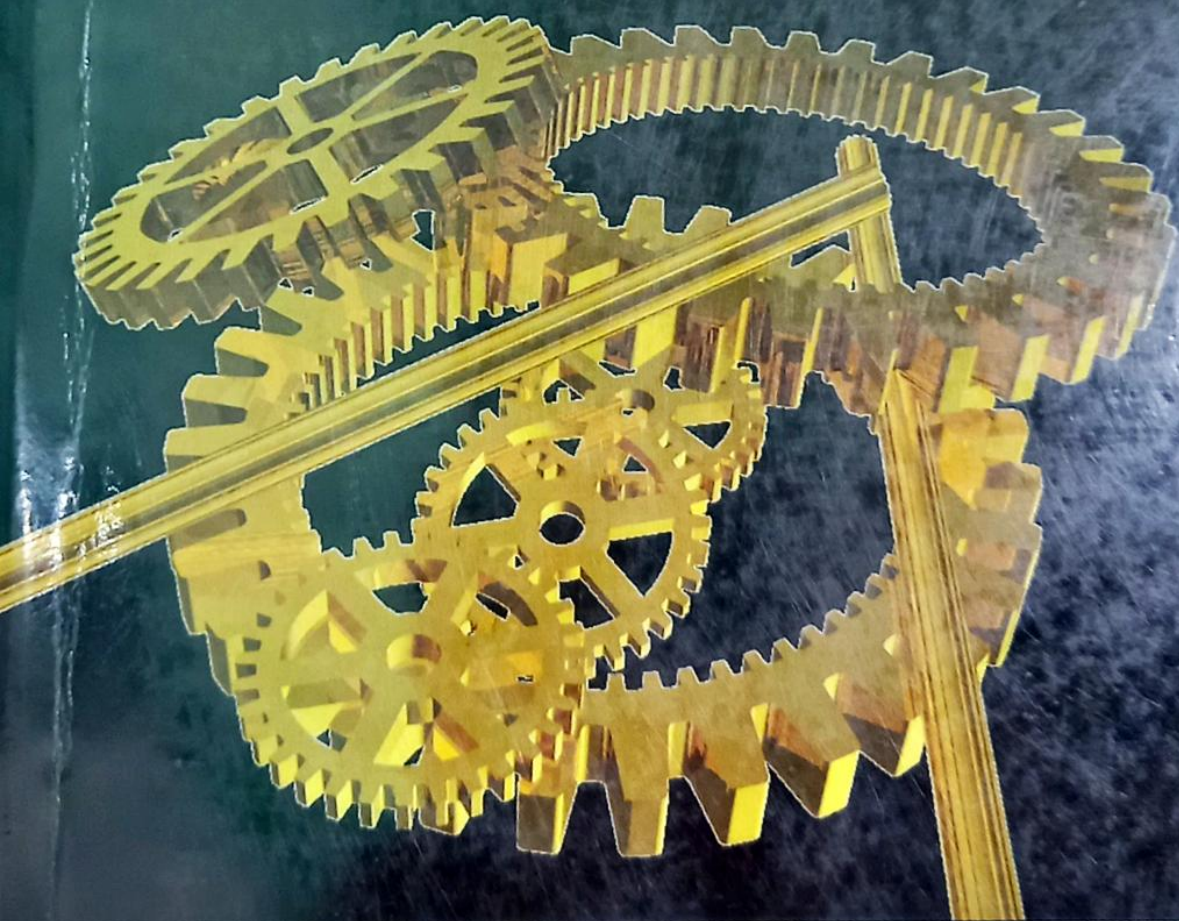


Engineering Mechanics



3G eLEARNING

ENGINEERING MECHANICS



3G eLEARNING

Engineering Mechanics

Copyright © 2014 by 3G Elearning FZ LLC

Digitally Printed at Replika Press Pvt. Ltd.

3G Elearning FZ LLC

UAE

www.3gelearning.com

email: 3ganmol@gmail.com

ISBN: 978-93-5115-132-6

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, scanning or otherwise without prior written permission of the publisher.

Reasonable efforts have been made to publish reliable data and information, but the authors, editors, and the publisher cannot assume responsibility for the legality of all materials or the consequences of their use. The authors, editors, and the publisher have attempted to trace the copyright holders of all material in this publication and express regret to copyright holders if permission to publish has not been obtained. If any copyright material has not been acknowledged, let us know so we may rectify in any future reprint. Registered trademark of products or corporate names are used only for explanation and identification without intent to infringe.

*Case Studies and/or Images presented in the book are the proprietary information of the respective organizations, and have been used here specifically and only for educational purposes.

