

## References

1. Aggarwal P, Moinzadeh K (1994) Order expedition in multi-echelon production/distribution systems, *IIE Trans*: 26 86–96.
2. Ajmone-Marsan M, Balbo G, Conte G, Donatelli S, Franceschinis G (1995) Modelling with generalized stochastic petri nets, Wiley, New York.
3. Akella R, Kumar P (1986) Optimal control of production rate in a failure prone manufacturing systems, *IEEE Trans Autom Control* 31: 116–126.
4. Ammar G, Gragg W (1988) Superfast solution of real positive definite Toeplitz systems, *SIAM J Matrix Anal Appl* 9: 61–76.
5. Axelsson O (1996) Iterative solution methods, Cambridge University Press, Cambridge, UK.
6. Axelsson O, Barker V (1984) Finite element solution of boundary value problems theory and computation, Academic Press, New York.
7. Axsäter S (1990) Modelling emergency lateral transshipments in inventory systems, *Manag Sci* 36: 1329–1338.
8. Benedetto F, Fiorentino G, Serra S (1993) C.G. preconditioning for Toeplitz matrices, *Computers Math Appl* 25: 35–45.
9. Berland P, Saad Y, Stewart W (1992) Numerical methods in Markov chain modeling, *Oper Res* 40: 1156–1179.
10. Berman A, Plemmons R (1994) Nonnegative matrices in mathematical sciences, SIAM, Philadelphia.
11. Bielecki T, Kumar P (1988) Optimality of zero-inventory policies for unreliable manufacturing Systems, *Oper Res* 36: 532–541.
12. Buchholz P (1994) A class of hierarchical queueing networks and their analysis, *Queue Syst* 15: 59–80.
13. Buchholz P (1995) Hierarchical Markovian models: symmetries and aggregation, *Perform Eval* 22: 93–110.
14. Buchholz P (1995) Equivalence relations for stochastic automata networks. Computations of Markov chains: Proceedings of the 2nd international workshop On numerical solutions of Markov chains. Kluwer, 197–216.
15. Bunch J (1985) Stability of methods for solving Toeplitz systems of equations, *SIAM J Sci Statist Comput* 6: 349–364.
16. Buss A, Lawrence S, Kropf D (1994) Volume and capacity interaction in facility design, *IIE Trans Des Manuf* 26: 36–49.
17. Buzacott J, Shanthikumar J (1993) Stochastic models of manufacturing systems, Prentice-Hall International Editions, Englewood Cliffs, NJ.
18. Buzacott J, Yao D (1986) Flexible manufacturing systems: a review of analytic models, *Manage Sci* 32: 890–905.
19. Chan R (1987) Iterative methods for overflow queueing models I, *Numer Math* 51: 143–180.
20. Chan R (1988) Iterative methods for overflow queueing models II, *Numer Math* 54: 57–78.

