**Lec.1. Introduction. Stages of electronics development. Terminology. Signals, their classification, parameters, the discrete and continuous spectrum of signals. Fourier Transform and Laplace transform.**

***Introduction***

Electronics deals with [electrical circuits](http://en.wikipedia.org/wiki/Electrical_circuit" \o "Electrical circuit) that involve [active electrical components](http://en.wikipedia.org/wiki/Active_component) such as [vacuum tubes](http://en.wikipedia.org/wiki/Vacuum_tube" \o "Vacuum tube), [transistors](http://en.wikipedia.org/wiki/Transistor" \o "Transistor), [diodes](http://en.wikipedia.org/wiki/Diode" \o "Diode) and[integrated circuits](http://en.wikipedia.org/wiki/Integrated_circuit), and associated passive electrical components and interconnection technologies. Commonly, electronic devices contain circuitry consisting primarily or exclusively of active semiconductors supplemented with passive elements; such a circuit is described as an [electronic circuit](http://en.wikipedia.org/wiki/Electronic_circuit).

The [nonlinear](http://en.wikipedia.org/wiki/Nonlinear) behaviour of active components and their ability to control electron flows makes amplification of weak signals possible, and electronics is widely used in [information processing](http://en.wikipedia.org/wiki/Information_processing), [telecommunication](http://en.wikipedia.org/wiki/Telecommunication), and [signal processing](http://en.wikipedia.org/wiki/Signal_processing). The ability of electronic devices to act as [switches](http://en.wikipedia.org/wiki/Switch) makes digital information processing possible. Interconnection technologies such as [circuit boards](http://en.wikipedia.org/wiki/Circuit_board), electronics packaging technology, and other varied forms of communication infrastructure complete circuit functionality and transform the mixed components into a regular working [system](http://en.wikipedia.org/wiki/System" \o "System).

Electronics is distinct from [electrical](http://en.wikipedia.org/wiki/Electricity" \o "Electricity) and [electro-mechanical](http://en.wikipedia.org/wiki/Electro-mechanical" \o "Electro-mechanical) science and technology, which deal with the generation, distribution, switching, storage, and conversion of electrical energy to and from other energy forms using [wires](http://en.wikipedia.org/wiki/Wire), [motors](http://en.wikipedia.org/wiki/Electric_motor), [generators](http://en.wikipedia.org/wiki/Electric_generator), [batteries](http://en.wikipedia.org/wiki/Battery_(electricity)),[switches](http://en.wikipedia.org/wiki/Switch), [relays](http://en.wikipedia.org/wiki/Relay), [transformers](http://en.wikipedia.org/wiki/Transformer), [resistors](http://en.wikipedia.org/wiki/Resistor), and other [passive components](http://en.wikipedia.org/wiki/Passive_component" \o "Passive component). This distinction started around 1906 with the invention by [Lee De Forest](http://en.wikipedia.org/wiki/Lee_De_Forest" \o "Lee De Forest) of the [triode](http://en.wikipedia.org/wiki/Triode" \o "Triode), which made electrical [amplification](http://en.wikipedia.org/wiki/Amplifier) of weak radio signals and audio signals possible with a non-mechanical device. Until 1950 this field was called "radio technology" because its principal application was the design and theory of radio [transmitters](http://en.wikipedia.org/wiki/Transmitter" \o "Transmitter), [receivers](http://en.wikipedia.org/wiki/Receiver_(radio)" \o "Receiver (radio)), and [vacuum tubes](http://en.wikipedia.org/wiki/Vacuum_tube" \o "Vacuum tube).

Today, most electronic devices use [semiconductor](http://en.wikipedia.org/wiki/Semiconductor" \o "Semiconductor) components to perform electron control. The study of semiconductor devices and related technology is considered a branch of[solid-state physics](http://en.wikipedia.org/wiki/Solid-state_physics), whereas the design and construction of [electronic circuits](http://en.wikipedia.org/wiki/Electronic_circuit) to solve practical problems come under [electronics engineering](http://en.wikipedia.org/wiki/Electronics_engineering). This article focuses on [engineering](http://en.wikipedia.org/wiki/Engineering)aspects of electronics.

