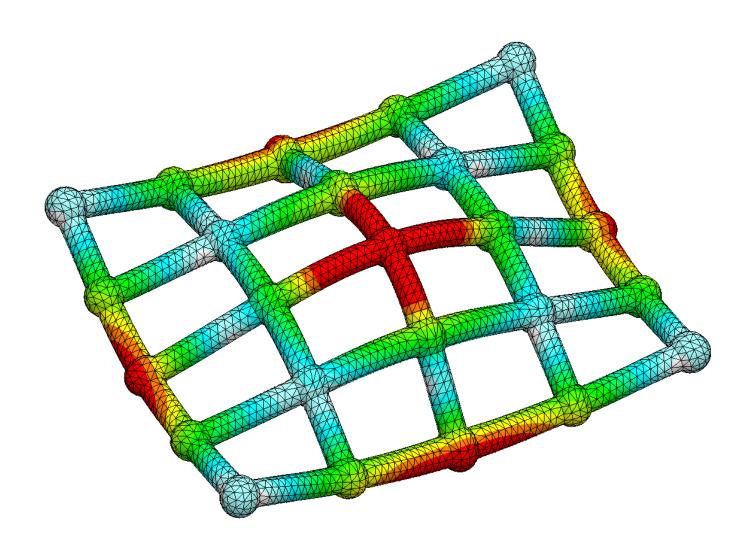
## Vibration Analysis

with SOLIDWORKS Simulation 2019



Paul M. Kurowski





## Visit the following websites to learn more about this book:



amazon.com





## **Table of contents**

Before you	u start	1
	Notes on hands-on exercises and functionality of Simulation	
	Prerequisites	
	Selected terminology	
1: Introdu	action to vibration analysis	5
	Differences between a mechanism and a structure	
	Difference between dynamic analysis and vibration analysis	
	Rigid body motion and degrees of freedom	
	Kinematic pairs	
	Discrete and distributed vibration systems	
	Single degree of freedom and multi degree of freedom vibration systems	
	Mode of vibration	
	Rigid Body Mode	
	Modal superposition method	
	Direct integration method	
	Vibration Analysis with SOLIDWORKS Simulation and SOLIDWORKS Motion	
	Functionality of SOLIDWORKS Simulation and SOLIDWORKS Motion	
	Terminology issues	
2: Introdu	action to modal analysis	35
	Modal analysis	
	Properties of a mode of vibration	
	Interpreting results of modal analysis	
	Normalizing displacement results in modal analysis	
3: Modal	analysis of distributed systems	45
	Modal analysis of distributed systems	
	Meshing considerations in modal analysis	
	Importance of mesh quality in modal analysis	
	Importance of modeling supports	
	Interpretation of results of modal analysis	

4: Modal analysis – the effect of pre-stress	51
Modal analysis with pre-stress	
Modal analysis and buckling analysis	
Artificial stiffness	
5: Modal analysis - properties of lower and higher modes	
Modal analysis using shell elements	
Properties of lower and higher modes	
Convergence of frequencies with mesh refinement	
6: Modal analysis – mass participation, properties of modes	73
Modal mass	
Modal mass participation	
Modes of vibration of axisymmetric structures	
Modeling bearing restraints	
Using modal analysis to find "weak spots"	
7: Modal analysis – mode separation	
Modal analysis with shell elements	
Modes of vibration of symmetric structures	
Symmetry boundary conditions in modal analysis	
Anti-symmetry boundary condition in modal analysis	
8: Modal analysis of axi-symmetric structures	101
Modes of vibration of axi-symmetric structures	
Repetitive modes	
Solid and shell element modeling	
9: Modal analysis – locating structurally weak spots	107
Modal analysis with beam elements	
Modes of vibration of symmetric structures	
Using results of modal analysis to identify potential design problems	
Frequency shift	
10: Modal analysis - a diagnostic tool	115
Modal analysis used to detect problems with restraints	
Modal analysis used to detect connectivity problems	
Rigid Body Motions of assemblies	

11: Time resp	ponse and frequency response of discrete systems	125
T	ime response	
S	teady state harmonic response	
F	requency sweep	
Ι	Displacement base excitation	
7	Velocity base excitation	
A	Acceleration base excitation	
F	Resonance	
N	Modal damping	
12: Harmoni	c base excitation of distributed systems	157
St	teady state harmonic excitation	
F	requency sweep	
Γ	Displacement base excitation	
F	Resonance	
N	Modal damping	
13: Omega so	quare harmonic force excitation	177
U	nbalanced rotating machinery	
R	esonance	
N	Iodal damping	
O	mega square excitation	
S	teady state response	
14: Time res	ponse analysis, resonance, beating	189
T	ime Response analysis	
В	ase excitation	
R	esonance	
N	Iodal damping	
В	eating phenomenon	
T	ransient response	
S	teady state response	
N	lass participation	

15: Vibrat	ion absorption	205
	Torsional vibration	
	Resonance	
	Modal damping	
	Vibration absorption	
	Frequency Response	
16: Rando	m vibration	223
	Random vibration	
	Power Spectral Density	
	RMS results	
	PSD results	
	Modal excitation	
17: Respon	nse spectrum analysis	247
	Non stationary random base excitation	
	Seismic response analysis	
	Seismic records	
	Response spectrum method	
	Generating response spectra	
	Methods of mode combination	
18: Nonlinear vibration		271
	Differences between linear and nonlinear structural analysis	
	Types of nonlinearities	
	Bending stiffness	
	Membrane stiffness	
	Modal damping	
	Rayleigh damping	
	Linear Time response analysis	
	Nonlinear Time response analysis	
	Modal Superposition Method	
	Direct Integration Method	
19: Vibrat	ion benchmarks	295

## Vibration Analysis with SOLIDWORKS Simulation 2019

20: Glossary of terms	331
21: References	335
22: List of exercises	337