

Introduction to Electronic Circuit for Instrumentation

- Fundamental quantities
 - Length
 - Mass
 - Time
 - Charge and electric current
 - Heat and temperature
 - Light and luminous intensity
 - Matter (atom, ion and molecule)

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Table 1.3 Standard prefixes

Prefix	Symbol	Power
atto	a	10^{-18}
femto	f	10^{-15}
pico	p	10^{-12}
nano	n	10^{-9}
micro	μ	10^{-6}
milli	m	10^{-3}
centi	c	10^{-2}
deci	d	10^{-1}
deka	da	10
kilo	k	10^3
mega	M	10^6
giga	G	10^9
tera	T	10^{12}

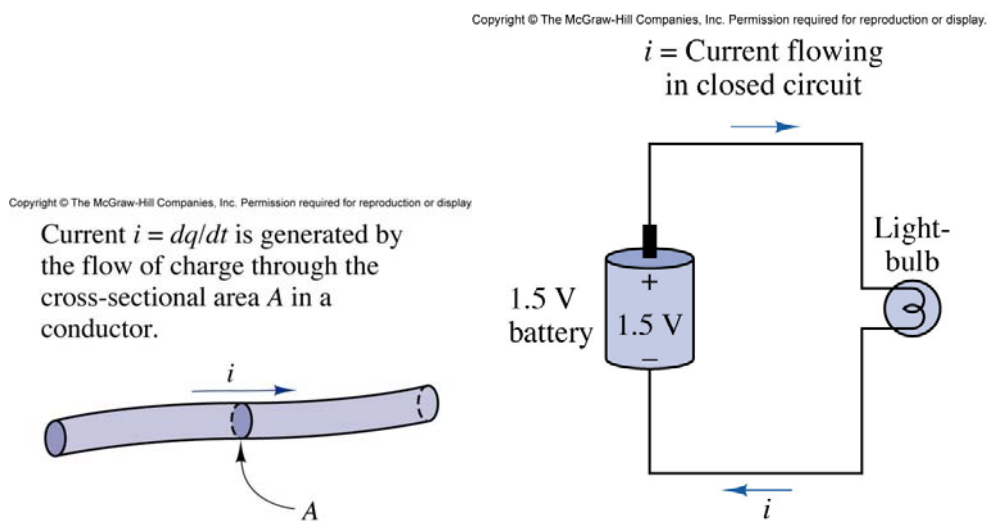
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Table 1.2 SI units

Quantity	Unit	Symbol
Length	Meter	m
Mass	Kilogram	kg
Time	Second	s
Electric current	Ampere	A
Temperature	Kelvin	K
Luminous intensity	Candela	cd

- Fields of study in science
 - Mathematics
 - Physics (mechanics and electromagnetics)
 - Chemistry
 - Biology
- How about engineering?
- Materials

- Electrical properties
 - Conductor
 - Semiconductor
 - Insulator and dielectrics
 - Magnetic properties
 - Diamagnetism
 - Paramagnetism
 - Ferromagnetism
 - Ferrimagnetism
 - Antiferromagnetism
 - Electrolyte
 - Gas
 - Cell and biological tissue
- Basics of electromagnetism
 - Space and time
 - Charge, mass, force and field
 - Work and potential
 - Voltage, current, power and energy
 - Voltage reference (signal ground, chassis ground and earth ground)
 - Statics and dynamics
 - Maxwell's equations



- How to sense or perceive?

- Human (sensor, sensory nerve and central nervous system)
 - See
 - Hear
 - Touch
 - Smell
 - Taste
 - Machine
-
- How to actuate or affect?
 - Human (central nervous system, motor nerve and muscle)
 - Machine
-
- Basic tools of machine sensation (signal, noise, interference and information)
 - Function of time, DC and AC
 - Signal waveform
 - Unit step
 - Pulse
 - Sinusoid
 - Exponential
 - Voltage signal with respect to signal ground
 - Grounded signal and isolated (or floating) signal
 - Unipolar signal and bipolar signal
 - Single-ended signal and differential signal
 - Differential-mode signal and common-mode signal
 - Balanced signal and unbalanced signal
 - Signal amplitude (peak, peak-to-peak, average and rms), period and frequency
 - Fourier series and transform
 - Random noise (probability, PDF, mean, standard deviation and variance)
 - Signal-to-noise ratio (SNR)
 - Numbers
 - Natural number and 0
 - Integer
 - Rational number
 - Irrational number
 - Real number
 - Imaginary number

- Complex number
- Analog and digital
 - Decimal and binary number
 - Sampling
 - Quantization
 - ADC and DAC
- Basics of instrumentation (machine sensation or perception)
 - General structure of instrumentation
 - Measurand
 - Sensor or transducer
 - Signal conditioning and processing (analog and digital)
 - Output
 - System model
 - Input and output
 - Gain or transfer function
 - Linearity and nonlinearity
 - Transient response and steady-state response
 - Time-domain representation and frequency-domain representation
 - Analysis
 - DC analysis
 - Transient analysis
 - Sinusoidal analysis or AC analysis
 - Frequency response
 - Design or problem solving
 - Problem statement
 - Identification of goal
 - Information collection (literature survey and summary)
 - Idea generation and planning
 - Details of solution (equation, implementation, experiment, and so on)
 - Validation
- Electric circuit
 - Source
 - Voltage source
 - Current source

- Dependent source
- Passive two-terminal electric component
 - Resistor
 - Capacitor
 - Inductor
- Load
 - Light bulb and LED
 - Speaker
 - Heater
 - Motor
 - ADC and digital devices
- Electronic circuit
 - Semiconductor device
 - Diode
 - Transistor
 - Operational amplifier
 - Switch and multiplexer
 - Analog ICs for nonlinear functions
 - Amplifier
 - Active filter
 - Nonlinear analog signal processing
 - Signal generation
 - ADC and DAC
- Digital circuit
 - Gate
 - Counter and register
 - Memory
 - PLD
 - Microprocessor
 - ADC and DAC
- Digital signal processing
 - Microprocessor or computer
 - Programming language

- Firmware, embedded software and software
- DSP implementation using C language function

- Examples of bioinstrumentation
 - Thermometer
 - Electrocardiogram (ECG)
 - Noninvasive blood pressure