

MACHINE DESIGN

[ENTIRELY IN SI UNITS]

By

Dr. N. C. Pandya, Dr. C. S. Shah

Edition : 21st Edition : 2022 ISBN : 9789385039539 Binding : Paperback : 1064 + 16 = 1080 Pages Size (mm) : 210 × 42 × 140 Weight : 970 g

ABOUT THE BOOK

This *text-book* aims at presenting the fundamental principles of Mechanical Engineering Design.

The fundamentals of theory and design are presented as lucidly as possible to enable the students in engineering institutions to get a clear grasp of the basic principles of the subject. It explains the general theory of mechanical engineering design and sets out problems for the students aimed at equipping them for design of machine parts with intelligence and understanding.

Throughout this book the chief aim has been to illustrate the subject matter fully with suitable diagrams and by direct treatment of the subject matter.

The book contains numerous examples carefully chosen from past examination papers of various Indian Universities.

The book is intended for Mechanical Engineering students preparing for degree examinations in engineering of almost all the Indian Universities, diploma examinations of various technical boards, certificate courses, examinations of A.M.I.E., U.P.S.C., G.A.T.E., I.E.S. and other similar competitive and professional Examinations. It should also prove of interest and of practical value to practising engineers.



CONTENT

- 1: MATERIALS OF CONSTRUCTION AND THEIR PROPERTIES
- 2: DESIGN CONSIDERATIONS IN MACHINE PARTS
- 3: CYLINDERS, TANKS AND PIPES
- 4: RIVETED JOINTS
- 5: BOLTS, NUTS AND SCREWS
- 6: COTTER AND KNUCKLE JOINTS
- 7: SHAFTS, KEYS AND COUPLINGS
- 8: SPRINGS
- 9: BEARINGS
- 10: STRUTS AND COLUMNS
- 11 : POWER SCREWS
- 12: LEVERS
- 13: BRACKETS
- 14: BELTS, PULLEYS AND CHAIN DRIVES
- 15: FLYWHEELS
- 16: GEARS
- 17: WELDED CONNECTIONS
- 18 : DESIGN OF MISCELLANEOUS MACHINE PARTS I : ENGINES AND BOILERS
- 19: DESIGN OF MISCELLANEOUS MACHINE PARTS II : BRAKES AND CLUTCHES
- 20: DESIGN PROJECTS

APPENDIX : I TO APPENDIX : XVII

INDEX

Follow us:

Catalogue

Checklist

Chapter 1 MATERIALS OF CONSTRUCTION AND THEIR PROPERTIES

- 1-1. Introduction
- 1-2. Choice of material
- 1-3. Materials of construction
- 1-4. Structure of materials
- 1-5. Mechanical properties of materials of construction
- 1-6. Determination of mechanical properties
- 1-7. Fabrication characteristics and processes of fabrication
- 1-8. Ferrous metals Cast iron, wrought iron and steel
- 1-9. Non-ferrous metals and alloys
- 1-10. Available sizes
- 1-11. Accuracy
- 1-12 Finishing processes
- 1-13. Non-metallic materials
- 1-14. Plastics
- 1-15. Composite materials
- 1-16. Improvements in properties of materials Examples I

Chapter 2 DESIGN CONSIDERATIONS IN MACHINE PARTS

- 2-1. Loads
- 2-2. Stress
- 2-3. Strain
- 2-4. Stress-Strain diagram Modulus of elasticity
- 2-5. Poisson's ratio
- 2-6. Modulus of rigidity
- 2-7. Bulk modulus
- 2-8. Basic requirements of machine elements
- 2-9. Factor of safety: Selection of allowable stresses
- 2-10. Procedure for designing a machine element
- 2-11. Tensile stress
- 2-12. Compressive stress
- 2-13. Shearing stress
- 2-14. Bearing pressure intensity
- 2-15. Bending (Flexure)
- 2-6. Shear stresses in a beam
- 2-17. Torsion
- 2-18. Eccentric loading
- 2-19. Combined stresses: Bending combined with direct load
- 2-20. Offset connecting links and C shaped frames
- 2-21. Shear stresses combined with tensile and compressive stresses
- 2-22. Theories of elastic failure
- 2-23. Designing for impact loads
- 2-24. Design of members subjected to impact torsion
- 2-25. Stress concentration
- 2-26. Notch sensitivity
- 2-27. Effect of repeated application of a load
- 2-28. Fluctuating stress for ductile materials
- 2-29. Cummulative damage in fatigue: (Miner's equation)
- 2-30. Fatigue life determined by short-term testing
- 2-31. Light weight and minimum dimensions
- 2-32. Elastic matching
- 2-33. Temperature stresses Examples II

