

Index

- absorption characteristic, 41
- acceleration
 - disturbing, 85
 - Keplerian, 29
 - linear, 8
 - longitudinal, 58, 78
- accumulation of momentum, 189
- ACS accuracy, 172
- action equation of motion, 299
- active attitude control, 112
- active control, 210, 214
- active damping, 117, 126
- active nutation control, 135
- active nutation damping, 225
- active wheel nutation damping, 146
- aerodynamic force, 32
- air density, 32
- altitude of
 - apogee, 65
 - geostationary orbit, 73
 - low-orbit satellite, 28, 72
 - orbit, 32
 - perigee, 65
- amplification of
 - position sensor noise, 179
 - rate sensor noise, 178
 - reaction wheel torque noise, 179
- analog sun sensor, 345
- angular dynamic equations, 88, 211
- angular momentum, 11, 88, 89
- angular motion, 88, 90
- angular velocity, 88, 101, 162
- angular velocity sensors, 175
- anomalies, eccentric, true, 18
- aphelion, 15
- apoapsis, 15
- apogee, 15
- apogee boost motor (ABM) 60, 381
- apsides, 68
- argument of perigee, 24, 28, 68
- Aries, first point of, 23
- ascending node, 23, 36
- asymptotes, 17
- atmospheric drag, 32, 72
- attitude calculation, 336
- attitude control, 163
 - gravity gradient, 112, 114
 - laws, 156
 - magnetic, 188, 222
 - reaction thrust, 242
 - solar torque, 222, 229
 - time-optimal, 195
- attitude determination hardware, 328
- attitude dynamics, 88
- attitude error, 76
- attitude kinematics, 88, 100
- attitude-maneuvering satellite, 112
- attitude maneuvers, 152
- attitude matrix, 318
- attitude sensors, 173, 174
- attitude stability, 173
- attitude transformations in space, 325
- axis of symmetry, 95
- ballistic coefficient, 33
- bandwidth of attitude control system, 180
- bang-bang control, 141, 195
- basic attitude control equation, 113, 152
- bending modes, 180
- bias attitude error, 335
- body cone, 98
- body coordinate frame, 318
- body rates estimation, 158
- Canopus, 363
- cantilever beam, 297
- cantilever natural frequency, 294
- Cape Canaveral, 73
- Cartesian coordinate system, 24, 27
- catalyst, 382
- catalytic activity, 383
- CCD matrix, 369
- central force, 12
- celestial background, 364
- celestial coordinates, 371
- celestial catalog, 365
- celestial map, 365
- celestial pole, 22
- celestial sphere, 23, 365
- center of
 - attracting body, 43
 - earth, 40
 - eccentricity circle, 55
- central force field, 12
- charge coupled device (CCD) detector, 369
- chatter, 143, 198, 201

