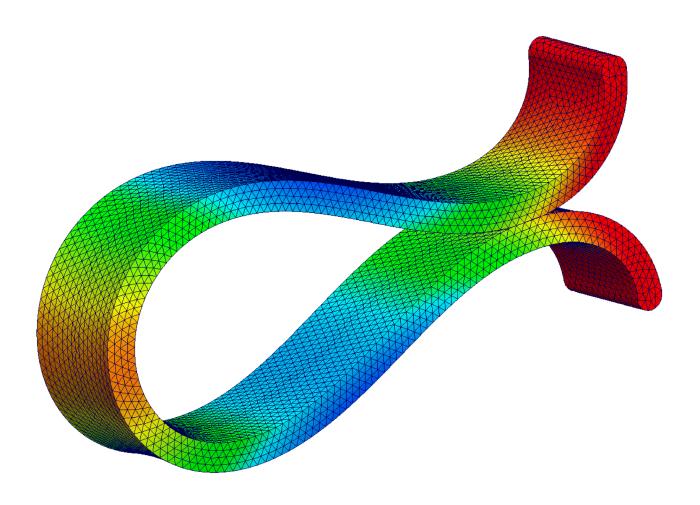
Engineering Analysis

with SOLIDWORKS Simulation 2023



Paul M. Kurowski

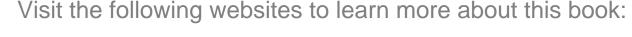














Table of contents

About the Author		
Ackno	owledgements	i
Table	e of contents	ii
Befor	e You Start	1
	Notes on hands-on exercises and functionality of SOLIDWORKS Simulation	
	Prerequisites	
	Selected terminology	
	Graphics	
1: Int	roduction	5
	What is Finite Element Analysis?	
	Finite Element Analysis used by Design Engineers	
	Objectives of FEA for Design Engineers	
	What is SOLIDWORKS Simulation?	
	Fundamental steps in an FEA project	
	Errors in FEA	
	A closer look at finite elements	
	What is calculated in FEA?	
	How to interpret FEA results	
	Units of measure	
	Using online help	
	Limitations of Static studies	
2: Sta	tic analysis of a plate	31
	Using the SOLIDWORKS Simulation interface	
	Linear static analysis with solid elements	
	Controlling discretization error with the convergence process	
	Finding reaction forces	
	Presenting FEA results in a desired format	

3: Static analysis of an L-bracket	79
Stress singularities	
Differences between modeling errors and discretization errors	
Using mesh controls	
Analysis in different SOLIDWORKS configurations	
Nodal stresses, element stresses	
4: Static and frequency analyses of a pipe support	99
Use of shell elements	
Frequency analysis	
Bearing load	
5: Static analysis of a link	127
Symmetry boundary conditions	
Preventing rigid body motions	
Limitations of the small displacements theory	
6: Frequency analysis of a tuning fork and a plastic part	137
Frequency analysis with and without supports	
Rigid body modes	
The role of supports in frequency analysis	
Symmetric and anti-symmetric modes	
7: Thermal analysis of a pipe connector and a heater	147
Analogies between structural and thermal analysis	
Steady state thermal analysis	
Analysis of temperature distribution and heat flux	
Thermal boundary conditions	
Thermal stresses	
Vector plots	
8: Thermal analysis of a heat sink	167
Analysis of an assembly	
Global and local Contact conditions	
Steady state thermal analysis	
Transient thermal analysis	
Thermal resistance layer	
Use of section views in result plots	

9: Static analysis of a hanger	
Global and local Contact conditions	
Hierarchy of Contact conditions	
10: Thermal stress analysis of a bi-metal loop	193
Thermal deformation and thermal stress analysis	
Saving model in deformed shape	
11: Buckling analysis of an I-beam	
Buckling analysis	
Buckling load safety factor	
Stress safety factor	
12: Static analysis of a bracket using adaptive solution methods	209
h-adaptive solution method	
p-adaptive solution method	
Comparison between h-elements and p-elements	
13: Drop test	227
Drop test analysis	
Stress wave propagation	
Vibration caused by impact	
Direct time integration solution	
14: Selected nonlinear problems	243
Large displacement analysis	
Analysis with shell elements	
Membrane effects	
Following and non-following load	
Nonlinear material analysis	
Residual stress	
15: Mixed meshing problem	287
Using solid and shell elements in the same mesh	
Mesh compatibility	
Manual and automatic finding of contact sets Shell Manager	

16: Analysis of weldments using beam and truss elements Different levels of idealization implemented in finite elements Preparation of a SOLIDWORKS model for analysis with beam elements Beam elements and truss elements Analysis of results using beam elements Limitations of analysis with beam elements	297
17: Review of 2D problems	325
Classification of finite elements	020
2D axisymmetric element	
2D plane stress element	
2D plane strain element	
18: Vibration analysis - modal time history and harmonic	353
Modal Time History analysis (Time Response)	
Harmonic analysis (Frequency Response)	
Modal Superposition Method	
Damping	
19: Analysis of random vibration	381
Random vibration	
Power Spectral Density	
RMS results	
PSD results	
Modal excitation	
20: Topology Optimization	401
Definition of Topology Optimization	
Design space	
Goals and constraints	
Topology Optimization criteria	
Examples of Topology Optimization	

21: Miscellaneous topics – part 1	421
Mesh quality	
Solvers and solvers options	
Displaying mesh in result plots	
Automatic reports	
E drawings	
Non uniform loads	
Frequency analysis with pre-stress	
Interference fit analysis	
Rigid connector	
Pin connector	
Bolt connector	
Remote load/mass	
Weld connector	
Bearing connector	
Cyclic symmetry	
Strongly nonlinear problem	
Submodeling	
Automated detection of stress singularities	
Stress averaging at mid-side nodes	
Terminology issues in the Finite Element Analysis	
22: Miscellaneous topics – part 2	493
Symmetry	
Antisymmetry	
Displacement and stress singularities	
Shell elements	
2D problems	
23: Implementation of FEA into the design process	543
Verification and Validation of FEA results	
FEA driven design process	
FEA project management	
FEA project checkpoints	
FEA reports	
24: Glossary of terms	563
25: Resources available to FEA users	
26: List of exercises	575