***Stages of electronics development***

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| --- | --- | --- |
| **Date** | **Invention/Discovery** | **Inventor(s)** |
| 1745 | [Capacitor](http://en.wikipedia.org/wiki/Capacitor) | Leyden |
| 1780 | [Galvanic action](http://en.wikipedia.org/wiki/Galvanic_cell) | Galvani |
| 1820 | [Electromagnetism](http://en.wikipedia.org/wiki/Electromagnetism) | Oersted |
| 1826 | [Ohm's law](http://en.wikipedia.org/wiki/Ohm%27s_law) | Ohm |
| 1831 | [Transformer](http://en.wikipedia.org/wiki/Transformer) | Faraday |
| 1831 | [Electromagnetic induction](http://en.wikipedia.org/wiki/Electromagnetic_induction) | Faraday |
| 1832 | Self-induction | Henry |
| 1834 | [Electrolysis](http://en.wikipedia.org/wiki/Electrolysis) | Faraday |
| 1839 | [Photovoltaic effect](http://en.wikipedia.org/wiki/Photovoltaic_effect) | Becquerel |
| 1845 | [Kirchhoff's circuit laws](http://en.wikipedia.org/wiki/Kirchhoff%27s_circuit_laws) | Kirchhoff |
| 1850 | [Thermistor](http://en.wikipedia.org/wiki/Thermistor) | Faraday |
| 1860 | [Microphone diaphragm](http://en.wikipedia.org/wiki/Microphone) | Reis |
| 1888 | [Induction motor](http://en.wikipedia.org/wiki/Induction_motor) | Ferraris and Tesla |
| 1895 | [X-rays](http://en.wikipedia.org/wiki/X-ray) | Roentgen |
| 1896 | [Wireless telegraphy](http://en.wikipedia.org/wiki/Wireless_telegraphy) | Marconi |
| 1908 | [Television](http://en.wikipedia.org/wiki/Television) | Campell, Swinton |
| 1911 | [Superconductivity](http://en.wikipedia.org/wiki/Superconductivity) | Onnes |
| 1930 | Patent of traffic signal timing system | Thomas Watson awarded patent |
| 1934 | [Liquid crystals](http://en.wikipedia.org/wiki/Liquid_crystal) | Dreyer |
| 1935 | [Transistor field effect](http://en.wikipedia.org/wiki/Field-effect_transistor) | Hieil |
| 1935 | [Scanning electron microscope](http://en.wikipedia.org/wiki/Scanning_electron_microscope) | Knoll |
| 1937 | [Xerography](http://en.wikipedia.org/wiki/Xerography) | Carlson |
| 1937 | [Oscillograph](http://en.wikipedia.org/wiki/Oscillograph) | Van Ardenne, Dowling, and Bullen |
| 1939 | Early [digital computer](http://en.wikipedia.org/wiki/Digital_computer) | Aitken and IBM |
| 1943 | First general-purpose computer ([ENIAC](http://en.wikipedia.org/wiki/ENIAC)) | Mauchly and Eckert |
| 1945 | First commercially successful computer ([UNIVAC I](http://en.wikipedia.org/wiki/UNIVAC_I)) | N/A |
| 1948 | [Bipolar transistor](http://en.wikipedia.org/wiki/Bipolar_transistor) | Bardeen, Bratlain, and Shockley |
| 1948 | [Holography](http://en.wikipedia.org/wiki/Holography) | Gabor and Shockley |
| 1954 | Solar battery | Chapin, Fuller, and Pearson |
| 1957 | [Sputnik I satellite](http://en.wikipedia.org/wiki/Sputnik_1) | U.S.S.R. |
| 1957 | [FORTRAN programming language](http://en.wikipedia.org/wiki/Fortran) | Watson Scientific |
| 1958 | [Video tape recorder](http://en.wikipedia.org/wiki/Video_tape_recorder) | U.S.A. |
| 1958 | [Laser](http://en.wikipedia.org/wiki/Laser) | Schalow and Townes |
| 1959 | First one-piece plain paper [photocopier](http://en.wikipedia.org/wiki/Photocopier) ([Xerox 914](http://en.wikipedia.org/wiki/Xerox_914)) | [Xerox](http://en.wikipedia.org/wiki/Xerox) |
| 1960 | [Light-emitting diode](http://en.wikipedia.org/wiki/Light-emitting_diode) | Allen and Gibbons |
| 1962 | [MOSFET](http://en.wikipedia.org/wiki/MOSFET) transistors | Hofstein, Heiman, and RCA |
| 1963 | First commercially successful [audio compact cassette](http://en.wikipedia.org/wiki/Compact_cassette) | [Philips](http://en.wikipedia.org/wiki/Philips) Corporation |
| 1964 | [BASIC programming language](http://en.wikipedia.org/wiki/BASIC_programming_language) | Kemeny and Kurtz |
| 1966 | [Optical fiber communications](http://en.wikipedia.org/wiki/Optical_fiber_communications) | Kao and Hockham |
| late 1960s | First [digital fax machine](http://en.wikipedia.org/wiki/Fax#Digital) | [Dacom](http://en.wikipedia.org/wiki/Dacom) |
| 1970 | [Floppy disk](http://en.wikipedia.org/wiki/Floppy_disk) recorder | IBM |
| 1970 | First [microprocessor](http://en.wikipedia.org/wiki/Microprocessor" \o "Microprocessor) (4004, 60,000 oper/s) | Intel |
| 1971 | [PASCAL programming language](http://en.wikipedia.org/wiki/Pascal_(programming_language)) | Wirth |