For more information visit:



3G ELEARNING

TABLE OF CONTENTS

1. Reference Frame and Non-inertial Frame		Force or Coriolis Effects 38
1.1 Concept of Frame of Reference 3	2.2 Foucault's Pendulum 39	
1.1.1 Newton's Laws of Motion 4	2.2.1 Time Period and Orbital Speed of a Satellite 43	
1.1.2 Comments on Newton's Laws 4	2.3 Invariance of Velocity of Light 45	
1.1.3 Space-Time Symmetry and Conservation Laws 6	2.4 The Concept of Relativity 49	
1.2 Inertial Frame 11	2.5 The Postulates of Special Relativity 51	
1.3 Galilean Transformation 13	2.5.1 The Principle of Special Relativity 52	
1.3.1 Invariants of Galilean Transformations 15	2.6 Lorentz Transformations 52	
1.3.2 Invariance of Acceleration 16	2.6.1 Deriving the Lorentz Transformations 54	
1.3.3 Invariance of Space and Time Intervals 16	2.7 Time Dilation and Length Contraction 56	
1.3.4 Galilean Invariance of Newton's Laws and Nature of Forces 17	2.7.1 Time Dilation 57	
1.4 Fictitious Forces and Displacement 19	2.7.2 Length Contraction 59	
1.4.1 Inertial and Accelerated Reference Frames 20	2.8 Variation of Mass with Velocity 60	
1.4.2 Motion in a Linearly Accelerated Reference Frame 21	2.8.1 Derivation of Velocity 61	
1.4.3 How to Recognize Fictitious Forces/Accelerated Reference Frames 23	2.8.2 Mass Energy Relation 61	
1.5 Velocity and Acceleration in Rotating Co-ordinate Systems 24	2.8.3 An Application of Mass-energy Equivalence 62	
1.5.1 Rotating Coordinate Systems 24		
1.5.2 Rotating Reference Frames 27		
1.6 Centrifugal Acceleration 29		
2. Coriolis Force and Relativity		3. Motion under Central Force
2.1 Concept of Coriolis Force 35		3.1 Kepler's Laws 66
2.1.1 Coriolis Effect 36		3.1.1 Kepler's Second Law 67
2.1.2 Application of the Coriolis		3.1.2 Kepler's Third Law 68
		3.2 Gravitational Law and Field 69
		3.2.1 Newton's Universal Law of Gravitation 69
		3.2.2 Gravitational Field 71
		3.3 Potential Due to a Spherical Body 72
		3.4 Gauss and Poisson Equations for Gravitational Self Energy 75

3.4.1	Gauss Equations for Gravitational Self Energy.....	75	6.	Moment of Inertia in Rotation Dynamics	
3.4.2	Poisson Equations for Gravitational Self Energy.....	79	6.1	Rigid Body and Rotational Motion.....	136
4.	System of Particles		6.1.1	Torque.....	138
4.1	Center of Mass.....	87	6.2	Rigid Body Dynamics and Euler Equation.....	141
4.2	Motion of the Center of Mass.....	93	6.2.1	Body-Fixed Axis.....	142
4.3	Concepts of Reduced Mass.....	95	6.2.2	Stability of Free Motion about a Principal Axis.....	144
4.4	The Rocket.....	98	6.3	Kinetic Energy of Rotation.....	146
4.4.1	Single Stage Rocket.....	99	6.3.1	Kinetic Energy of a Body Rotating About an Axis through its Centre of Mass.....	146
4.4.2	Multistage Rocket.....	100	6.3.2	Kinetic Energy of a Rotating Body whose Centre of Mass has Also a Linear Velocity.....	147
4.5	Energy and Momentum Conservation.....	101	6.4	Angular Momentum and Angular Impulse.....	153
4.5.1	Energy Conservation.....	101	6.4.1	Angular Impulse.....	157
4.5.2	Momentum Conservation.....	102	6.5	General Theorems on Moment of Inertia.....	158
5.	Collisions and Angular Momentum		6.5.1	The Theorem (or Principle) of Perpendicular Axes.....	158
5.1	Concepts of Elastic Collision.....	107	6.5.2	The Theorem (or Principle) of Parallel Axes.....	160
5.2	Inelastic Collisions.....	108	6.6	Moment of Inertia of a Spherical Shell.....	162
5.2.1	K.E. Lost in Inelastic Collision.....	109	6.7	Moment of Inertia of a Solid Sphere.....	164
5.3	Analysis of Collision in Center of Mass Frame.....	110	6.8	Moment of Inertia of a Solid Cylinder.....	166
5.3.1	Energy and the center of mass frame.....	112	6.8.1	About its own Axis of Cylindrical Symmetry.....	166
5.3.2	Scattering in Two Dimensions.....	113	6.8.2	About the Axis through, Its Centre and Perpendicular to Its Axis of Cylindrical Symmetry.....	166
5.3.3	Analysis in the Center of Mass Frame.....	117	6.9	Moment of Inertia of a Hollow Cylinder.....	168
5.4	Angular momentum of a system of particles.....	119	6.9.1	About its Axis of Cylindrical Symmetry.....	168
5.4.1	Angular Momentum for a Single Particle.....	120	6.9.2	About an Axis Passing Through its Centre and Perpendicular to its Own Axis.....	169
5.4.2	Angular Momentum of a System of Particles.....	121			
5.4.3	Angular Momentum of particles with a moving center of mass.....	124			
5.5	Conservation of Angular Momentum.....	126			
5.6	Angular Momentum about an Arbitrary Point.....	131			

