

Index

- $\mathcal{A}$, notation, 65
- Absolute continuity, 51
- ac gain, 171
- Active power, 70
- Aizerman's conjecture, counterexamples, 177
statement, 172
- Algebras, 16
- Almost periodic function, 8
- Anticausal operator, 14
- Argument of a complex-valued function, 128
- Attenuating operator, conditions for invertibility, 36
definition, 24
relation to stability, 108
- Autocorrelation function, 66
- Averaging theory, 173
- $\mathcal{B}, \mathcal{B}^+, \mathcal{B}^-, \mathcal{B}^\circ$, notation, 21
- $\tilde{\mathcal{B}}, \tilde{\mathcal{B}}^+, \tilde{\mathcal{B}}^-, \tilde{\mathcal{B}}^\circ$, notation, 21
- Backwards extension, 41
- Banach algebra, 17
- Banach space, 4
- Bound of an operator, 11, 15
- Bounded operator, 11, 15
- Cauchy-Schwartz inequality, 5
- Cauchy sequence, 3
- Causal operator, conditions for invertibility, 35
definition, 14
- Causal Operator (*continued*)
properties, 14
- Characteristic of a memoryless operator, 100
- Circle criterion, 122
illustration, 133
instability part, 132
statement, 131
- Commutation of operators, 12
- Complex power, 70
- Composition of operators, 12
- Conic operator, conditions for invertibility, 31, 37
definition, 24
properties, 24
relation to continuity, 113
relation to instability, 110
relation to stability, 108
- Continuity of feedback systems, conditions, 110
definition, 92
relation to linearization, 166
- Continuous operator, 11
- Contraction mapping principle, 28
- Contraction operator, conditions for invertibility, 29
definition, 24
properties, 24
relation to continuity of feedback systems, 113
- Contraction property, 17

- Convolution operator,
 - conditions for positivity, 50
 - definition, 49
 - properties, 49
- Critical disk, 130
- Crosscorrelation function, 66
- $\mathcal{D}$, notation, 130
- dc gain, 171
- Describing function, 171
- Discontinuity of feedback systems,
 - conditions, 110
 - definition, 92
- Dissipative operator, 16. *see also* Positive operator
- Domain of an operator, 3, 26
- Dominant matrix, 59
- Dominant sequence, 64
- Doubly dominant matrix, 59, 63, 82
- Doubly hyperdominant matrix, 59, 63, 82
- Doubly stochastic matrix, 59
- Encirclements, 128, 133
- Equivalent gain, 171
- Extended space,
 - conditions for positivity, 81
 - definition, 13
 - properties, 12
- Extension of an operator, 3, 15, 41
- Exterior conicity, 24
- $\mathcal{F}, \tilde{\mathcal{F}}$, notation, 51, 65
- Factorization of operators, 72
- FE, notation, 87
- Feedback systems,
 - assumptions, 89
 - concepts, 86
 - mathematical model, 87
- Finite gain stability, 92
- First and third quadratic function, 58
- Fourier transform, 6
- Frequency-power relations, 66
- Frozen time Nyquist criterion, 148
- $\mathcal{G}$, notation, 49
- $\mathcal{G}^*, \mathcal{G}^+, \mathcal{G}^\sigma$, notation, 131, 134
- $\mathcal{G}_T$, notation, 53
- Gain on an interval, 96
- Generalized Fourier series, 8
- Hardy, Littlewood, and Polya inequality. *See* Rearrangement inequality
- Hilbert space, 5
- Hölder's inequality, 5
- Hyperdominant matrix, 59, 63, 82
- Hyperdominant sequence, 64
- I, I^+ , notation, 2
- Ideal, 17
- Implicit function theorem, 176
- Incremental gain, 171
- Infinite matrix array, 62
- Inner product, 5
- Inside-the-sector operator, 25
- Instability,
 - conditions, 109
 - definition, 92
- Instantaneous gain, 97
- Interior conicity, 24
- Invertibility,
 - conditions, 28
 - definition, 12, 17
- K , notation, 3
- $\mathcal{K}$, notation, 50
- $\mathcal{K}_T$, notation, 53
- $\mathcal{L}, \mathcal{L}^+, \mathcal{L}^-$, notation, 19, 21, 23
- LA, LA^+ , notation, 125, 128
- Laplace transforms, 124, 126
- l_p, L_p, l_2, L_2 , notation, 4, 5
- l_2 -stability, 157
- LFE, notation, 123, 167
- Limit-in-the-mean transform, 6
- Linear system, 116
- Linearization,
 - definition, 162
 - properties, 162
 - relation to continuity of feedback systems, 166
 - relation to invertibility, 165
 - relation to stability, 161
- Linearized feedback systems, 167
- Lipschitz constant, 11, 15
- Lipschitz-continuous operator, 11, 15
- Lipschitz continuity of feedback systems, 92
- Loop transformation, 138
- LPFE, notation, 141
- $\mathcal{M}$, notation, 66

