

1. Record Nr.	UNINA9910299950403321
Autore	Preumont André
Titolo	Vibration Control of Active Structures : An Introduction // by André Preumont
Pubbl/distr/stampa	Cham : , : Springer International Publishing : , : Imprint : Springer, , 2018
ISBN	3-319-72296-4
Edizione	[4th ed. 2018.]
Descrizione fisica	1 online resource (XXIV, 518 p. 339 illus.)
Collana	Solid Mechanics and Its Applications, , 0925-0042 ; ; 246
Disciplina	624.171
Soggetti	Vibration Dynamical systems Dynamics Mechanical engineering Noise control Structural materials Vibration, Dynamical Systems, Control Mechanical Engineering Noise Control Structural Materials
Lingua di pubblicazione	Inglese
Formato	Materiale a stampa
Livello bibliografico	Monografia
Nota di contenuto	Preface to the third edition.- Preface to the second edition.- Preface to the first edition.- 1 Introduction.- 1.1 Active versus passive. - 1.2 Vibration suppression.- 1.3 Smart materials and structures. - 1.4 Control strategies.- 1.4.1 Feedback.- 1.4.2 Feedforward. - 1.5 The various steps of the design.- 1.6 Plant description, error and control budget.- 1.7 Readership and Organization of the book. - 1.8 References.- 1.9 Problems.- 2 Some concepts in structural dynamics.- 2.1 Introduction.- 2.2 Equation of motion of a discrete system.- 2.3 Vibration modes.- 2.4 Modal decomposition.- 2.4.1 Structure without rigid body modes.- 2.4.2 Dynamic °exibility matrix. - 2.4.3 Structure with rigid body modes.- 2.4.4 Example.- 2.5 Collocated control system.- 2.5.1 Transmission zeros and constrained system.- 2.6 Continuous structures.- 2.7 Guyan reduction.- 2.8

Craig-Bampton reduction.- 2.9 References.- 2.10 Problems.- 3
Electromagnetic and piezoelectric transducers.- 3.1 Introduction.
- 3.2 Voice coil transducer.- 3.2.1 Proof-mass actuator.- 3.2.2
Geophone.- 3.3 General electromechanical transducer.- 3.3.1
Constitutive equations.- 3.3.2 Self-sensing.- 3.4 Reaction wheels
and gyrostabilizers.- 3.5 Smart materials.- 3.6 Piezoelectric
transducer.- 3.6.1 Constitutive relations of a discrete transducer.
- 3.6.2 Interpretation of k_2 .- 3.6.3 Admittance of the piezoelectric
transducer.- 3.7 References.- 3.8 Problems.- 4 Piezoelectric beam,
plate and truss.- 4.1 Piezoelectric material.- 4.1.1 Constitutive
relations.- 4.1.2 Coenergy density function.- 4.2 Hamilton's
principle.- 4.3 Piezoelectric beam actuator.- 4.3.1 Hamilton's
principle.- 4.3.2 Piezoelectric loads.- 4.4 Laminar sensor.- 4.4.1
Current and charge amplifiers.- 4.4.2 Distributed sensor output.
- 4.4.3 Charge amplifier dynamics.- 4.5 Spatial modal filters.- 4.5.1
Modal actuator.- 4.5.2 Modal sensor.- 4.6 Active beam with
collocated actuator-sensor.- 4.6.1 Frequency response function.
- 4.6.2 Pole-zero pattern.- 4.6.3 Modal truncation.- 4.7
Admittance of a beam with a piezoelectric patch.- 4.8 Piezoelectric
laminate.- 4.8.1 Two dimensional constitutive equations.- 4.8.2
Kirchhoff theory.- 4.8.3 Stiffness matrix of a multi-layer elastic
laminate.- 4.8.4 Multi-layer laminate with a piezoelectric layer.
- 4.8.5 Equivalent piezoelectric loads.- 4.8.6 Sensor output.- 4.8.7
Beam model vs. plate model.- 4.8.8 Additional remarks.- 4.9 Active
truss.- 4.9.1 Open-loop transfer function.- 4.9.2 Admittance
function.- 4.10 Finite element formulation.- 4.11 References.- 4.12
Problems.- 5 Passive damping with piezoelectric transducers.- 5.1
Introduction.- 5.2 Resistive shunting.- 5.3 Inductive shunting.- 5.4
Switched shunt.- 5.4.1 Equivalent damping ratio.- 5.5 References.
- 5.6 Problems.- 6 Collocated versus non-collocated control.- 6.1
Introduction.- 6.2 Pole-zero flipping.- 6.3 The two-mass problem.
- 6.3.1 Collocated control.- 6.3.2 Non-collocated control.- 6.4
Notch filter.- 6.5 Effect of pole-zero flipping on the Bode plots.- 6.6
Nearly collocated control system.- 6.7 Non-collocated control
systems.- 6.8 The role of damping.- 6.9 References -- 6.10
Problems ..- 7 Active damping with collocated system.- 7.1
Introduction.- 7.2 Lead control.- 7.3 Direct velocity feedback (DVF).
- 7.4 Positive Position Feedback (PPF).- 7.5 Integral Force Feedback
(IFF).- 7.6 Duality between the Lead and the IFF controllers.- 7.6.1
Root-locus of a single mode.- 7.6.2 Open-loop poles and zeros.
- 7.7 Actuator and sensor dynamics.- 7.8 Decentralized control with
collocated pairs.- 7.8.1 Cross talk.- 7.8.2 Force actuator and
displacement sensor.- 7.8.3 Displacement actuator and force sensor.
- 7.9 References.- 7.10 Problems.- 8 Vibration isolation.- 8.1
Introduction.- 8.2 Relaxation isolator.- 8.2.1 Electromagnetic
realization.- 8.3 Active isolation.- 8.3.1 Sky-hook damper.- 8.3.2
Integral Force Feedback.- 8.4 Flexible body.- 8.4.1 Free-free beam
with isolator.- 8.5 Payload isolation in spacecraft.- 8.5.1 Interaction
isolator/attitude control.- 8.5.2 Gough-Stewart platform.- 8.6 Six-
axis isolator.- 8.6.1 Relaxation isolator.- 8.6.2 Integral Force
Feedback.- 8.6.3 Spherical joints, modal spread.- 8.7 Active vs.
passive.- 8.8 Car suspension.- 8.9 References.- 8.10 Problems.
- 9 State space approach.- 9.1 Introduction.- 9.2 State space
description.- 9.2.1 Single degree of freedom oscillator.- 9.2.2
Flexible structure.- 9.2.3 Inverted pendulum.- 9.3 System transfer
function.- 9.3.1 Poles and zeros.- 9.4 Pole placement by state
feedback.- 9.4.1 Example: oscillator.- 9.5 Linear Quadratic
Regulator.- 9.5.1 Symmetric root locus.- 9.5.2 Inverted pendulum.- 9.6