7. Fluids, Stream Line and Turbulent Flow	Angle—Young's Equation.....219
7.1 Properties of Matter.....174	8.4.2 Contact Angle Hysteresis220
7.1.1 Classification of Matter175	8.5 Experimental Setup and Method.... 222
7.2 Kinematics of Moving Fluids178	8.5.1 Direct Measurement
7.2.1 Methods of Research	by Telescope Goniometer222
of Fluid Movement.....178	8.5.2 Captive Bubble Method.....226
7.3 Euler's Equation, Bernoulli's	8.5.3 Tilting Plate Method227
Theorem and Viscous Fluids.....182	8.5.4 Wilhelmy Balance Method228
7.4 Poiseuille's law191	9. Elasticity and Bending of Beams
7.5 Capillary Tube Flow.....194	9.1 Small Deformations 232
7.5.1 Balance Point of Compressor	9.1.1 Types of Deformation.....233
and Capillary Tube.....195	9.2 Young's Modulus 236
7.5.2 Effect of Load Variation197	9.2.1 Temperature Effects
7.6 Reynolds's Number198	on Young's Modulus.....238
7.7 Stokes' Law199	9.3 Bulk Modulus..... 238
8. Surface Tension	9.4 Modulus of Rigidity for
8.1 Surface Tension and Surface	an Isotropic 242
Energy..... 205	9.5 Poisson Ratio 244
8.1.1 Surface Tension.....205	9.6 Relationships between Elastic
8.1.2 Surface Energy.....207	Constants..... 247
8.2 Molecular Interpretation	9.7 Theory of Bending of Beams..... 248
of Surface Tension 208	9.7.1 Stresses248
8.2.1 Molecular Explanation of the	9.7.2 Tensile and Compressive
Shape of Liquid Surfaces209	Stresses249
8.2.2 Types of Molecular Units.....210	9.7.3 Shearing Stresses249
8.3 Saturated Vapor Pressure, Surface	9.8 Bending Moments and Shearing
Tension and Curvature of Liquid	Forces 250
Surface..... 211	9.8.1 Bending Moments251
8.3.1 SVP of water:.....212	9.8.2 Shear Force251
8.4 Contact Angle and Wetting	9.8.3 Shear Force and Bending
Properties218	Moment Diagrams.....252
8.4.1 Surface Tension and Contact	9.9 Experimental Determination of
	Elastic Constants by Bending
	of Beam..... 253

Bibliography

Engineering Mechanics

The importance of Engineering Mechanics is well known in various engineering fields. The book is structured to cover the key aspects of the subject Engineering Mechanics.

The book uses plain, lucid language to explain fundamentals of this subject. The book provides logical method of explaining various complicated concepts and stepwise methods to explain the important topics. Each chapter is well supported with necessary illustrations, practical examples and solved problems. All the chapters in the book are arranged in a proper sequence that permits each topic to build upon earlier studies. All care has been taken to make students comfortable in understanding the basic concepts of the subject.

The book not only covers the entire scope of the subject but explains the philosophy of the subject. This makes the understanding of this subject clearer and makes it more interesting. The book will be very useful not only to the students but also to the subject teachers. The students have to omit nothing and possibly have to cover nothing more. The main objective of a basic course in Engineering Mechanics is to enable the student to understand and analysis the actions and reactions of bodies at rest or in motion. For this a thorough understanding of the underlying physics is necessary, along with the ability to solve problems in a simple and logical manner. The contents of this book have been developed keeping this in mind.

The Book comes with a companion DVD for rich learning experience, which includes:

1. E-Book with further reading and learning links
2. Interactive E-lecture of each chapter. E-lectures are expressive, informational, entertaining and persuasive, it uses the tool of self-exploration, which makes it easy to learn and understand each topic in detail. It is very informative as concrete details are provided and also entertaining, as graphics and other visuals are provided to make the learning process more interactive.
3. Video Lecture of each chapter which explains each topic in detail with examples, animations, images and text and makes it easy to understand the topics in easier, simpler and better way.
4. Huge Database of Interactive Assessments for each chapter
5. Further reading and learning links for each topic
6. Glossary and Notes for each chapter to understand each chapter with to the point information

The DVD is also a useful tool for teachers to teach with digital resources in classroom and do a great job of illustrating skills and techniques that are otherwise difficult to explain.

ISBN 978-93-5115-132-6



9 789351 151326

US\$ 35.00
₹ 2000.00

www.3gelearning.com
email: 3ganmol@gmail.com



3G eLEARNING