- chemical propulsion
 - liquid, 382
 - solid, 381
- circularization of GTO, 75
- classical orbit parameters, 24, 27
- code
 - binary, 352
 - Gray, 352
- cold gas propulsion, 381
- conical section, 14
- conservation of angular momentum, 161
- conservation of energy, 10
- conservative force, 10
- constant of gravitation, 9
- control hardware, 379
- control torques, 113
- control torque saturation, 223
- coplanar transfer orbit, 69
- cosine sun detector, 345
- coupling coefficients and matrices, 310
- critical inclination, 37
- damper
 - boom articulation, 123
 - external spring boom, 123
 - magnetic hysteresis, 123
 - point mass, 123
 - wheel, 124
- damping
 - active, 126
 - all-magnetic active, 129
 - passive, 123, 146
 - passive wheel nutation, 144
- damping factor, coefficient, 123, 145
- dead zone, 140, 285
- deflection mode
 - in-plane, 309
 - out-of-plane, 309
 - torsional, 309
- denutation, 139
- despin, 139
- digital sun sensor, 351
- direction cosine error matrix, 154, 318
- direction cosine matrix, 104, 153, 318, 323
- direction cosines, 46
- discrete control, 273
- displacement equations of motion, 300
- dissipation function, 293
- disturbed Keplerian orbit, 37
- disturbing torque, 114, 132
- disturbance torques, 122, 274
- double stars, 365
- drag coefficient, 32
- drift rate, 79
- dry center of mass, 305
- dual-cone optical head, 333
- dual-cone scanner, 334
- dual-spin stabilization, 132, 148, 210
- earth albedo, 329
- earth circle, 337
- earth
 - equatorial plane, 23, 56
 - escape velocity, 16
 - earth sensors, 174, 329
 - noise amplification, 220
- earth's magnetic field, 123, 126, 186
- eccentric anomaly, 18
- eccentricity, 14, 21, 42,
- eccentricity circle, 52, 84
- eccentricity corrections, 78, 84
- eccentricity derivative, 55
- eccentricity vector, 43, 52, 81
- eccentricity vector evolution, 55
- ecliptic plane, 23, 45
- ecliptic pole, 48
- eigenaxis rotation, 195
- eigenfrequency, 295
- eigenvalue, 92, 299
- eigenvector, 92, 299
- eigenvector of rotation, 323
- electric propulsion, 385
- ellipsoid
 - of inertia, 93
 - of momentum, 94
- emission spectra, 363
- energy
 - kinetic, 9
 - potential, 9
- energy constant, 16
- energy dissipation, 99, 138, 149, 244
 - rate, 138
- energy sink, 138
- epoch, 23
- equatorial plane, 22, 37, 42, 73
- escape velocity (from circular orbit), 16
- Euler angle errors, 153
- Euler angle rotation, 319
- Euler angles, 101, 104, 110
- Euler angular rates, 153
- Euler axis of rotation, 155, 188, 323
- Euler–Hill equations, 57
- Euler's moment equation, 95, 145
- evolution of the eccentricity vector, 50
- evolution of the inclination vector, 43
- external disturbances, 275
- external torque, 107
- field of view (FOV), 329, 350, 373
- first point of the Aries, 23
- flexibility coefficients, 298
- flexibility matrix, 298

- flexible solar array, 291
- flexural rigidity, 297
- flux of light, 357
- focus, 8, 15
- force-deflection equation, 297
- frequency of oscillation, 117
- friction, 394
- fuel consumption, 64, 70, 136, 143
- fuel tank, 302

- Gauss planetary equations, 30
- generalized coordinates, 293
- generalized forces, 293
- geocentric inertial system, 22, 23
- geocentric latitude, 35
- geographical
 - latitude, 36, 68, 73
 - longitude, 35, 78
- geomagnetic equator, 187
- geopotential function, 35
- geostationary, 28, 42, 73
- geostationary orbit corrections, 80
- geosynchronous, 42, 73
- gravitational
 - attraction field, 17
 - force, 44
 - potential, 34, 37
- gravity gradient, 112
 - attitude control, 114
 - characteristic equation, 114
 - moments, 108
 - stabilization, 112, 122, 126
 - vector, 109
- Gray binary code, 351
- Greenwich meridian, 43

- hardware
 - attitude determination, 174, 328
 - control, 160, 379
- harmonic coefficients, 14
 - sectoral, 35
 - spherical, 34
 - tesseral, 35
 - zonal, 35
- harmonic motion, 49, 117
- Hill equations, 58
- Hohmann transfer, 70
- horizon-crossing sensor, 330
- horizon sensor, 330
- hyperbolic orbit, 17

