social considerations are discussed as well as systems of units in work, energy, and power.

The ensuing chapters take up such basic concerns as load analysis from the the points of view of equilibrium equations, free body diagrams, beam loadings and force flow concepts; materials and their respective tests, energy absorption by machines, static body forces, explanations of axial, direct, torsional, bending and transverse shear on straight and curved beams, Mohr's circle, and concentration factors.

Chapter 5 progresses naturally into a discussion of elastic strain, deflection, stability, strain gage equations, and Castigliano's theory. A consideration of elastic stability rounds out the chapter.

Various failure theories, safety and reliability factors, the Gauss normal distribution curve, dynamic loading, and the simple relationships of stress and deflection due to linear, bending, and torsional impact are considered in chapters 6 and 7. However, the discussion is hindered here, by Juvinall's failure to present a review of vibration theory with this material.

Chapters 8 and 9 turn to the fatigue concept with a good explanation of the standard fatigue tests. The contents include fatigue life, production of randomly varying loads (Miner's rule), the influence of surface conditions on the fatigue strength of materials, the effects of stress combinations due to combined alternating and mean loads, the effects of corrosion, cavitation damage, and adhesive and abrasive fretting wear. Chapter 8 is particularly fine; chapter 9 introduces the preliminary aspects of mechanical design applied to machines.

The next chapter treats threaded fasteners and power screws. This includes bolt tightening and initial tension, thread loosening, bolt and screw selection, and both static and fatigue loading; unfortunately, the presentation is weakened by Juvinall's failure to discuss the stresses due to thermal, preload, and bending loading.

Chapters 11 and 12 treat riveting, welding subjected to torsional and bending loads, brazing, soldering, and the various aspects of spring design consisting of coil, torsion bar, helical compression and beam springs. The various aspects of buckling and fatigue loading are addressed within the framework of the design needs of helical springs. Twelve is another particularly good chapter, replete with a number of illustrative examples.

An excellent introduction to the various types of lubrications and sliding bearings is found in chapter 13. It proceeds from the basic concepts to a discussion of viscosity, hydrodynamic lubrication theory, heat dissipation and equilibrium oil temperature, and boundary-mixed film lubrication.

Chapter 14 delves into roller element bearings, comparing the alternate means of supporting rotating shafts, the design and fretting of rolling element bearings, bearing selection, and proper mounting. Chapter 15 considers spur gears, beginning with geometry and nomenclature. Then Juvinall explains interference and contact ratios, gear tooth strength, the Lewis equation for gear tooth bending, gear trains, gear fatigue analysis, and gear materials. "Heywood's equation" for the bending strength of gears does not appear in the discussion, however, although it is a necessary aspect in a gear designer's repertoire.

The next two chapters turn to helical, level and worm gears, including gear force, tooth loading, first gear trains (differentials), worm gear analysis, shafts with provisions for bearings, couplings, and universal joints. The review of this material should have been expanded also, in this case to include the determination of natural frequencies via matrix methods.

The discussion in chapters 18 and 19 takes up clutches and brakes, cone clutches, and long shoe brakes. A number of miscellaneous power transmission concepts, viz. flat, toothed and V-belts, roller and inverted tooth chains, follow. The concluding section has a short discourse on fluid couplings and hydrodynamic torque converters.

The concluding chapter presents a most valuable case study of the original hydromatic transmission. It begins with the use of free-body diagrams to determine gear ratios and component loads, then introduces brake and clutch design with an important discussion of gearing design.

The reviewer would have liked to see a more detailed section on vibrations in the book; more importantly, Juvinall should have provided an introduction to finite elements. These are being used to a large extent in contemporary mechanism and machine component design, and should not be absent from a contemporary text on the fundamentals of machine component design. These faults do not seriously detract from Juvinall's book; on the contrary, it presents a veritable storehouse of the theory of mechanisms, design of machine components, and the strength of materials couched in excellent and well-illustrated discussions.

[1] General Electric Co., Schenectady, N.Y. 12345

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