21. Chan R (1989) Circulant preconditioners for Hermitian Toeplitz systems, SIAM J Matrix Anal Appl 10: 542–550.
22. R. Chan (1991) Toeplitz preconditioners for Toeplitz systems with nonnegative generating functions, IMA J Numer Anal 11: 333–345.
23. Chan R (1993) Iterative methods for queueing networks with irregular state-spaces, Proceedings of the IMA Workshop on linear algebra, Markov chains and queueing models, Springer-Verlag, London, 89–110.
24. Chan R, Chan T (1992) Circulant preconditioners for elliptic problems, J Numer Lin Algebra Appl 1: 77–101.
25. Chan R, Ching W (1996) Toeplitz-circulant preconditioners for Toeplitz matrix and its application in queueing networks with batch arrivals, SIAM J Sci Comput 17: 162–172.
26. Chan R, Ching W (1999) A direct method for stochastic automata networks. Proceedings of the symposium on applied probability, Chinese University of Hong Kong, China.
27. Chan R, Ching W (2000) Circulant preconditioners for stochastic automata networks, Numer Math 87: 35–57.
28. Chan R, Ng K (1996) Conjugate gradient methods for Toeplitz systems, SIAM Rev 38: 427–482.
29. Chan R, Strang G. (1989) Toeplitz equations by conjugate gradient with circulant preconditioner, SIAM J Sci Stat Comput 10: 104–119.
30. Chan R, Nagy J, Plemmens R (1993) FFT-based preconditioners for Toeplitz-block least square problems, SIAM J Numer Anal 30: 1740–1768.
31. Chan R, Tang P (1994) Fast band-Toeplitz preconditioners for Hermitian Toeplitz Systems, SIAM J Sci Statist Comput 15: 164–171.
32. Chan R, Ching W, Wong C (1996) Optimal trigonometric preconditioners for elliptic problems and queueing problems, SEA Bull Math 3: 117–124.
33. Chan R, Yeung M (1993) Circulant preconditioners for complex Toeplitz matrices, SIAM J Numer Anal 30: 1193–1207.
34. Chan T (1988) An optimal circulant preconditioner for Toeplitz systems, SIAM J Sci Statist Comput 9: 767–771.
35. Ching W (1997) Circulant preconditioners for failure prone manufacturing systems, Lin Alg Appl 266: 161–180.
36. Ching W (1997) An inventory model for manufacturing systems with delivery time guarantees, Computers Oper Res 25: 367–377.
37. Ching W (1997) Preconditioned conjugate gradient methods for manufacturing systems: The 8th SIAM conference on parallel processing for scientific computing.
38. Ching W (1997) A model for two-stage manufacturing systems: The 5th Mediterranean IEEE conference on control and systems, Cyprus.
39. Ching W (1997) Markov modulated Poisson processes and production planning in manufacturing systems: The WMC'97 international symposium on manufacturing systems, Auckland, New Zealand.
40. Ching W (1997) Markov modulated Poisson processes for multi-location inventory problems, Int J Prod Econ 53: 217–223.
41. Ching W (1998) Iterative methods for manufacturing systems of two stations in tandem, Appl Math Lett 11: 7–12.
42. Ching W (1998) A new model for multi-location inventory problems, Comput Ind Eng 35: 149–152.
43. Ching W (1998) Circulant preconditioners for stochastic automata networks: The 5th Copper mountain conference on iterative methods, Copper Mountain, Colorado, USA.

44. Ching W (1998) Optimal (S,s) policies for manufacturing systems of unreliable machines in tandem: The international symposium on product quality and integrity, Anaheim, USA, 365–370.
45. Ching W (1999) Iterative methods for manufacturing systems: Proceedings of the 2nd world manufacturing congress, Durham, UK, 346–350.
46. Ching W (2000) A model for FMS of unreliable machines: Proceedings of the 4th world CSCC conference, Vouliagmeni, Greece.
47. Ching W (2000) Circulant preconditioning for unreliable manufacturing systems with batch arrivals, *Int Appl Math* 4: 11–21.
48. Ching W (2001) Machine repairing models for production systems, to appear in *Int J Prod Econ*.
49. Ching W (2001) Markovian approximation for manufacturing systems of unreliable machines in tandem, to appear in *Int J Naval Res Logist*.
50. Ching W, Chan R, Zhou X (1997) Circulant preconditioners for Markov modulated Poisson processes and their applications to manufacturing systems, *SIAM J Matrix Anal Appl* 18: 464–481.
51. Ching W, Chan R, Zhou X (1998) Conjugate gradient methods for Markov modulated Poisson processes: The 2nd Asian mathematical conference, Thailand, 407–416.
52. Ching W, Zhou X (1995) Hedging point production planning for failure prone manufacturing systems: Proceedings of the 5th conference of the operational research society of Hong Kong, 163–172.
53. Ching W, Zhou X (1996) Matrix methods for production planning in failure prone manufacturing systems, *Lecture Notes in Control and Information Sciences*, Springer-Verlag, London, vol 214, 2–30.
54. Ching W, Zhou X (1996) Machine repairing models for manufacturing systems: The IEEE 5th conference on emerging technologies and factory automation.
55. Ching W, Zhou X (1997) Optimal (S,s) production policies with delivery time guarantee, *Lectures in Applied Mathematics, Mathematics of Stochastic Manufacturing Systems* The American Mathematical Society, vol 33, 71–81.
56. Ching W, Zhou X (1997) Optimal (S,s) policies for manufacturing systems with buffers holding costs: The 15th world congress of scientific computation modeling and applied mathematics, Berlin, Germany.
57. Ching W, Zhou X (2000) Circulant approximation for preconditioning in stochastic automata networks, *Comput Math Appl* 39: 147–160.
58. Cho D, Parlar M (1991) A survey of maintenance models for multi-unit systems, *Eur J Oper Res* 51: 1–23.
59. Concus P, Golub G, Meurant G (1985) Block preconditioning for conjugate gradient method, *SIAM J Statist Comput* 6: 220–252.
60. Concus P, Meurant G (1986) On computing INV block preconditionings for conjugate gradient method, *BIT* 26: 493–504.
61. Conway J. (1973) Functions of one complex variable, Springer-Verlag, Berlin.
62. Davis P (1979) Circulant matrices, John Wiley and Sons, New York.
63. Dewan S, Mendelson H (1990) User delay costs and internal pricing for a service facility, *Manage Sci* 36: 1502–1517.
64. Donohue K (1994) The economics of capacity and marketing measure in a simple manufacturing environment, *Prod Oper Manage* 3: 78–99.
65. Eben-Chaime M (1995) The queueing theory machine interference model: use and application, *Prod Planning Control* 6: 39–44.
66. Feller W (1957) An introduction to probability theory and its applications, vol 1, Wiley, New York.
67. Flood J (1995) Telecommunication switching traffic and networks, Prentice-Hall, New York.