| 1971 | First [microcomputer](http://en.wikipedia.org/wiki/Microcomputer)-on-a-chip | [Texas Instruments](http://en.wikipedia.org/wiki/Texas_Instruments) |
| 1972 | [8008 processor](http://en.wikipedia.org/wiki/Intel_8008) (200 kHz, 16 kB) | [Intel](http://en.wikipedia.org/wiki/Intel) |
| 1973 | [Mobile phone](http://en.wikipedia.org/wiki/Mobile_phone) | John F. Mitchell and Dr. Martin Cooper of [Motorola](http://en.wikipedia.org/wiki/Motorola) |
| 1974 | [C (programming language)](http://en.wikipedia.org/wiki/C_(programming_language)) | Kernighan, Ritchie |
| 1975 | [Liquid-crystal display](http://en.wikipedia.org/wiki/Liquid-crystal_display) | United Kingdom |
| 1975 | First personal computer ([Altair 8800](http://en.wikipedia.org/wiki/Altair_8800" \o "Altair 8800)) | Roberts |
| 1975 | [Digital camera](http://en.wikipedia.org/wiki/Digital_camera) | [Steven Sasson](http://en.wikipedia.org/wiki/Steven_Sasson) of [Eastman Kodak](http://en.wikipedia.org/wiki/Eastman_Kodak) |
| 1975 | [Microsoft](http://en.wikipedia.org/wiki/Microsoft) founded | Gates and Allen |
| 1976 | [Apple I computer](http://en.wikipedia.org/wiki/Apple_1) | Wozniak, Jobs |
| 1977 | Launch of the "[1977 trinity computers](http://en.wikipedia.org/wiki/History_of_personal_computers#1977_and_the_emergence_of_the_.22Trinity.22)" expanding [home computing](http://en.wikipedia.org/wiki/Home_computer), the [Apple II](http://en.wikipedia.org/wiki/Apple_II), [Commodore PET](http://en.wikipedia.org/wiki/Commodore_PET) and the [TRS-80](http://en.wikipedia.org/wiki/TRS-80) | Apple, Tandy Corporation, Commodore Business Machines |
| 1977 | First [handheld electronic game](http://en.wikipedia.org/wiki/Handheld_game_console) ([Auto Race](http://en.wikipedia.org/wiki/Mattel_Auto_Race)) | [Mattel](http://en.wikipedia.org/wiki/Mattel) |
| 1981 | [IBM Personal Computer](http://en.wikipedia.org/wiki/IBM_Personal_Computer) (8088 processor) | [IBM](http://en.wikipedia.org/wiki/IBM) |
| 1982 | [Laser printer](http://en.wikipedia.org/wiki/Laser_printer) | [IBM](http://en.wikipedia.org/wiki/IBM) |
| 1983 | [Satellite television](http://en.wikipedia.org/wiki/Satellite_television) | U.S. Satellite Communications, Inc. |
| 1983 | [C++](http://en.wikipedia.org/wiki/C%2B%2B) (programming language) | Stroostrup |
| 1984 | [Macintosh](http://en.wikipedia.org/wiki/Macintosh) computer (introduced) | Apple Computer |
| 1984 | [CD-ROM](http://en.wikipedia.org/wiki/CD-ROM) player for personal computers | Philips |
| 1989 | [Sega Genesis (console)](http://en.wikipedia.org/wiki/Sega_Genesis) | [Sega](http://en.wikipedia.org/wiki/Sega) |
| 1989 | First commercial handheld [GPS receiver](http://en.wikipedia.org/wiki/GPS_navigation_device) (Magellan NAV 1000) | [Magellan Navigation Inc.](http://en.wikipedia.org/wiki/Magellan_Navigation) |
| 1989 | [Silicon-germanium](http://en.wikipedia.org/wiki/Silicon-germanium) transistors | IBM fellow Bernie Meyerson |
| 1990 | 486 microprocessor (33MHz) | [Intel](http://en.wikipedia.org/wiki/Intel) |
| 1994 | [Pentium processor](http://en.wikipedia.org/wiki/Pentium_processor) (60/90 MHz, 166.2 mips) | Intel |
| 1994 | [Bluetooth](http://en.wikipedia.org/wiki/Bluetooth) | [Ericsson](http://en.wikipedia.org/wiki/Ericsson) |
| 1994 | First [DVD player](http://en.wikipedia.org/wiki/DVD_player) ever made | Tatung Company |
| 1995 | [PlayStation (console)](http://en.wikipedia.org/wiki/PlayStation) | [Sony Computer Entertainment](http://en.wikipedia.org/wiki/Sony_Computer_Entertainment) |
| 1996 | [Alpha 21164](http://en.wikipedia.org/wiki/Alpha_21164) processor (550 MHz) | Digital Equipment |
| 2001 | [Xbox (console)](http://en.wikipedia.org/wiki/Xbox) | [Microsoft](http://en.wikipedia.org/wiki/Microsoft) |
| 2001 | [iPod](http://en.wikipedia.org/wiki/IPod) | [Apple Inc.](http://en.wikipedia.org/wiki/Apple_Inc.) |
| 2007 | [iPhone](http://en.wikipedia.org/wiki/IPhone) | [Apple Inc.](http://en.wikipedia.org/wiki/Apple_Inc.) |
| 2011 | [IBM Watson](http://en.wikipedia.org/wiki/IBM_Watson) defeated two of Jeopardy's greatest champions | [IBM](http://en.wikipedia.org/wiki/IBM) |
| 2011 | [Wifi (console)](http://en.wikipedia.org/wiki/Wii) | [Nintendo](http://en.wikipedia.org/wiki/Nintendo) |

