

Table of Contents

Dedication	iii
Preface	xiii
Chapter 1: Introduction to FEA	
Introduction to FEA	1-2
General Working of FEA	1-3
Nodes, Elements, and Element Types	1-4
Areas for Application of FEA	1-6
General Procedure of Conducting Finite Element Analysis	1-7
FEA through Autodesk Simulation Mechanical	1-7
Effective Utilization of FEA	1-8
Advantages and Limitations of FEA Software	1-9
Key Assumptions in FEA	1-9
Assumptions Related to Geometry	1-10
Assumptions Related to Material Properties	1-10
Assumptions Related to Boundary Conditions	1-10
Assumptions Related to Fasteners	1-10
Types of Analysis	1-10
Structural Analysis	1-11
Thermal Analysis	1-13
Fluid Flow Analysis	1-13
Electromagnetic Field Analysis	1-14
Coupled Field Analysis	1-14
Important Terms and Definitions	1-14
Strength	1-14
Load	1-14
Stress	1-14
Strain	1-15
Elastic Limit	1-15
Ultimate Strength	1-16
Factor of Safety	1-16
Lateral Strain	1-16
Poisson's Ratio	1-16
Bulk Modulus	1-16
Creep	1-17
Classification of Materials	1-17

Theories of failure	1-17
Von Mises Stress Failure Criteria	1-17
Maximum Shear Stress Failure Criterion	1-18
Maximum Normal Stress Failure Criteria	1-18
Self-Evaluation Test	1-18
Review Questions	1-19

Chapter 2: Introduction to Autodesk Simulation Mechanical

Introduction	2-2
Linear Analysis	2-3
Non-linear Analysis	2-3
Thermal Analysis	2-4
System Requirements	2-4
Getting Started with Autodesk Simulation	2-4
Quick Access Toolbar	2-8
Ribbon and Tabs	2-10
Navigation Bar	2-13
Browser Tree View	2-13
ViewCube	2-13
Miniaxis	2-14
Scale Ruler	2-14
Setting the Unit System	2-15
Important Environments of Autodesk Simulation Mechanical	2-16
FEA Editor Environment	2-16
Result Environment	2-16
Report Environment	2-16
Shortcut Menus	2-17
Color Schemes	2-17
Hotkeys	2-18
Self-Evaluation Test	2-19
Review Questions	2-20

Chapter 3: Importing and Exporting Geometry

Introduction	3-2
Importing CAD Model	3-2
Importing 3D Models from Autodesk Inventor	3-5
Importing 3D Models from SolidWorks	3-7
Splitting Surfaces of CAD Models	3-9
Simplifying the Model Geometry Before Importing	3-11
Simplifying the Model Geometry in Autodesk Inventor	3-11
Simplifying the Model Geometry in SolidWorks	3-12
Importing FEA Model	3-13
Saving FEA Model	3-13
Exporting FEA Model	3-13

Archiving FEA Model	3-14
Creating an Archive File	3-15
Retrieve an Archive File	3-16
Repairing Archive File	3-16
Managing an Existing Archive File	3-17
Deleting an Archive File	3-17
Understanding the Drawing Display Tools	3-18
Enclose (Fit All)/Zoom (Fit All)	3-18
Zoom	3-18
Window/Zoom (Window)	3-18
Selected/Zoom (Selected)	3-19
Pan	3-19
Orbit	3-19
Constrained Orbit/Orbit (Constrained)	3-19
Previous View	3-20
Next View	3-20
Changing the View Using the ViewCube	3-20
Home	3-21
Orthographic	3-21
Perspective	3-21
Lock to Selection	3-21
Set Current View as Home	3-21
Set Current View as Front	3-21
Reset Front	3-21
Properties	3-22
Navigating the Model Using SteeringWheels	3-24
Controlling the Display of Models	3-24
Setting the Visual Styles	3-25
Setting the Camera Type	3-25
Tutorial 1	3-26
Tutorial 2	3-33
Self-Evaluation Test	3-38
Review Questions	3-39
Exercise 1	3-40
Exercise 2	3-41
Exercise 3	3-41

Chapter 4: Creating and Modifying Geometry

Introduction	4-2
Selection Methods	4-2
Point or Rectangle Selection Method	4-2
Rectangle Selection Method	4-3
Polyline Selection Method	4-4
Circle Selection Method	4-5
Creating 2D Sketched Geometry	4-6
Modifying the Grid Spacing	4-7

Drawing Lines	4-8
Drawing Circles	4-11
Drawing Rectangles	4-14
Drawing Arcs	4-14
Drawing Construction Vertices	4-18
Creating Fillets	4-19
Creating Tangent Lines	4-20
Creating Splines	4-21
Editing and Modifying Geometry	4-22
Trimming Sketched Entities	4-22
Extending Sketched Entities	4-23
Intersecting Sketched Entities	4-23
Dividing Sketched Entities	4-24
Changing Attributes	4-25
Mirroring Sketched Entities	4-26
Moving, Rotating, Scaling, and Copying Sketched Entities	4-27
Tutorial 1	4-31
Tutorial 2	4-38
Tutorial 3	4-44
Self-Evaluation Test	4-50
Review Questions	4-50
Exercise 1	4-51

