**Index**

### A
- achievable rate 52, 53, 58
- adaptive mode switching 40
- amplify-and-forward 159
- amplitude matching 46
- antenna beam pattern 143
- antenna impedance 65
- artificial noise 199
- auction based method 171

### B
- backscatter 61
- battery information 278
- beacon 287
- beamforming 199
- binary modulation 64
- bit-error rate 47
- blockage 139, 148
- block fading 122, 183, 274

### C
- central processing unit (CPU) 254
- channel estimation 51, 208
- channel hardening 208
- channel state information 21, 123, 203, 235, 279
- circuit design 53
- circuit power consumption 52, 124, 234
- circularly symmetric complex Gaussian (CSCG) 26, 200, 289
- cognitive radio 90
- coherence bandwidth 46
- coherence time 257
- coherent RF combiner 291
- complementary cumulative distribution function (CCDF) 144
- complementary slackness conditions 134
- computation offloading 254, 257
- confluent hypergeometric function 68
- constellation 49, 182, 187
- constructive interference 182
- conversion efficiency 20
- convex function 258, 261
- cooperative 158, 217, 219, 273
- cooperative protocol 275
- CPU frequency 259
- CVX 265

### D
- DC power 23, 289, 291
- decode-and-forward 159
- delay-sensitive transmission 108
- diode 20, 41
- distributed beamforming 165, 279
- duality gap 90, 211
- dual problem 262
- dual variables 90, 211, 261
- dynamic CSI acquisition 28
Index

e
eigenchannels 181
eigenmode 86
eigenvalue
decomposition 208, 257
ergy accumulation 218
ergy beamforming 86, 87
ergy causality 52, 53, 58
ergy causality constraint 237
ergy efficiency 85
ergy harvesting 181
ergy storage 65, 121, 124
epoch 122, 125
ergodic capacity 159
ergodic random process 122
Euclidean distance 287

f
fairness 173
far-field 17, 82, 287
feedback 21, 94, 287
The fifth-generation (5G) 157
frequency flat 23, 200, 220
frequency non-selective 62, 183

g
Gamma distribution 64
Gamma function 63, 146
gradient 130

h
half-duplex 175, 275
hardware impairments 176
harvest-then-transmit 94, 124, 219
homogeneous Poisson point process 141, 274
hybrid access point 219

i
imperfect CSI 199
indicator function 144
Internet-of-Things (IoT) 1, 17, 39, 197, 233, 253

k
Karush-Kuhn-Tucker (KKT) 134, 211, 263

l
Lagrange duality method 261
Lagrange dual method 238
Lagrange multipliers 134
linear energy harvesting model 41
linear matrix inequalities (LMIs) 206
line-of-sight (LOS) 18, 63, 141, 247
logistic function 42
low-pass filter 20

m
Markov Chain 222, 275
maximal-ratio transmission (MRT) 51, 92
maximization 126, 167, 236
maximum ratio combining 258
millimeter wave 139
mobile edge computing 253
multicarrier 166
multiple-input multiple-output 181, 197, 234
multiple-input single-output (MISO) 90, 183, 255
multi-tone (PAPR) SWIPT 40, 48, 53

n
Nakagami 63, 220
Nash Equilibrium 172
non-convex 185, 206
non-cooperative 166, 169
nonlinear energy harvesting model 42, 52, 54, 58
non-linear RF-based EH model 200
non-line-of-sight (NLOS) 18
non-orthogonal multiple access (NOMA) 99, 176, 234
null space 212, 262
Index

o
off-the-shelf solvers 265
omnidirectional 147, 287
one-dimensional search 206
opportunistic beamforming 273
optimal solution 52, 86
outage probability 41, 69, 107, 159, 221

p
PAPR 9, 23, 39
Pareto boundary 84
path-loss model 62, 274
phase alignment 46
phase shift keying 182
Poisson point process (PPP) 101, 141
positive semidefinite 212, 264
power allocation 86
power conversion efficiency 40
power sensitivities 83
power splitting 6, 51, 159, 181, 187, 282
power-splitting ratio 51, 55, 57
precoding 46, 87
Processing Cost 124
proportional fairness 122, 125

q
QoS 197
quadrature amplitude modulation 53

r
rank-constrained optimization
  Problem 206
rank-one matrix 86, 212
rate-energy region 29, 87
rate-energy tradeoff 39, 47, 57, 58
receiver architecture 51
reconfigurable energy harvester 40, 53, 57, 58
rectenna 19, 69, 287
rectifier 20, 42, 65, 144
reflection coefficient 65
Relaying 158, 159, 218
Relay selection 158, 164, 274
resource allocation 200, 235, 255
RFID 61, 64
robust optimization 210

s
scheduling 83
SDP relaxation 185
second-order cone programming
  (SOCP) 181
second order statistics 163, 164
secrecy rate 199
secure SWIPT 11, 199
SE maximization problem 236
semidefinite programming 185, 205
side lobe 143, 150
sigmoid 74, 202
 simultaneous wireless information and
  power transfer (SWIPT) 18, 39, 61, 81, 157, 181, 197, 254, 273
singular value decomposition 86
Slater’s condition 90, 262, 263
spatial multiplexing 87, 90
S-Procedure 206
steady-state distribution 277
stochastic geometry 140, 273
successive interference cancellation 234, 273
successive linear approximation 182
supercapacitor 124
symbol-level precoding 182

t
Taylor series 42
TDMA 28, 129, 234
throughput 159, 224, 236
Time Division Duplex 200
time switching 6, 83, 100
transceiver design 33, 43
transmit beamforming 86, 94
two-way relaying 168, 175
Index

$u$
uniform power allocation  45

$W$
water-filling  86
waveform design  48, 181

Wireless-powered communication  
121, 273
wireless power transfer  39
wireless sensors  121, 198
wiretap channel  199