

Table of Contents

Chapter 1 General Principles	1
1. Build a broad knowledge base	1
2. Practice your interview skills	1
3. Listen carefully	2
4. Speak your mind	2
5. Make reasonable assumptions.....	2
Chapter 2 Brain Teasers	3
2.1 Problem Simplification.....	3
Screwy pirates.....	3
Tiger and sheep.....	4
2.2 Logic Reasoning	5
River crossing	5
Birthday problem	5
Card game.....	6
Burning ropes.....	7
Defective ball.....	7
Trailing zeros	9
Horse race	9
Infinite sequence	10
2.3 Thinking Out of the Box.....	10
Box packing	10
Calendar cubes.....	11
Door to offer	12
Message delivery	13
Last ball	13
Light switches.....	14
Quant salary	15
2.4 Application of Symmetry	15
Coin piles.....	15
Mislabeled bags	16
Wise men	17
2.5 Series Summation	17
Clock pieces.....	18
Missing integers.....	18
Counterfeit coins I	19
2.6 The Pigeon Hole Principle.....	20
Matching socks	21
Handshakes	21
Have we met before?	21
Ants on a square.....	22
Counterfeit coins II.....	22

Contents

2.7 Modular Arithmetic.....	23
Prisoner problem.....	24
Division by 9	25
Chameleon colors	26
2.8 Math Induction.....	27
Coin split problem	27
Chocolate bar problem.....	28
Race track	29
2.9 Proof by Contradiction.....	31
Irrational number	31
Rainbow hats	31
Chapter 3 Calculus and Linear Algebra.....	33
3.1 Limits and Derivatives	33
Basics of derivatives.....	33
Maximum and minimum	34
L'Hospital's rule.....	35
3.2 Integration	36
Basics of integration	36
Applications of integration	38
Expected value using integration.....	40
3.3 Partial Derivatives and Multiple Integrals	40
3.4 Important Calculus Methods.....	41
Taylor's series.....	41
Newton's method.....	44
Lagrange multipliers.....	45
3.5 Ordinary Differential Equations.....	46
Separable differential equations.....	47
First-order linear differential equations	47
Homogeneous linear equations	48
Nonhomogeneous linear equations	49
3.6 Linear Algebra	50
Vectors.....	50
QR decomposition	52
Determinant, eigenvalue and eigenvector.....	53
Positive semidefinite/definite matrix	56
LU decomposition and Cholesky decomposition	57
Chapter 4 Probability Theory.....	59
4.1 Basic Probability Definitions and Set Operations.....	59
Coin toss game.....	61
Card game.....	61
Drunk passenger	62

N points on a circle	63
4.2 Combinatorial Analysis	64
Poker hands.....	65
Hopping rabbit.....	66
Screwy pirates 2.....	67
Chess tournament.....	68
Application letters.....	69
Birthday problem.....	71
100th digit.....	71
Cubic of integer	72
4.3 Conditional Probability and Bayes' formula	72
Boys and girls	73
All-girl world?	74
Unfair coin	74
Fair probability from an unfair coin.....	75
Dart game.....	75
Birthday line	76
Dice order	78
Monty Hall problem.....	78
Amoeba population.....	79
Candies in a jar	79
Coin toss game.....	80
Russian roulette series.....	81
Aces	82
Gambler's ruin problem.....	83
Basketball scores.....	84
Cars on road	85
4.4 Discrete and Continuous Distributions.....	86
Meeting probability.....	88
Probability of triangle	89
Property of Poisson process	90
Moments of normal distribution	91
4.5 Expected Value, Variance & Covariance	92
Connecting noodles.....	93
Optimal hedge ratio	94
Dice game	94
Card game.....	95
Sum of random variables	95
Coupon collection.....	97
Joint default probability	98
4.6 Order Statistics	99
Expected value of max and min.....	99
Correlation of max and min	100
Random ants	102
Chapter 5 Stochastic Process and Stochastic Calculus	105

Contents

5.1 Markov Chain	105
Gambler's ruin problem.....	107
Dice question	108
Coin triplets	109
Color balls.....	113
5.2 Martingale and Random walk	115
Drunk man	116
Dice game	117
Ticket line	117
Coin sequence.....	119
5.3 Dynamic Programming	121
Dynamic programming (DP) algorithm.....	122
Dice game	123
World series.....	123
Dynamic dice game	126
Dynamic card game	127
5.4 Brownian Motion and Stochastic Calculus	129
Brownian motion	129
Stopping time/ first passage time.....	131
Ito's lemma	135
Chapter 6 Finance	137
6.1. Option Pricing	137
Price direction of options.....	137
Put-call parity	138
American v.s. European options	139
Black-Scholes-Merton differential equation.....	142
Black-Scholes formula.....	143
6.2. The Greeks	149
Delta	149
Gamma.....	152
Theta	154
Vega.....	156
6.3. Option Portfolios and Exotic Options.....	158
Bull spread.....	159
Straddle.....	159
Binary options.....	160
Exchange options.....	161
6.4. Other Finance Questions	163
Portfolio optimization	163
Value at risk.....	164
Duration and convexity.....	165
Forward and futures	167
Interest rate models.....	168

Chapter 7 Algorithms and Numerical Methods	171
7.1. Algorithms	171
Number swap	172
Unique elements	173
Horner's algorithm	174
Moving average	174
Sorting algorithm	174
Random permutation.....	176
Search algorithm	177
Fibonacci numbers.....	179
Maximum contiguous subarray.....	180
7.2. The Power of Two	182
Power of 2?	182
Multiplication by 7.....	182
Probability simulation.....	182
Poisonous wine	183
7.3 Numerical Methods	184
Monte Carlo simulation	184
Finite difference method	189