- Manley-Rowe formulas, 52, 72
 Measurement noise, 116
 Memoryless operator,
 conditions for positivity, 49
 definition, 14
 Memoryless time-invariant operators,
 51
 Metric space, 3
 Minkowski's inequality, 5
 Modeling errors, 90
 Monotone nonlinearity,
 conditions for positivity, 57
 conditions for stability, 155
 Monotone operator, 26, 157. *see also*
 Positive operator
 Multipliers and stability, 136

 $\mathcal{N}, \mathcal{N}^+, \mathcal{N}^-, \mathcal{N}^o$, notation, 19, 21
 Negative operator, 27
 Noninvertibility of operators, 40
 Nonlinear capacitor, 71
 Nonlinear inductor, 71
 Nonlinear operators, 10
 Nonlinear resistor, 70
 Norm, 4
 Nyquist criterion, 122
 illustration, 130
 statement, 128
 Nyquist locus, 130, 131

 Odd-monotone nonlinearity,
 conditions for positivity, 57
 conditions for stability, 155
 Odd-monotone operator, 157
 Operator, 3, 11
 Operator algebras, 19
 Outside the sector operator, 25

 P_T , notation, 13
 Parseval's inequality, 6
 Passive operator, 26, 40. *see also*
 Positive operator
 Periodic gain,
 conditions for positivity, 53
 conditions for stability, 140
 Permutation matrix, 59
 PFE, notation, 90
 Physical feedback system, 90
 Plant variations, 116
 Popov criterion, 52
 Positive operator,
 conditions for invertibility, 33, 39
 definition, 26

 Positive Operator (*continued*)
 examples, 45
 properties, 24
 relation to continuity of feedback
 systems, 114
 relation to stability, 109

 Quasi-periodic function, 71

 R, R^+ , notation, 2
 Range of an operator, 11
 Reactive power, 70
 Rearrangement inequality,
 classical statement, 57, 59
 generalization, 60
 Regular subalgebra, 17
 Restriction of an operator, 3, 28

 S , notation, 13
 $\mathcal{S}$, notation, 66
 S_2^1 , notation, 52
 σ , notation, 17
 Sector operator,
 conditions for invertibility, 32, 38
 definition, 25
 properties, 25
 relation to continuity of feedback
 systems, 113
 relation to stability, 109
 Sensitivity, 114
 Similarly ordered sequence, 58, 63
 Similarly ordered and symmetric
 sequence, 58, 63
 Solution of feedback equations, 89
 Spectrum, 17
 Square root of an operator, 55
 Stability,
 alternative definitions, 106
 conditions, 106
 definition, 92
 discussion, 101
 relation to linearization, 161
 Stieltjes matrix, 59
 Subalgebra, 17

 T_+ , notation, 20
 Time-interval of definition, 13
 Time-invariant operator, 20
 Toeplitz operator, 64
 Total gain, 171
 Transform theory, 6
 Translation operator, 20
 Truncation operator, 13

Unbiased sequences, 58, 63

Vector space, 3

W , W_* , notation, 13

Well-posedness of feedback systems,
 conditions, 96
 definition, 90
 discussion, 93
 examples, 95

Wiener-Hopf equation, 80

z -transform, 7