Chapter 3 CYLINDERS, TANKS AND PIPES

- 3-1. Introduction
- 3-2. Types of vessels
- 3-3. Design of thin cylinders
- 3-4. Design of a thin spherical shell
- 3-5. Cylindrical shell with hemispherical ends
- 3-6. General theory of membrane stresses in vessels under internal pressure

Charotar Publishing House Pvt. Ltd. Opposite Amul Dairy, Old Civil Court Road, Anand 388 001 India

- 3-7. Design of pipes
- 3-8. Design of thick cylinders
- 3-9. Design equation for thick cylinders Examples III

Chapter 4 RIVETED JOINTS

- 4-1. Introduction
- 4-2. Rivets
- 4-3. Rivet heads
- 4-4. Types of riveted joints
- 4-5. Caulking and fullering
- 4-6. Design of a riveted joint for boiler construction
- 4-7. Efficiency of a riveted joint
- 4-8. Joints for storage tanks
- 4-9. Lozenge joint
- 4-10. Eccentric loads on riveted connections
- 4-11. Rules in designing riveted joints
- 4-12. Advantages of welding over riveting Examples IV

Chapter 5 BOLTS, NUTS AND SCREWS

- 5-1. Introduction
- 5-2. Definitions
- 5-3. Forms of screw threads
- 5-4. Advantages of square threads over V threads
- 5-5. Screw fastenings
- 5-6. Locking devices for nuts
- 5-7. Washers
- 5-8. Eye bolt
- 5-9. Efficiency of threads
- 5-10. Stresses in screw fastenings
- 5-11. Initial stresses
- 5-12. Stresses due to external forces
- 5-13. Stresses due to combined load
- 5-14. Bolts of uniform strength
- 5-15. Screwed boiler stays
- 5-16. Bolts subjected to shear
- 5-17. Bolts under eccentric loading
- 5-18. Design of a nut
- 5-19. Power transmitting capacity of set screws Examples V

Chapter 6 COTTER AND KNUCKLE JOINTS

(A) DESIGN OF CPTTERED JOINTS

Introduction

Examples VI

Design of axles

Form of keys

Design of sunk keys

7-10. Effect of keyways in sunk keys

7-1. Introduction

Keys

Joint of suspension links

- 6-1. Introduction
- 6-2. Design of cottered joints
- 6-3. Gib and cotter

6-6.

6-7.

6-8.

7-2.

7-3.

7-4.

7-5.

7-6.

7-7.

7-8.

7-9.

🕲 +91 2692 256237, 240089, 🕲 +91 99249 78998 😂 charotar@cphbooks.com, 🕮 https://cphbooks.in 🤇 f /charotar y /cphpl1511 🚳 /charotarpub (in) /in/charotar/

6-4. Connection of a piston rod to a crosshead6-5. Cotter foundation bolts

Design of a coupler or a turnbuckle

Chapter 7 SHAFTS, KEYS AND COUPLINGS

Design of shafts on the basis of strength

Design of shafts on the basis of rigidity

Design of hollow and non-circular shafts

Follow us:

Materials and design stresses

(B) DESIGN OF A KNUCKLE JOINT

- 7-11. Taper pins
- 7-12. Feather keys and splined shafts
- 7-13. Force and shrink fits (Driving fits on solid shafts)
- 7-14. Couplings: Introduction
- 7-15. Sleeve couplings or muff couplings
- 7-16. Clamp or compression couplings
- 7-17. Flange-couplings
- 7-18. Marine type of flange couplings
- 7-19. Flexible couplings
- 7-20. Bushed pin type of flexible couplings
- 7-21. Bibby type of flexible coupling
- 7-22. Leather pad type flexible coupling
- 7-23. Oldham's coupling
- 7-24. Universal coupling
- 7-25. Safety couplings7-26. Flexible shafts
 - Examples VII

Chapter 8 SPRINGS

- 8-1. Introduction
- 8-2. Close coiled helical springs subjected to axial loading Circular wire
- 8-3. Optimum design of helical springs
- 8-4. Helical springs of non-circular wires
- 8-5. Concentric helical springs
- 8-6. General considerations in design of compression and extension springs
- 8-7. Torsion helical springs
- 8-8. Spiral springs (Power springs)
- 8-9. Leaf springs
- 8-10. Belleville springs
- 8-11. Energy-storage capacity Examples VIII