- image dissector, 367
- immunity to sensor noise, 246
- impulsive force, 59
- impulsive thrust, 64
- inclination, 24, 42
 - angle, 28
 - circle, 82
 - correction, 74, 82
 - station keeping, 80, 81
 - zeroing, 74
- inclination derivatives, 49
- inclination drift, 41
- inclination vector, 43, 82
 - evolution, 43
- inertia matrix, 88
- inertial coordinate system, 22, 25
- inertial frame, 26
- inertial measuring unit (IMU), 181
- inertial reference frame, 26
- influence coefficient, 292
- infrared earth sensor, 329
- infrared static earth sensor, 343
- in-plane deflection mode, 309
- integrator, 278
- inverse square law of force, 9, 10
- ion thruster, 386

- Keplerian acceleration, 29
- Keplerian orbit, 8, 12
- Kepler's laws, 8, 19
- Kepler's time equation, 20
- Kourou, 73

- Lagrange's equations, 45, 293
- Lagrange's method, 293
- Lagrange's planetary equation, 33
- latch valves, 384
- launch site, 73, 74
- law of areas, 19
- Legendre polynomials, 35, 41
- linearized attitude dynamics equations of
 - motion, 108, 312
- line of apsides, 65
- line of nodes, 37
- liquid slosh, 180, 301
- local coordinate system, 25
- longitude station keeping, 85
- longitudinal acceleration, 56, 78
- longitudinal drift rate, 79
- lunar pole, 48

- magnetic active damping, 129
- magnetic attitude control, 185
- magnetic control dipole, 126
- magnetic field, 123, 126, 128
- magnetic moments, 397
- magnetic torquers (torquods), 126, 187, 397
- magnetic torque equation, 191
- magnetic unloading of momentum, 189
- magnetotorquers, 397
- magnitude m of a star, 357
- major axis, 16, 92

- mask detector, 349
- mass matrix, 298
- massless cantilever beam, 297
- mean anomaly, 20
- mean longitude, 43
- mean motion, 20
- mean radius of earth, 35
- minimum impulse bit, 245, 284
- minimum torque impulse bit, 285
- minor axis, 92
- modal frequency, 294
- modeling liquid slosh, 301
- modeling solar panels, 291
- modulator
 - pulse width, (PW), 273
 - pulse width–pulse frequency (PWPF), 266, 270
 - pseudo rate (PR), 270
- Molniya orbit, 37
- moment of inertia, 89
 - maximum, 92
 - minimum, 92
 - principal, 92
 - about spin axis, 90
- moment of momentum, 11
- momentum axis of orbit, 25
- momentum bias, 212,
- momentum-biased attitude stabilization, 161, 210
- momentum accumulation, 165
- momentum
 - linear, 8,
 - angular, 11, 88
- momentum-biased satellite, 217
- momentum bias stabilization, 150
- momentum capacity, 206
- momentum dumping, 165, 241
 - magnetic, 194
 - reaction, 241, 250
- momentum exchange device, 107, 160, 393
 - control moment gyro, 161
 - momentum wheel, 107, 161, 237
 - reaction wheel, 161
- momentum management, 169
- momentum wheel, 161, 211, 393
- monopropellant propulsion system, 382
- moon's orbit, 45, 48
- multi-mass modeling, 296, 308
- multi-mass sloshing model, 308

- nadir, 214, 331
- nadir-pointing stabilized satellite, 120
- n -body problem, 39
- natural eccentricity radius, 55, 84
- natural frequency, 180
- natural frequency of oscillation, 300, 301

- Newton's laws, 8
 - second law of motion, 39
- node line, 24,
- noise amplification, 178, 220
- nonconservative perturbing forces, 28
- nonhomogeneity of the earth, 34
- nonspinning satellite
 - dynamic equations of, 107
 - kinematic equations of, 100
- nonviscous liquid, 302
- North–South station keeping, 81
- nozzle throat, 381
- nutation
 - damper, 146
 - destabilization, 99
 - instability, 100
 - stability, 100,
- nutation angle, 98, 133
- nutation frequency, 136, 212, 220
- nutational motion, 132

