

Index

- Abs, 98
- Absolute address variable, 83
- Acceleration sensor, 20
- Accelerometer, 2
- Actuator, 6
- AD590, 16
- AD7302, 270
- ADCON0, 73, 114
- ADCON1, 73, 114
- Adder, 244
- ADFM, 74
- ADRESH, 73
- ADRESL, 73
- ADXL202, 21
- Air flow sensor, 23
- Analog comparator, 5
- Analog temperature sensor, 16
- Analog to digital converter, 2, 72–75
- AND, logical, 86
- Anemometer, 23
- Arithmetic logic unit, 7
- Array of Jury's stability test, 189
- Arrays, 84, 85
 - multiple dimension, 85
- Asm, 103
- Assembly language, 9
- Attenuation property, 143
- Auxiliary storage, 8

- Back emf, 42
- Backslash character, 86
- Ballast coding, 12
- BASIC, 9, 77
- Bank0, 67
- Bank1, 67
- Bidirectional bus, 7

- Bidirectional I/O, 71
- Binary number, 89
- Bit, 78
- Block diagrams, 153
- Bode diagram, 205
- Break statement, 96
- Built-in function 98
- Buzzer, 119

- CAN bus, 57
- Capacitor, 37
- Cascade\realization, 246
- Centralized control, 5
- Characteristic equation, 187
- Choice of sampling interval, 263
- Client, 6
- Closed-loop system, 1
- Closed-loop time response, 166
- Closed-loop tuning, 237
- Coefficient sensitivity, 246
- Comments, 81
- Compensator, 1
- Configuration register, 71
- Connecting an LCD, 111
- Connecting an LED, 107
- Continue statement, 96
- Continuous time system, 2, 131
- Control,
 - centralized, 5
 - direct digital control, 11
 - distributed,
 - supervisory, 6
- Control engineer, 1
- Control unit, 7
- Controller, 1
- Controller algorithm, 10

308 INDEX

- Controller realization, 243
 - cascade, 246
 - direct canonical, 243
 - direct noncanonical, 245
 - parallel, 249
 - pid, 250
- Cos, 98
- Cosine function, 139
- Current sink, 72
- Current source, 72
- Dahlin controller, 217
- Damping ratio, 178
- Dashpot, 28, 33
- Data acquisition, 6
- Data memory, 8
- D/A converter, 3
- DC motor, 42
- DCS, 6
- DDC, 11
- Dead-beat controller, 215
- Decimal number, 89
- Define, 101
- Delay, 244
- Delays, 105
- Delayus, 105
- Derivative kick, 233
- Dielectric constant, 18
- Differential equation, 27
- Digital controller, 214
 - dead-beat, 215
 - dahlin, 217
 - pole placement, 219
 - pid, 230
- Digital temperature sensor, 16
- Digital to analog converter, 3
- Direct current motor, 43
- Direct digital control, 6
- Direct structure, 243
- Direct noncanonical structure, 245
- Discrete controller design, 213
- Distinct real root, 150
- Distributed control, 5
- Disturbance, 1
- Do statement, 95
- Double, 78
- DS1620, 16
- Dynamic response, 14
- EEADR, 71
- EECON1, 71
- EECON2, 71
- EEDATA, 71
- EEPROM, 5
- EEPROM,
 - accessing, 104
- Electrical system, 37
- Electromechanical system, 42
- Encoder, 21
- Endasm, 103
- Energy stored,
 - in a capacitor, 37
 - in an inductor, 37
 - in mass, 29
 - in a spring, 28
- EPROM, 8
- Error signal, 1,4
- Exponential function, 138
- External interrupt, 10, 11, 67
- Factorizing characteristic equation, 187
- Final value theorem, 144
- Finite word length, 282
- First order module, 260
- Flash memory, 5
- Float, 78
- Flow chart, 121
- Flow meter, 22
- Flow rate sensor, 23
- Fluid system, 44
- For statement, 94
- Force sensor, 21
- Functions,
 - built-in, 98
 - user, 97
- Gain margin, 209
- Gear train, 35
- General purpose computer, 7, 8
- General purpose register, 7, 67
- Hard disk, 8
- Hardware requirements, 119
- HD44780, 111
- Heat flow, 49
- Hexadecimal number, 89
- High level language, 9
- Hydraulic capacitance, 45
- Hydraulic inertance, 45
- Hydraulic resistance, 44
- Hydraulic system, 44
- Hysteresis effect, 20
- Ideal sampling, 131–133
- If-else, 91
- Include, 103
- Inductor, 37
- Induced voltage, 19
- Inertance, 44
- Initial value theorem, 143
- Inertia of load, 43