Chapter 9 BEARINGS

- 9-1. Introduction
- 9-2. Bearing area
- 9-3. Sliding bearings: Solid journal bearings
- 9-4. Divided journal bearing: Plummer block
- 9-5. Hydrodynamic theory of lubrication
- 9-6. Oil grooving
- 9-7. Heating of bearings
- 9-8. Design procedure for hydrodynamic journal bearings
- 9-9. Bearing materials
- 9-10. Design of bearing caps and bolts
- 9-11. Foot step or pivot bearings
- 9-12. Collar bearings
- 9-13. Anti-friction bearings
- 9-14. Radial ball bearings
- 9-15. Roller bearings
- 9-16. Selection of ball and roller bearings
- 9-17. Bearing load
- 9-18. Equivalent bearing load
- 9-19. Carrying capacity and life
- 9-20. Relationship between load and life
- 9-21. Requisite bearing life for different types of machines
- 9-22. Life of Timken bearings
- 9-23. Influence of high temperatures on load carrying capacity

Charotar Publishing House Pvt. Ltd. Opposite Amul Dairy, Old Civil Court Road, Anand 388 001 India

- 9-24. Permissible misalignment
- 9-25. Friction in rolling bearings
- 9-26. Comparison of sleeve and rolling bearings Examples X

Chapter 10 STRUTS AND COLUMNS

- 10-1. Introduction
- 10-2. Euler's formula
- 10-3. End fixity coefficients
- 10-4. Radius of gyration and plane of buckling
- 10-5. Rankine's formula
- 10-6. Tetmajer's formula
- 10-7. Johnson formula
- 10-8. Design of push rods
- 10-9. Eccentrically loaded columns Examples X

Chapter 11 POWER SCREWS

- 11-1. Introduction
- 11-2. Forms of threads
- 11-3. Force analysis
- 11-4. Design of a screw
- 11-5. Design of a nut
- 11-6. Practical design of simple lifting machines (screw jack)
- 11-7. Compound screw
- 11-8. Differential screw
- 11-9. Ball screws Examples XI

Chapter 12 LEVERS

- 12-1. Introduction
- 12-2. General procedure for design of levers
- 12-3. Hand lever
- 12-4. Foot lever
- 12-5. Cranked lever
- 12-6. Lever of a lever loaded safety valve
- 12-7. Rocker arm for Diesel engines (Straight arm)
- 12-8. Angular levers
- 12-9. Design of overhung cranks
- 12-10. Design of a crank pin (overhung crank)
- 12-11. Miscellaneous examples Examples XII

Chapter 13 BRACKETS

- 13-1. Brackets
- 13-2. Hangers
- 13-3. Wall boxes
- 13-4. Design considerations Examples XIII

Chapter 14 BELTS, PULLEYS AND CHAIN DRIVES

- 14-1. Introduction
- 14-2. Materials for belts
- 14-3. Design of belts
- 14-4. Design procedure for flat belts
- 14-5. V-belt drives

14-10. Steel pulleys

14-13. Speed cones

14-17. Roller chains

🕲 +91 2692 256237, 240089, 🕲 +91 99249 78998 😂 charotar@cphbooks.com, 🛞 https://cphbooks.in 🚺 (f) /charotar y /cphpl1511 🚳 /charotarpub (in) /in/charotar/

14-11. Wooden pulleys

14-12. Fast and loose pulleys

14-8. Cast iron pulleys

- 14-6. Design of V-flat drives
- 14-7. Pulleys: Materials and types

14-9. Design of cast iron pulleys

14-16. Chain drives (Introduction)

14-18. Design of chain drives Examples XIV

14-14. Short centre drive - Gravity idlers

14-15. Special tension adjusting belt drives

Follow us:

Chapter 15 FLYWHEELS

- 15-1. Introduction
- 15-2. Determination of mass of a flywheel for a given coefficient of fluctuation of speed
- 15-3. Flywheel for punches and shears
- 15-4. Engine flywheels
- 15-5. Flywheel for electric generators
- 15-6. Stresses in rim of flywheels
- 15-7. Design of a hub
- 15-8. Arms of the flywheel Examples XV

