APPENDIX A

Symbols, Dimensions, and Units

Base dimensions and their SI unit symbols

$$M = \text{mass (kg)},\ L = \text{length (m)},\ T = \text{time (s)},\ Q = \text{charge (C)},$$
$$\tau = \text{temperature (K or } ^\circ\text{C)}$$

TABLE A.1 Electromagnetics

Parameter and its Symbol	Dimensions	Unit Name	Unit Symbol
Charge Q	Q	coulombs	C
Electric field intensity **E**	$MLT^{-2}Q^{-1}$	volts/m	V/m
Electric flux density **D**	QL^{-2}	coulombs/m^2	C/m^2
Electric scalar potential ϕ_v	$ML^2T^{-2}Q^{-1}$	volts	V
Current I	QT^{-1}	amperes	A
Current density **J**	$QL^{-2}T^{-1}$	amperes/m^2	A/m^2
Conductivity σ	$M^{-1}L^{-2}TQ^2$	siemens/m	S/m
Resistance R	$ML^2T^{-1}Q^{-2}$	ohms	Ω
Permittivity ε	$M^{-1}L^{-3}T^2Q^{-2}$	farads/m	F/m
Capacitance C	$M^{-1}L^{-2}T^2Q^{-2}$	farads	F
Magnetic field intensity **H**	$L^{-1}T^{-1}Q$	amperes/m	A/m
Magnetic flux density **B**	$MT^{-1}Q^{-1}$	webers/m^2 = teslas	Wb/m^2 = T
Magnetic vector potential **A**	$MLT^{-1}Q^{-1}$	webers/m	Wb/m
Magnetization **M**	$L^{-1}T^{-1}Q$	amperes/m	A/m
Permeability μ	MLQ^{-2}	henrys/m	H/m
Inductance L	ML^2Q^{-2}	henrys	H
Flux ϕ	$ML^2T^{-1}Q^{-1}$	webers	Wb
Reluctance $\mathfrak{R}$	$M^{-1}L^{-2}Q^2$	amperes/weber	A/Wb

Magnetic Actuators and Sensors, Second Edition. John R. Brauer.

TABLE A.2 Mechanics

Parameter and its Symbol	Dimensions	Unit Name	Unit Symbol
Mass M	M	kilograms	kg
Length l	L	meters	m
Time t	T	seconds	s
Velocity $\mathbf{V}$	LT^{-1}	meters/second	m/s
Force $\mathbf{F}$	MLT^{-2}	newtons	N
Pressure p	$ML^{-1}T^{-2}$	newtons/m^2 = pascals	N/m^2 = Pa
Density ρ	ML^{-3}	kilogram/m^3	kg/m^3
Energy or work W	ML^2T^{-2}	newton meters = joules	N m = J
Power P	ML^2T^{-3}	watts	W
Stiffness K	MT^{-2}	kilogram/second^2	kg/s^2
Damping B	MT^{-1}	kilogram/second	kg/s
Modulus of elasticity E	$ML^{-1}T^{-2}$	newtons/m^2 = pascals	N/m^2 = Pa

TABLE A.3 Hydraulics

Parameter and its Symbol	Dimensions	Unit Name	Unit Symbol
Pressure p	$ML^{-1}T^{-2}$	newtons/m^2 = pascals = 1.E–5 bar	N/m^2 = Pa = 1.E–5 bar
Flow rate Q	L^3T^{-1}	m^3/s = 1000 liters/s	m^3/s = 1000 L/s
Laminar orifice resistance R	$M^{-2}L^{-1}T^{-1}$	pascal s/m^3	Pa s/m^3
Turbulent orifice coefficient K	$M^{-2}L^9T^3$	m^7/(N^{2}s)	m^7/(N^{2}s)
Hydraulic capacitance C	$M^{-1}L^4T^2$	m^3/pascal	m^3/Pa

TABLE A.4 Heat

Parameter and its Symbol	Dimensions	Unit Name	Unit Symbol
Temperature T	τ	kelvin = 273 + degree celsius	K = 273 + °C
Quantity of heat energy W	ML^2T^{-2}	newton meters = joules	N m = J
Heat flow or heat flux Q	ML^2T^{-3}	watts	W
Heat flux density q	MT^{-3}	watts/m^2	W/m^2
Thermal conductivity k	$MLT^{-3}\tau^{-1}$	watts/(m °C)	W/(m °C)
Film coefficient h	$MT^{-3}\tau^{-1}$	watts/(°C m^2)	W/(°C m^2)