- oblateness effects of the earth, 34, 329
- onboard star catalog, 370
- one–vibrating mass model, 302
- open-loop gain, 313
- operational constraints, 67
- optical scanning mechanism, 330, 367
- optical sensor head, 349
- orbital
 - adjustment, 65, 78
 - corrections, 80
 - frequency, 212
 - maneuvers, 64
 - period, 32
 - plane, 24, 44
 - pole, 24, 43, 80
 - rate, 117
- orbit change
 - in-plane, 68, 75
 - multi-impulse, 70
 - out-of-plane, 75
 - single-impulse, 65
- orbit coordinates, 25
- orbit mechanics, 8
- orbit parameters, 24, 32
- orbit reference frame, 101, 105
- orbits
 - altitude, 32
 - circular, 15
 - coaxial, 71
 - coplanar, 71
 - elliptical, 15
 - equatorial, 24
 - geostationary, 42, 73
 - geosynchronous, 42, 73
 - heliosynchronous, 36

- hyperbolic, 17
- parabolic, 16
- sun-synchronous, 36
- oscillation frequency, 305
- osculating orbit, 29
- out-of-plane deflection mode, 309

- passive attitude control, 112
- passive dampers, 123
- passive wheel nutation damping, 144
- parabolic trajectory, 78
- parasitic disturbing torques, 161
- passage time from perigee, 21
- pendulum, frequency of oscillation, 302
- periapsis, 15
- perigee, 15
 - argument, 24
 - passage, 20
- perihelion, 15
- perturbation acceleration, 29, 31, 40, 85
- perturbed
 - orbit, 28
 - equation of motion, 29
- perturbing body, 40
- perturbing forces, 28, 33, 85
- perturbing potential function, 37
- perturbing third body, 39
- photomultiplier, 367
- planetary precession, 23
- Polaris, 214, 357
- pole
 - celestial, 22
 - ecliptic, lunar, 48
 - orbital, 44, 80
- polhode, 94
- positioning accuracy, 173
- potential energy, 10, 14
- power loss, 392
- precession
 - lunar pole, 48
 - planetary, 23
- precessional motion, 22
- prime focus, 15, 18
- principal axes, 93
- principal axes of inertia, 91
- principal moments of inertia, 92
- product of inertia, 90, 225, 248
- propellant
 - control valve, 384
 - liquid, 382
 - mass, 72
 - solid, 381
- proper real orthogonal matrix, 319
- propulsion, 379
 - bipropellant, 385
 - chemical, 381
 - cold gas, 381
 - electric, 385
 - liquid, 382
 - monopropellant, 382
 - solid propellant, 381
- propulsion rocket equation, 380
- pseudoinverse matrix, 160
- pseudo rate (PR) modulator, 270
- pulsed controller, 273
- pulsed reaction system, 273
- pulse width modulation, 265, 273
- pulse width–pulse frequency modulation, 265, 267
- pulsing mode, 260

- quaternion, 104, 322
- quaternion error vector, 156
- quaternion method, 322
- quaternion multiplication, 326
- quaternion vector, 104

- radiance detector, 330, 344
- radiation pressure 41
- rate
 - gyro, 158, 375
 - integrating gyro, 105, 175, 375
- rate sensor, 175, 373
- reaction control system, 140
- reaction thruster attitude control, 260
- reaction thruster, 242, 260
 - HT, LT, 385
- reaction torque, 260, 265
- reaction wheel, 161, 206, 393
- reciprocity theorem, 298
- reference coordinate system, frame, 101
- relative acceleration, 58
- relative distance, 58
- relative motion, 10, 58
- restrictions on orbit changes, 69
- reticle slit pattern, 351
- right ascension, 24, 28, 43
- right-handed system, 23
- right pseudoinverse transformation, 169
- rigid body, 88, 291
 - rotation kinetic energy, 90
- roll deadbeat limit, 247
- roll–yaw attitude control, 237
- root locus, 146
- rotating frame, 102
- rotational axis, 91
- rotational kinetic energy, 90, 94
- rotational motion, 88, 238