- Input port, 9
- Input section, 255
- INTCON, 68
- Integral wind-up, 233
- Internal clock, 65
- Interrupt, 104
- Interrupt service routine, 11, 104
- Inverse z-transform, 141
- Inversion formula, 152
- Isalnum, 98
- Isupper, 98
- Iteration, 123

- Jury's test, 187, 189

- Kirchoff's law
 - current law, 38
 - voltage law, 38

- LAN, 6
- LCD, 11, 12, 57, 113
- Left shifting property, 143
- Level sensor, 269
- Linearity, 14
- Liquid level system, 46
- Liquid sensor, 22
- LM35DZ, 16, 113
- LM675, 270
- LM7805, 61
- Logical AND, 86
- Logical NOT, 86
- Logical OR, 86
- Long, 78
- LVDT, 18

- Magnetic tape, 8
- Mass, 28–32
- Mathematical model, 27
- MATLAB,
 - bode diagram, 292
 - impulse response, 292, 300
 - inverse z-transform, 303
 - matrices, 286
 - nichols diagram, 294
 - nyquist diagram, 292, 302
 - polynomials, 289
 - root locus, 294, 300
 - step response, 291, 300
 - transfer function, 291
 - vectors, 286
 - z-transform, 302
 - zeroes and poles, 294
- Matrices, 286
- MCLR, 61, 67
- Mechanical stress, 17

- Mechanical system,
 - rotational, 32
 - translational, 28
- Microcontroller, 8, 9
- Microcontroller implementation, 253
- Microcontroller programmer, 119
- Microcontroller project development, 119
- MIMO, 1
- Minicomputer, 8
- Minimum PIC configuration, 61
- Moment of inertia, 33
- Moving magnet, 20
- Multiple order root, 151
- Multiplier, 244

- Newline character, 86
- Null character, 86
- Number base, 89
- Nyquist criterion, 201

- Octal number, 89
- Open-loop system, 1, 154
- Open-loop time response, 156
- Open-loop tuning, 234
- OPTION_REG, 68
- OR, logical, 86
- Oscillator,
 - clock, 61
 - external, 63
 - high-speed crystal, 63
 - internal, 65
 - low-power crystal, 61
 - low-speed crystal, 61
 - resistor-capacitor, 63
 - resonator, 63
- Output port, 9
- Output section, 255
- Overshoot, 174

- Paddlewheel sensor, 22
- Parallel realization, 249
- Partial fractions method, 148
- PASCAL, 8, 77
- Peak time, 174
- Persistent variables, 83
- Phase margin, 209
- PI controller, 236
- PIC16F84, 66–71
- PIC16F627, 77
- PIC16F629, 77
- PIC16F877, 66
- PICC Lite, 77, 82, 86, 90
- PID controller, 230, 236
- PID tuning, 234
- Plant, 1
- Pointers, 99–101

310 INDEX

- Pole placement, 219
- Polling, 10, 11
- Polynomials, 289
- PORTA, 70
- PORTB, 70
- Position sensor, 17
 - LVDT, 18
 - potentiometer, 17
 - rotary potentiometer, 18
- Potentiometer, 17
- Power amplifier, 270
- Power-on reset, 57
- Power series method, 145
- Power supply, 61
- Pre-processor command
 - asm, 103
 - define, 101
 - endasm, 103
 - include, 103
- Pre-scaler, 57
- Pressure sensor, 21
- Program development tools, 120
- Properties of z-transforms,
 - attenuation, 143
 - final value, 144
 - initial value, 143
 - linearity, 143
 - left-shifting, 143
 - right-shifting
- Proportional controller, 235
- Pseudocode, 123
- Pulse train, 131
- Pulse transfer function, 153
- Push-button switch, 109
- PWM, 57, 72