68. Flynn B, Sakakibara S, Schroeder R (1995) Relationship between JIT and TQM: practice and performance, *Acad Manage J* 38: 1325–1360.
69. Freeland J (1980) Coordination strategies for production and marketing in a functionally decentralized firm, *IIE Trans* 12: 126–132.
70. Golub G, van Loan C (1983) Matrix computations, John Hopkins University Press, Baltimore, MD.
71. Grenander U, Szegö G (1984) Toeplitz forms and their applications, 2nd ed, Chelsea Pub. Co., New York.
72. Heffes H, Lucantoni D (1986) A Markov modulated characterization of packetized voice and data traffic and related statistical multiplexer performance, *IEEE J Select Areas Commun* 4: 856–868.
73. Hestenes M, Stiefel E (1952) Methods of conjugate gradients for solving linear systems, *J Res Nat Bur Stand* 49: 490–536.
74. Hill A, Khosla I (1992) Models for optimal lead time reduction, *Prod Oper Manage* 1: 185–197.
75. Hogg R, Craig A (1978) Introduction to mathematical statistics, Collier-Macmillan.
76. Horn R, Johnson C (1985) Matrix analysis, Cambridge University Press.
77. Hu J (1995) Production rate control for failure prone production systems with no backlog permitted, *IEEE Trans Autom Control* 40: 291–295.
78. Hu J, Vakili P, Yu G (1994) Optimality of hedging point policies in the production control of failure prone manufacturing systems, *IEEE Trans Autom Control* 39: 1875–1880.
79. Hu J, Xiang D (1993) The queueing equivalence to optimal control of a manufacturing system with failures, *IEEE Trans Autom Control* 38: 499–502.
80. Hu J, Xiang D (1994) Structure properties of optimum production controllers in failure prone manufacturing systems, *IEEE Trans Autom Control* 39: 640–642.
81. Huckle T (1992) Circulant and skew-circulant matrices for solving Toeplitz matrix problems, *SIAM J Matrix Anal Appl* 13: 767–777.
82. Karmarkar U (1994) A robust forecasting techniques for inventory and lead time Management, *J Oper Manage* 12: 45–54.
83. Kaufman L (1982) Matrix methods for queueing problems, *SIAM J Sci Statist Comput* 4: 525–552.
84. Kelley C (1995) Iterative methods for linear and non-linear equations, SIAM, Philadelphia.
85. Kochel P (1996) On queueing models for some multi-location problems, *Int J Prod Econ* 45: 429–433.
86. Law A, Kelton W (1991) Simulation modeling and analysis, McGraw-Hill, 2nd Edn. New York.
87. Lee H (1987) A multi-echelon inventory model for repairable items with emergency lateral transshipments, *Manage Sci* 33: 1302–1316.
88. Li L (1992) The role of inventory in delivery-Time completion, *Manage Sci* 38: 182–197.
89. Mantzaflis T (1980) An incomplete factorization techniques for positive definite linear systems, *Math Comp* 34: 473–497.
90. Meier-Hellstern K (1989) The analysis of a queue arising in overflow models, *IEEE Trans Commun* 37: 367–372.
91. Moinzadeh K, Schmidt C (1991) An (S-1,S) inventory system with emergency orders, *Oper Res* 39: 308–321.
92. Monden Y (1983) Toyota production system, Industrial Engineering Manufacturing Press, Atlanta, GA.
93. Nelson B (1995) Stochastic modeling analysis and simulation, McGraw-Hill, New York.

