

Introduction to Analog Electronics

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Course?level overview – suitable for beginners and as a refresher

1. What Is Analog Electronics?

Aspect	Description
Definition	Deals with continuous?time signals that can take any value within a range (voltage, current, charge, etc.).
Contrast with Digital	Digital electronics uses discrete levels (0/1, high/low). Analog signals vary smoothly and often represent real?world phenomena (sound, temperature, light intensity).
Typical Applications	Audio amplifiers, sensor front?ends, power supplies, radio frequency (RF) circuits, instrumentation, motor control, mixed?signal ICs.

2. Fundamental Concepts

Concept	Key Points	Typical Symbol
Signal	Continuous function of time, e.g., $v(t)$ or $i(t)$.	–
Amplitude	Height of the signal (peak, RMS, peak?to?peak).	V_p , V_{rms}
Frequency	Number of cycles per second (Hz).	f
Phase	Relative timing between two signals (degrees or radians).	?
Impedance (Z)	Opposition to AC current; combines resistance (R) and reactance (X).	$Z = R + jX$
Gain	Ratio of output to input (voltage, current, power). Expressed as linear factor or dB.	$A_v = V_{out}/V_{in}$
Bandwidth	Frequency range over which the circuit meets a specified performance (e.g., gain within -3?dB).	–
Noise	Unwanted random variations; characterized by spectral density, SNR, ENOB, etc.	–

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3. Basic Passive Components

Component	Symbol	Primary Function	Typical Equation
Resistor	R	Limits current, creates voltage drops, sets bias points.	$V = I \cdot R$
Capacitor	C	Stores electric field energy, blocks DC, passes AC.	$I = C \cdot dV/dt$; $X_C = 1/(2\pi fC)$
Inductor	L	Stores magnetic field energy, opposes changes in current.	$V = L \cdot dI/dt$; $X_L = 2\pi fL$
Transformer	–	Couples magnetic flux between windings, provides impedance transformation and isolation.	$V_1/V_2 = N_1/N_2$

Tip: In AC analysis, replace each component with its **impedance** (R, jX) and use Kirchhoff's laws as you would for DC circuits.

4. Semiconductor Devices

Device	Symbol	Operating Regions	Typical Use in Analog Circuits
Diode	D	Forward, reverse (breakdown)	Rectification, clipping, voltage reference
BJT (Bipolar Junction Transistor)	Q	Cut-off, active, saturation	Small-signal amplification, switching
MOSFET (Metal-Oxide-Semiconductor FET)	M	Cut-off, triode, saturation	Voltage-controlled resistor, amplifier, switch
JFET	J	Cut	