Chapter 16 GEARS

- 16-1. Introduction
- (A) DESIGN OF SPUR GEARS
- 16-2. General characteristics
- 16-3. Spur gear terminology
- 16-4. Gear tooth forms
- 16-5. Accuracy of gears
- 16-6. Materials
- 16-7. Allowable stresses
- 16-8. Design considerations
- 16-9. Strength of gear teeth Lewis equation
- 16-10. Dynamic tooth load
- 16-11. Design for wear
- 16-12. Gear wheel proportions
- 16-13. Internal gears
- 16-14. Racks

(B) DESIGN OF HELICAL GEARS

- 16-15. Introduction
- 16-16. Proportions for helical gears
- 16-17. Design of helical gear teeth
- 16-18. Herringbone gears
- 16-19. Rating of machine cut spur and helical gears (C) DESIGN OF BEVEL GEARS
- 16-20. Introduction
- 16-21. Definitions
- 16-22. Strength of bevel gear teeth
- 16-23. Constructional details
- 16-24. Bearing loads
 - (D) DESIGN OF WORM GEARS
- 16-24. Introduction
- 16-26. Worm gear nomenclature
- 16-27. Strength of worm gear teeth
- 16-28. Bearing loads on the shafts Examples XVI

Chapter 17 WELDED CONNECTIONS

- 17-1. Introduction
- 17-2. Welding processes
- 17-3. Types of welded joints
- 17-4. Working stresses in welds
- 17-5. Strength of welds
- 17-6. Special cases of fillet welds
- 17-7. Eccentric loads on welded connections
- 17-8. Design procedure recommended by American Welding Society
- 17-9. Fillet welds under varying loads Examples XVII

Chapter 18 DESIGN OF MISCELLANEOUS MACHINE PARTS-I ENGINES AND BOILERS

- 18-1. Design of flat plates
- 18-2. Design of a piston for I.C. Engines
- 18-3. Design of crossheads
- 18-4. Design of connecting rods
- 18-5. Design of crankshafts
- 18-6. Design of a spring-loaded Hartnell governor
- 18-7. Design of an eccentric
- 18-8. Compensating ring for a manhole
- 18-9. Design of safety valves for boilers
- 18-10. Design of a screw down steam stop valve
- 18-11. Design of cams (I.C. Engines)
- 18-12. Design of a valve gear for I.C. Engines Examples XVIII

Chapter 19 DESIGN OF MISCELLANEOUS MACHINE PARTS-II BRAKES AND CLUTCHES

- (A) HOISTING EQUIPMENTS
- 19-1. Introduction
- 19-2. Design of hoisting chains and drums
- 19-3. Design of a hoisting rope
- 19-4. Design of wire ropes
- 19-5. Stresses in curved beams
- 19-6. Design of a crane hook (B) BRAKES
- 19-7. Introduction
- 19-8. Types of brakes
- 19-9. Design procedure for block brakes
- 19-10. Band brakes: Introduction
- 19-11. Design procedure for band brakes (C) CLUTCHES
- 19-12. Introduction
- 19-13. Design procedure for friction clutches Examples XIX

Chapter 20 DESIGN PROJECTS 20-1. Introduction

APPENDICES I TO XVII

APPENDIX I :	International system of units (SI System)
APPENDIX II :	Sizes of pulleys for flat and V-belts
APPENDIX III :	Width of flat cast iron and mild steel pulleys
APPENDIX VII :	Basic thicknesses of sheet and diameters of wire
	in millimetres
APPENDIX V :	Properties of Ferrous Materials
APPENDIX VI :	Properties of Plastics
APPENDIX VII :	List of Indian Standards: "Testing of Materials"
APPENDIX VIII :	Indian Standards referred in the text
APPENDIX IX :	Preferred Numbers (Rounded values)
APPENDIX X :	(a) Metric coarse threads
	(b) Metric Fine threads
APPENDIX XI :	Common sizes of transmission shafts
APPENDIX XII :	Deflection formulas for machine parts
APPENDIX XIII :	Properties of geometrical Sections
APPENDIX XIV :	Imperial or Legal Standard Wire Gauge
APPENDIX XV :	Load carrying capacity of V-belts
APPENDIX XVI :	Service factors for belt drives
APPENDIX XVII:	Worm data

Index

Charotar Publishing House Pvt. Ltd. Opposite Amul Dairy, Old Civil Court Road, Anand 388 001 India 🕲 +91 2692 256237, 240089, 🕲 +91 99249 78998 😂 charotar@cphbooks.com, 🕮 https://cphbooks.in 🤇 f) /charotar y /cphpl1511 🔞 /charotarpub (in) /in/charotar/