94. Oda T (1991) Moment analysis for traffic associated with Markovian queueing systems, *IEEE Trans Commun* 30: 737–745.
95. Pidd M (1992) Computer simulation in management science, John Wiley and Sons, 3rd Edn. Chichester.
96. Plateau B, Atif K (1991) Stochastic automata network for modeling parallel systems, *IEEE Trans Software Eng* 12: 370–389.
97. Pyke C (1990) Priority repair and dispatch policies for repairable item logistic systems, *Naval Res Logist* 37: 1–30.
98. Ross S (1970) Applied probability models with optimization applications, Holden Day, San Francisco, Cal.
99. Ross S (1983) Stochastic processes, Wiley, New York.
100. Ross S (1985) Introduction to probability models, Wiley, New York.
101. Saad Y (1996) Iterative methods for sparse linear systems, PWS, Publishing Co., Boston.
102. Seila A (1990) Multivariate estimation of conditional performance measure in regenerative simulation, *Am J Math Manage Sci* 10: 17–45.
103. Sethi S, Yan H, Zhang Q, Zhou X (1993) Feedback production planning in a stochastic two-machine flowshop: asymptotic analysis and computational results, *Int J Prod Econ* 30–31: 79–93.
104. Sethi S, Zhang Q, Zhou X (1992) Hierarchical controls in stochastic manufacturing systems with machines in tandem, *Stoch Stoch Rep* 41: 89–118.
105. Sethi S, Zhou X (1994) Dynamic stochastic job shops and hierarchical production planning, *IEEE Trans Autom Control* 39: 2061–2076.
106. Siha S. (1996) Modeling the blocking phenomenon in JIT Environment: an alternative scenario, *Comput Eng* 30: 61–75.
107. Sonneveld P (1989) CGS, a fast lanczos-type solver for non-symmetric linear systems, *SIAM J Sci Comput* 10: 36–52.
108. Stewart W, Atif K, Plateau B (1995) The numerical solution of stochastic automata networks, *Eur J Oper Res* 86: 503–525.
109. Strang G (1986) A proposal for Toeplitz matrix calculations, *Stud Appl Math* 74: 171–176.
110. Suri R (1983) Robustness of queueing network formulas, *J Assoc Comput Mach* 30: 564–594.
111. Tyrtyshnikov E (1992) Optimal and super-optimal circulant preconditioners, *SIAM J Matrix Anal Appl* 13: 459–473.
112. Van der Vorst H (1982) Preconditioning by incomplete decomposition, Ph. D Thesis, Rijksuniver-siteit te Utrecht, Netherlands.
113. Varga R (1963) Matrix iterative analysis, Prentice-Hall, Englewood, NJ.
114. Yamazaki G, Kawashima T, Sakasegawa H (1985) Reversibility of tandem blocking queueing systems, *Manage Sci* 31: 78–83.
115. Yan H, Zhou X, Yin G (1994) Finding optimal number of kanbans in a manufacturing system Via stochastic approximation and perturbation analysis, *Lecture Notes in Control and Information Sciences*, Cohen G, Quadrat J (Eds), Springer-Verlag, London, 572–578.
116. Young H, Byung B, Chong K (1992) Performance analysis of leaky-bucket bandwidth enforcement strategy for bursty traffics in an ATM network, *Comput Net ISDN Syst* 25: 295–303.