Observer design.- 9.7 Kalman Filter.- 9.7.1 Inverted pendulum.
- 9.8 Reduced order observer.- 9.8.1 Oscillator.- 9.8.2 Inverted pendulum.- 9.9 Separation principle.- 9.10 Transfer function of the compensator.- 9.10.1 The two-mass problem.- 9.11 References.
- 9.12 Problems.- 10 Analysis and synthesis in the frequency domain.- 10.1 Gain and phase margins.- 10.2 Nyquist criterion.
- 10.2.1 Cauchy's principle.- 10.2.2 Nyquist stability criterion.
- 10.3 Nichols chart.- 10.4 Feedback specification for SISO systems.
- 10.4.1 Sensitivity.- 10.4.2 Tracking error.- 10.4.3 Performance specification.- 10.4.4 Unstructured uncertainty.- 10.4.5 Robust performance and robust stability.- 10.5 Bode gain-phase relationships.- 10.6 The Bode Ideal Cutoff.- 10.7 Non-minimum phase systems.- 10.8 Usual compensators.- 10.8.1 System type.
- 10.8.2 Lead compensator.- 10.8.3 PI compensator.- 10.8.4 Lag compensator.- 10.8.5 PID compensator.- 10.9 Multivariable systems.- 10.9.1 Performance specification.- 10.9.2 Small gain theorem.- 10.9.3 Stability robustness tests.- 10.9.4 Residual dynamics.- 10.10References.- 10.11Problems.- 11 Optimal control.- 11.1 Introduction.- 11.2 Quadratic integral.- 11.3 Deterministic LQR.- 11.4 Stochastic response to a white noise.
- 11.4.1 Remark.- 11.5 Stochastic LQR.- 11.6 Asymptotic behavior of the closed-loop.- 11.7 Prescribed degree of stability -- 11.8 Gain and phase margins of the LQR.- 11.9 Full state observer.- 11.9.1 Covariance of the reconstruction error.- 11.10Kalman-Bucy Filter (KBF).- 11.11Linear Quadratic Gaussian (LQG).- 11.12Duality.
- 11.13Spillover.- 11.13.1Spillover reduction.- 11.14Loop Transfer Recovery (LTR).- 11.15Integral control with state feedback.- 11.16 Frequency shaping.- 11.16.1Frequency-shaped cost functionals.
- 11.16.2Noise model ..- 11.17References.- 11.18Problems.- 12 Controllability and Observability.- 12.1 Introduction.- 12.1.1 Definitions.- 12.2 Controllability and observability matrices.- 12.3 Examples.- 12.3.1 Cart with two inverted pendulums.- 12.3.2 Double inverted pendulum.- 12.3.3 Two d.o.f. oscillator.- 12.4 State transformation.- 12.4.1 Control canonical form.- 12.4.2 Left and right eigenvectors.- 12.4.3 Diagonal form.- 12.5 PBH test.- 12.6 Residues.- 12.7 Example.- 12.8 Sensitivity.- 12.9 Controllability and observability Gramians.- 12.10Internally balanced coordinates.
- 12.11Model reduction.- 12.11.1Transfer equivalent realization.
- 12.11.2Internally balanced realization.- 12.11.3Example.- 12.12 References.- 12.13Problems.- 13 Stability.- 13.1 Introduction.
- 13.1.1 Phase portrait.- 13.2 Linear systems.- 13.2.1 Routh-Hurwitz criterion.- 13.3 Lyapunov's direct method.- 13.3.1 Introductory example.- 13.3.2 Stability theorem.- 13.3.3 Asymptotic stability theorem.- 13.3.4 Lasalle's theorem.- 13.3.5 Geometric interpretation.- 13.3.6 Instability theorem.- 13.4 Lyapunov functions for linear systems.- 13.5 Lyapunov's indirect method ..- 13.6 An application to controller design.- 13.7 Energy absorbing controls.
- 13.8 References.- 13.9 Problems.- 14 Applications.- 14.1 Digital implementation.- 14.1.1 Sampling, aliasing and prefiltering.
- 14.1.2 Zero-order hold, computational delay.- 14.1.3 Quantization.- 14.1.4 Discretization of a continuous controller.
- 14.2 Active damping of a truss structure.- 14.2.1 Actuator placement.- 14.2.2 Implementation, experimental results.- 14.3 Active damping generic interface.- 14.3.1 Active damping.- 14.3.2 Experiment.- 14.3.3 Pointing and position control.- 14.4 Active damping of a plate.- 14.4.1 Control design.- 14.5 Active damping of a stiff beam.- 14.5.1 System design.- 14.6 The HAC/LAC strategy.
- 14.6.1 Wide-band position control.- 14.6.2 Compensator design.- 14.6.3