- sampled transfer function, 284
- sampling frequency, 273
- satellite motion, 59

- scalar potential function, 34
- scanning mechanism, 330
- scanning rate, 338
- Schmidt trigger, 265,
- sectoral harmonic coefficients, 35
- secular term
 - of inclination derivative, 50
- semi-latus rectum, 14
- semimajor axis, 16, 65
- semiminor axis, 16
- sensor noise, 113, 173
 - amplification, 178, 266
- side force, 308
- sidereal angle, 42
- sidereal day, 42
- signal processing, 330, 369
- simulation, 6-DOF, 120
- single-mass structural dynamics, 293
- single-spin stabilization, 132, 144
- slosh dipole, 305
- solar
 - efficiency, 234
 - energy flux, 41
 - pressure, 28
 - radiation, 41
 - torques, 388
 - wind, 41
- solar control torques, 229, 388
- solar flaps, 230
- solar panels, 230
- solar radiation perturbing function, 53
- solar torque capability, 392
- space cone, 98
- specific angular momentum, 12
- specific impulse I_{sp} , 380
- spectra of a star, 357
- spherical harmonic expansion, 34
- stability of rotation, 96
- star catalog, 369
- star identification, 371
- star scanner, 366
- star sensor, 353
 - assembly, 367
 - specification, 373
- star tracking, 366
- static earth sensor, 343
- steady-state error, 278
- stellar distribution, 364
- stiffness coefficient, 292, 298
- stiffness constant, 299
- stiffness matrix, 298
- structural dynamics, 113, 291, 291
- structural model, 295, 296
- structural modeling, 291,
- sun acquisition, 350
- sun sensors, 174, 345
 - analog, 345
 - digital, 351
 - one-axis, 347
 - two-axis, 349
- sun-synchronous orbit, 36
- switching curve, 198
- tachometer, 396
- terminator, 329
- tesseral harmonic coefficients, 35, 37
- thermal emission, 329
- thermopile, 344
- third-body perturbing force, 39
- three-axes stabilized, 100
- three-body problem, 39
- thruster activation time, 263
- thrusters, 387
 - electrothermal monopropellant, 384
 - hydrazine, 383
 - ion, 386
- time delay, 200
- time derivation
 - of direction cosine matrix, 104
 - of quaternion vector, 104
- time-optimal attitude control, 195
- time response, 117, 212, 235
- time since periapsis passage, 18
- torque
 - arm, 262
 - commands, 141
 - control law, 152, 207
 - impulse bit, 245, 262
 - solar, 234, 388
- torque spectra noise, 394
- torque impulses, 273
- torque wheel, 107
- torsional deflection mode, 309
- total energy, 10, 14
- total energy per unit mass, 14
- total impulse, 380
- transfer
 - geostationary (GTO), 73, 85
 - geosynchronous, 73
 - Hohmann 70
 - orbit, 64, 71
- transformation, three-dimensional, 25
- transplanetary s/c voyage, 17
- true anomaly, 18
- two-body problem, 10
- unbalanced torque, 232
- unified propulsion system, 384
- universal constant of gravity, 9
- variable stars, 365
- variance in earth radiation, 336

Cambridge University Press

978-0-521-78780-2 - Spacecraft Dynamics and Control: A Practical Engineering Approach

Marcel J. Sidi

Index

[More information](#)*Index*

409

variation of parameters, 34

Vega, 357

velocity

angular, 59

circular, 51

radial, 31

relative, 59

vector, 8, 30

velocity change, 64, 78

velocity increment, 52

velocity loss, 64, 133

vernal equinox, 23

vibrating mass model, 302

viscosity damping coefficient, 163

visual magnitude, 363

wheel damper, 123

wheel momentum dumping, 250

wheel momentum management, 396

windmill torque, 231

work and energy, 9

yaw error, 217

yaw measurement, 215

zero-bias momentum system, 190