- Quantization error, 282

- RAM, 5, 82
- Range, 14
- Real time clock, 13
- Register file map, 67
- Repeatability, 14
- Reset circuit, 61, 62
- Resistor, 37
- Resolution, 14
- Resonator, 63
- Right shifting property, 143
- RISC, 57
- Rise time, 174
- ROM, 5
- Root locus, 194
- Rotary damper, 33
- Rotary potentiometer, 18
- Rotational mechanical system, 32
- Rotational spring, 33

- Routh-Hurwitz criterion, 187, 192
- RTD, 15

- Sampled data system, 131
- Sampler, 131
- Sampling process, 131
- Sampling period, 134, 263
- Saturation wind-up, 233
- SCADA, 6
- Second order module, 254
- Second order system, 174
- Selection, 121
- Sensor,
 - acceleration, 20
 - air flow rate, 23
 - analog, 14
 - digital, 14
 - electrical noise, 17
 - force, 21
 - liquid, 22
 - LVDT, 18
 - paddlewheel, 22
 - position, 17
 - pressure, 21
 - RTD, 15
 - self heating, 16
 - temperature, 15
 - thermal coupling, 17
 - thermocouple, 15
 - time constant, 17
 - velocity, 20
- Server, 6
- Set-point, 3
- Settling time, 174
- Sequence, 121
- Shift left, 86
- Shift right, 86
- Signed char, 78
- Signed int, 78
- Sine function, 139
- Single chip computer, 5
- Single quote character, 86
- SISO, 1
- Software requirements, 119
- Special function register, 67
- Speed control system, 4
- Spring, 28, 33
- Sqrt, 98
- Stability test,
 - Bode diagram, 205
 - Jury's test, 189
 - Nyquist diagram, 201
 - root locus, 194
- Static variables, 82
- Steady state error, 174
- Stiffness constant, 28

- Stirred tank, 51
- Strain gage, 21
- Strien, 99
- Structure, 89, 90
- Structure chart, 121
- Supervisory control, 6
- System model,
 - electrical, 37
 - electromechanical, 42
 - fluid, 44
 - hydraulic, 44
 - mechanical, 28, 32
 - thermal, 49
- System stability, 187
- Switch-case, 92

- Tab character, 86
- Tachogenerator, 2,4
- Tachometer, 20
- Temperature measurement, 15–17
- Temperature sensor,
 - integrated circuit, 15
 - RTD, 15
 - thermistor, 15
 - thermocouple, 15
- Thermal capacitance, 49
- Thermal resistance, 49
- Thermal system, 49, 50
- Thermistor, 2
- Thermocouple, 15
- Three tank system, 54
- Tick rate, 13
- Ticks per second, 13
- Time constant, 266
- Time response comparison, 171
- Timer interrupt, 10, 12
- TMR0, 70
- Torsional spring, 33
- Torque, 36
- Translational mechanical system, 28
- TRISA, 70
- TRISB, 70
- Two tank system, 47

- Ultrasonic level measurement, 22
- Undamped natural frequency, 179, 181
- Unit circle, 187, 197

- Unit ramp function, 137
- Unit step function, 137
- Unsigned char, 78
- Unsigned int, 78
- Unsigned long, 78
- Update section, 255
- USART, 5
- User function, 97

- Variables,
 - absolute address, 83
 - bit, 78
 - double, 80
 - float, 80
 - long, 79
 - persistent, 83
 - signed char, 79
 - signed int, 79
 - static, 82
 - storing in program memory, 82
 - unsigned char, 78
 - unsigned int, 79
 - unsigned long, 79
 - volatile, 83
- Vector, 286
- Velocity sensor, 20
- Visual basic, 7
- Visual C++, 7
- Volatile variables, 83

- WAN, 6
- Watchdog timer, 57
- Water pump, 269
- While statement, 95
- Wireless LAN, 6

- z-domain, 171
- z-transform, 136
 - of cosine function, 139
 - of exponential function, 138
 - of unit ramp function, 137
 - of sine function, 139
 - of unit step function, 137
 - tables of, 140
- Zero-order-hold, 134, 135, 158
- Ziegler-Nichols, 234