Results.- 14.7 Vibroacoustics: Volume displacement sensors.
- 14.7.1 QWSIS sensor.- 14.7.2 Discrete array sensor.- 14.7.3
Spatial aliasing.- 14.7.4 Distributed sensor.- 14.8 References.- 14.9
Problems.- 5 Tendon Control of Cable Structures.- 15.1
Introduction.- 15.2 Tendon control of strings and cables.- 15.3
Active damping strategy.- 15.4 Basic Experiment.- 15.5 Linear
theory of decentralized active damping.- 15.6 Guyed truss experiment.
- 15.7 Micro Precision Interferometer testbed.- 15.8 Free floating
truss experiment.- .

Sommario/riassunto

This textbook is an introduction to the dynamics of active structures and to the feedback control of lightly damped flexible structures; the emphasis is placed on basic issues and simple control strategies that work. Now in its fourth edition, more chapters have been added, and comments and feedback from readers have been taken into account, while at the same time the unique premise of bridging the gap between structure and control has remained. Many examples, covering a broad field of applications from bridges to satellites and telescopes, and problems bring the subject to life and take the audience from theory to practice. The book has 19 chapters dealing with some concepts in structural dynamics; electromagnetic and piezoelectric transducers; piezoelectric beam, plate and truss; passive damping with piezoelectric transducers; collocated versus non-collocated control; active damping with collocated systems; vibration isolation; state space approach; analysis and synthesis in the frequency domain; optimal control; controllability and observability; stability; applications; tendon control of cable structures; active control of deformable mirrors for Adaptive Optics and large earth-based and space telescopes; and semi-active control. The book concludes with an exhaustive bibliography and index. This book is intended for structural engineers who want to acquire some background in vibration control, and for control engineers who are dealing with flexible structures. It can be used as a textbook for a graduate course on vibration control or active structures. A solutions manual is available through the publisher to teachers using this book as a textbook.
