

Contents

Preface	i
Acknowledgements	ii
About the CD-Rom	iii
1 Introduction	

1.1	Steps in the Finite Element Analysis Process	1-3
1.2	Library of Element types	1-4
1.3	Overview of ANSYS Workbench	1-5
1.4	Advantages of Using Finite Element Analysis	1-7
1.5	Historical Development	1-7
1.6	Scope of Book	1-8
	Exercises	1-8

2 Stiffness Matrices

2.1	One-dimensional Spring Element	2-1
2.2	A Single Spring Element	2-2
2.3	Assembling the Total Structure's Stiffness Matrix	2-3
2.4	Boundary Conditions	2-6
2.5	Summary	2-8
	Exercises	2-8

3 Introduction to Workbench

3.1	Starting Workbench	3-1
	3.1.1 The Start Window	3-2
3.2	The Project Page	3-4
3.3	Saving Your Work	3-6
3.4	Common Interface Features	3-6
	3.4.1 Selecting Model Entities	3-7
	3.4.2 Manipulating Model Entities	3-7
	3.4.3 Window Manager Features	3-8
3.5	Material Properties	3-9
3.6	Customizing The Workbench Interface	3-11
	3.6.1 Orientation of the Sketching Plane in DesignModeler	3-11
	3.6.2 Disabling the Map of Analysis Types	3-12
	Exercises	3-13

4 Using DesignModeler to Create 3D Solid Geometry

4.1	Introduction to 3D Modeling	4-1
4.2	Introduction to DesignModeler	4-3
	4.2.1 Sketching Plane Orientation	4-5

	4.3 4.4 4.5 4.6	Tutorial 4_1 Rectangular Extrusion Tutorial 4_2 Revolved Extrusion Tutorial 4_3 3D Bracket with Hole Additional Topics Exercises	4-6 4-14 4-23 4-32 4-33
5	Using	DesignModeler to Create Surface and Line Geometry	
	5.1 5.2 5.3	Surface and Line Bodies Defined Tutorial 5_1 2D Surface Model (surface from sketch) Tutorial 5_2 Creating a Surface Patch for Loads and Boundary Conditions	5-1 5-2 5-4
	5.4 5.5	Tutorial 5_3 Creating a Surface Model by Extruding Lines Tutorial 5_4 3D Line Model Exercises	5-6 5-8 5-11
6	Intro	duction to Finite Element Simulation	
	6.1 6.2	Steps Required to Solve a Problem Tutorial 6_1 4"x1"x1" 3D Cantilevered Beam Exercises	6-2 6-3 6-18
7	Using	the Wizards	
	7.1 7.2 7.3 7.4	Introduction to Simulation Wizards Map of Analysis Types Wizards Supplied with Workbench Tutorial 7_1 Stress Analysis Using the Stress Wizard	7-1 7-2 7-2 7-4
8	Mode	ling Techniques	
	8.1 8.2 8.3 8.4 8.5 8.6 8.7	Meshing Aspect Ratio and Badly Shaped Elements Mesh Refinement in Workbench Relevance Convergence Tutorial 8_1 Using Convergence to Improve the Results Supports	8-1 8-3 8-4 8-4 8-6 8-7 8-15
	8.8 8.9 8.10 8.11	Loads Application of Loads and Supports Example Model That Illustrates How Supports and Loads Are Applied Use of Symmetry Exercises	8-18 8-20 8-21 8-22 8-23
9	3D So 9.1 9.2 9.3 9.4 9.5 9.6	Did Element Modeling & Simulation Techniques 3D Element Capabilities and Limitations Stress Results Modeling Techniques Tutorial 9_11mporting a 3D Bracket from IGES file Stress Concentrations Hex Dominate Meshing Exercises	9-2 9-3 9-3 9-13 9-14 9-15

10.1	Plane Stress/Strain Models in Workbench	10-1
10.2	Axisymmetric Models in Workbench	10-2
10.3	Plane Stress/Strain and Axis. Element Capabilities and Limitations	10-3
10.4	Defining Plane Stress/Strain and Axis. Models in Workbench	10-4
10.5	Loads and Boundary Conditions	10-5
10.6	Stress Results	10-6
10.7	Tutorial 10_1 Plate with Hole under Tension	10-6
10.8	Tutorial 10_2 Pressure Vessel	10-13
	Exercises	10-20

11 Plate and Shell Element Modeling

11.1	Modeling Techniques	11-1
11.2	Creating the Finite Element Mesh	11-3
11.3	Tutorial 11_1 Thin Bracket	11-4
	Exercises	11-13

12 Natural Frequency and Mode Shapes Analysis

12.1	Free Vibration, One degree of Freedom System	12-2
12.2	Multiple Degrees of Freedom	12-3
12.3	Manual Calculations of Beam Vibrations	12-6
12.4	Finite Element Modal Analysis	12-7
12.5	Modeling Techniques	12-8
12.6	Tutorial 14_1 Modal Analysis of a Cantilevered Beam	12-8
	Exercises	12-14

13 Steady-state Heat Transfer

13.1	Fundamentals of Heat Transfer	13-1
13.2	Element Equations for One-Dimensional Conduction	13-4
13.3	Modeling Considerations	13-7
13.4	Application of Thermal Loads and Boundary Conditions	13-8
13.5	Tutorial 13_1 Conduction Through a Plane Wall with Heat Source	13-10
13.6	Tutorial 13_2 Air Cooled Heat Sink	13-17
	Exercises	13-22

14 Finite Element Analysis for engineers

14.1 14.2 14.3 14.4	Interpreting Your Results Theories of Failure Absolute Versus Comparative Answers Rules to Live By	14-2 14-3 14-4 14-5
Appendix	A Matrices and Simultaneous Equations	A-1
Appendix	B Matrix Operations Using Excel	B-1

Index