Chapter 5: Meshing-I

Introduction to Meshing	5-2
Generating Mesh	5-3
Generating 3D Mesh	5-3
Specifying 3D Mesh Settings	5-4
Viewing the Meshing Results	5-22
Unmatched and Multi-Matched Feature lines	5-24
Unmatched Feature Lines	5-24
Multi-matched Feature Lines	5-25
Eliminating Unmatched and Multi-Matched Feature lines	5-26
Generating 2D Mesh	5-27
Specifying 2D Mesh Settings	5-28
Tutorial 1	5-32
Tutorial 2	5-40
Self-Evaluation Test	5-44
Review Questions	5-45
Exercise 1	5-46
Exercise 2	5-47
Exercise 3	5-47

Chapter 6: Meshing-II

Introduction	6-2
Creating Refine Mesh	6-2
Refining Mesh by Adding Refinement Points	6-2
Refining Mesh by using Add to Selection Method	6-8
Creating Refine Mesh on a Part	6-13
Editing Refinement Points	6-15
Editing Refinement Points by Using the Refinement Point Browser Dialog Box	6-15
Editing Refinement Points by Using the Modify Refinement Point Dialog Box	6-15
Tutorial 1	6-16
Tutorial 2	6-24
Tutorial 3	6-31
Self-Evaluation Test	6-35
Review Questions	6-36
Exercise 1	6-37

Chapter 7: Working with Joints and Contacts

Introduction	7-2
Creating Joints	7-3
Automatic detection of axis/center point	7-4
Manual axis/center-point specification	7-4
Creating Bolted Connection	7-5
Working with Contacts	7-8
Types of Contacts	7-8
Applying Contact Between Parts	7-10
Overriding Existing Contact Type	7-11
Specifying Friction Coefficients, Direction, and Interference for Contact	7-11
Renaming Contacts	7-14
Deleting Contacts	7-14
Tutorial 1	7-15
Tutorial 2	7-20
Tutorial 3	7-26
Self-Evaluation Test	7-34
Review Questions	7-35
Exercise 1	7-36
Exercise 2	7-37

Chapter 8: Defining Materials and Boundary Conditions

Introduction	8-2
Assigning Material	8-2
Managing Material Libraries	8-5
Creating New Material Library	8-5
Adding Material Categories	8-7
Adding Material Under a Material Category	8-8
Deleting Material	8-10
Deleting Material Category	8-10
Loading Material Library File	8-10
Setting Material Library as Default Library	8-11
Removing/Deleting Library	8-11
Copying Material Library	8-12
Boundary Conditions	8-13
Constraints	8-13
Loads	8-26
Tutorial 1	8-55
Tutorial 2	8-62
Self-Evaluation Test	8-68
Review Questions	8-69
Exercise 1	8-70
Exercise 2	8-71

Chapter 9: Performing Analysis and Viewing Results

Introduction	9-2
Specifying Multiple Load Cases	9-2
Specifying Solver for Analysis	9-5
Specifying Result Output Files to be Saved	9-7
Changing the Analysis Type	9-7
Performing Analysis (Solution Phase)	9-9
Viewing Results (Postprocessor Phase)	9-12
Reviewing the Displacement Results	9-12
Reviewing the Stress Results	9-18
von Mises	9-18
Tensor	9-18
Tresca*2	9-20
Principal Stress	9-20
Safety Factor	9-23
Modifying Allowable Stress Values	9-23
Beam and Truss	9-24
Reviewing the Strain Results	9-26
von Mises	9-26
Tensor	9-27
Tresca*2	9-27
Principal Strain	9-27

Beam and Truss	9-28
Reviewing the Reaction Force Results	9-29
Internal Force	9-29
Applied Force	9-30
Reaction Force (Negative)	9-31
Internal Moment	9-32
Applied Moment	9-33
Reaction Moment (Negative)	9-33
Reviewing the Current Result for Nodes and Faces	9-34
Reviewing Current Result for a part	9-38
Adding Probes to Display Current Results	9-39
Reviewing Results in Graphical PATH Format	9-40
Graphical Representation of Results in Path Form	9-40
Graphical Representation of Results in Bar Form	9-42
Graphical Representation of Combined Nodal Results	9-44
Animating Results	9-46
Modifying Legend Properties	9-47
Displaying loads and Constraints	9-49
Creating Presentations	9-50
Creating an Image File	9-54
Generating Report	9-54
Tutorial 1	9-56
Tutorial 2	9-62
Self-Evaluation Test	9-67
Review Questions	9-68
Exercise 1	9-69
Exercise 2	9-70

Chapter 10: Advanced Structural Analysis

Introduction	10-2
Dynamic Analysis	10-2
Modal Analysis	10-2
Harmonic/Frequency Response Analysis	10-2
Transient Analysis	10-2
Steps to Perform Dynamic Analysis	10-3
Nonlinear Analysis	10-4
Geometric Nonlinearity	10-5
Material Nonlinearity	10-6
Boundary Nonlinearity (Changing Status)	10-6
Steps to Perform Nonlinear Analysis	10-6
Tutorial 1: Modal Analysis	10-6
Tutorial 2: Modal Analysis	10-14
Tutorial 3: Harmonic/Frequency Response Analysis	10-20
Tutorial 4: Transient Analysis	10-28
Tutorial 5: Nonlinear Analysis	10-35

Self-Evaluation Test	10-42
Review Questions	10-42
Exercise 1	10-43
Exercise 2	10-43
Index	I-1