# Index

- Arrival rate, 9
- Asymptotic solution, 140
- Average running cost, 72
- Average waiting time, 8, 13, 30
- Backlog cost, 71, 72, 79, 88, 96, 107, 120
- Band-Toeplitz matrix, 35
- Batch arrival, 27, 33, 75, 89
- BGS, 49, 71, 101, 114, 149
- Block Gauss-Seidel method, 49, 71, 87, 101, 139, 149
- Central warehouse, 142
- CGS, 24, 42, 51, 61, 70, 88, 101
- Circulant approximation, 48, 49, 94, 97, 98, 107, 111, 116, 117
- Circulant matrix, 35, 36
- Circulant preconditioner, 36, 37
- Clustered eigenvalues, 24, 35, 55, 58
- Clustered singular values, 23, 28, 48, 49, 51, 87, 98, 101, 107, 114
- Computer aided manufacturing, 93
- Conjugate Gradient Squared, 24
- Consistent estimator, 120
- Continuous time, 1
- Cycle time, 119, 121
- Delivery time guarantee policy, 119
- Depot queue, 137
- Discrete Fourier transform, 36
- Discrete time, 1
- Domain decomposition, 25
- Eigenvalues, 22, 24
- ELT, 142
- Emergency lateral transshipment, 133
- Emergency replenishment, 133
- Erlangian distribution, 121
- Erlangian repairing process, 89
- Exponential distribution, 4–8, 30
- First-come-first-served, 11, 93, 119, 142
- Flexible manufacturing system, 93
- Frobenius norm, 37
- Gauss-Seidel method, 21, 22, 31, 42
- Generating function, 35, 36, 38
- Generator matrix, 3, 10, 12, 14, 15, 18, 19, 22, 25, 26, 28, 29, 33, 47–50, 68, 76, 77, 94, 95, 97, 101, 107–111, 113, 115, 116, 120, 125, 126, 134, 135, 137, 138, 140, 144, 148
- Hedging point, 65
- Hedging point production policy, 65, 104, 107
- HPP policy, 72, 75–77, 93, 102
- Initial value problem, 5
- Inventory cost, 66, 67, 71, 79, 88, 96, 107, 120, 135, 142, 146, 149
- Irreducible continuous time Markov chain, 68
- Irreducible Markov chain, 3, 10
- Iteration matrix, 22, 27, 31
- Iterative methods, 10, 19, 20, 22, 26, 28, 97, 101, 139
- Jacobi method, 20–22, 26, 27, 35, 42
- JIT, 65
- Just-in-time, 65, 73
- Kronecker tensor product, 15
- Limiting probability, 1, 3
- Little’s queuing formula, 12
- Local warehouse, 150
- Machine interference, 14
- Machine interference model, 31
- Machines in tandem, 115
- Make-to-order, 65, 133

- Manufacturing system, 1, 4, 11, 19, 24, 65–68, 75, 78, 81, 89, 107, 108, 110, 112, 119, 120
- Markov chain, 1
- Markov process, 1, 50
- Markov-modulated Poisson process, 47, 136
- Maximum likelihood estimator, 44, 45
- MMPP, 47, 136, 137
- Multi-location inventory problem, 133, 139, 141
- Near-optimal, 67
- Near-Toeplitz, 34, 79
- No-memory property, 7, 8
- Normalization constant, 12
- One-for-one, 142
- Optimal (s,S) policy, 120
- Optimal hedging point, 67, 71, 94
- Optimal policy, 65
- Order-to-make, 65
- Ordered statistics, 122
- Overflow, 134, 135
- PCG, 76, 81, 87, 97, 98, 101, 112–114
- PCGS, 25, 101, 114
- Permutation matrix, 81
- Perron and Frobenius theory, 34
- Poisson distribution, 4, 6
- Poisson process, 4, 6, 8, 142
- Poisson solvers, 25
- Preconditioned conjugate gradient method, 27
- Preconditioned conjugate squared method, 25
- Preconditioner, 23, 25, 26, 34–36, 39, 76, 79, 81, 85, 86, 99, 100
- Queueing system, 1, 9–11, 13, 15, 33, 41, 47
- Regularization, 55, 58, 59
- Regularization method, 48, 58
- Rejection cost, 135, 139
- Reliability factor, 131
- Reliability value, 124
- Schur's Triangularization Theorem, 60
- Service level, 124
- Service rate, 9, 11
- Shifted exponential distribution, 120, 121
- Single echelon model, 133
- Singular values, 23, 28, 48, 49, 51, 54, 55, 59, 87, 98, 99, 101, 107, 108, 112–114, 117
- Spectral radius, 22
- Spectrum, 23
- Starving probability, 143, 145
- Steady state, 3, 10, 12
- Steady-state probability distribution, 1, 3, 12, 14, 16, 48, 68
- Steady-state probability vector, 19, 26
- Stochastic matrix, 19
- Strang's circulant approximation, 53
- Supply chain, 133
- System throughput, 94, 102
- Tele-traffic, 49
- Telecommunication system, 48, 49, 51
- Tensor product, 15
- The (s,S) policy, 120, 121
- Toeplitz matrix, 35, 36, 41
- Toeplitz-circulant preconditioner, 44
- Transshipment, 150
- Two-echelon inventory system, 133
- Two-queue free queuing system, 16
- Two-queue overflow system, 17
- Two-stage manufacturing system, 107
- Unbiased estimator, 120
- Unreliable machines, 65, 67, 89, 93, 104
- Waiting space, 11
- Waiting time, 6
- Waiting time paradox, 8
- Weyl's Theorem, 57
- Work-in-progress, 93, 110
- Zero inventory policy, 65