***Signals, their classification, parameters, the discrete and continuous spectrum of signals***

*Signal processing* - A typical role for signals is in signal processing. A common example is signal transmission between different locations. The embodiment of a signal in electrical form is made by a transducer that converts the signal from its original form to a waveform expressed as a current (I) or a voltage (V), or an electromagnetic waveform, for example, an optical signal or radio transmission. Once expressed as an electronic signal, the signal is available for further processing by electrical devices such as electronic amplifiers and electronic filters, and can be transmitted to a remote location by electronic transmitters and received using electronic receivers.

*Some definitions* - Definitions specific to subfields are common. For example, in information theory, a signal is a codified message, that is, the sequence of states in a communication channel that encodes a message.

In the context of signal processing, arbitrary binary data streams are not considered as signals, but only analog and digital signals that are representations of analog physical quantities.

In a communication system, a transmitter encodes a message into a signal, which is carried to a receiver by the communications channel. For example, the words "Mary had a little lamb" might be the message spoken into a telephone. The telephone transmitter converts the sounds into an electrical voltage signal. The signal is transmitted to the receiving telephone by wires; and at the receiver it is reconverted into sounds.

In telephone networks, signalling, for example common-channel signaling, refers to phone number and other digital control information rather than the actual voice signal.

Signals can be categorized in various ways. The most common distinction is between discrete and continuous spaces that the functions are defined over, for example discrete and continuous time domains. Discrete-time signals are often referred to as time series in other fields. Continuous-time signals are often referred to as continuous signals even when the signal functions are not continuous; an example is a square-wave signal.

A second important distinction is between discrete-valued and continuous-valued. Digital signals are sometimes defined as discrete-valued sequences of quantified values, that may or may not be derived from an underlying continuous-valued physical process. In other contexts, digital signals are defined as the continuous-time waveform signals in a digital system, representing a bit-stream. In the first case, a signal that is generated by means of a digital modulation method is considered as converted to an analog signal, while it is considered as a digital signal in the second case.

*Discrete-time and continuous-time signals* - If for a signal, the quantities are defined only on a discrete set of times, we call it a discrete-time signal. A simple source for a discrete time signal is the sampling of a continuous signal, approximating the signal by a sequence of its values at particular time instants.

A discrete-time real (or complex) signal can be seen as a function from (a subset of) the set of integers (the index labeling time instants) to the set of real (or complex) numbers (the function values at those instants).

A continuous-time real (or complex) signal is any real-valued (or complex-valued) function which is defined at every time t in an interval, most commonly an infinite interval.

**Analog and digital signals -** Less formally than the theoretical distinctions mentioned above, two main types of signals encountered in practice are analog and digital. The figure shows a digital signal that results from approximating an analog signal by its values at particular time instants. Digital signals are discrete and quantized, as defined below, while analog signals possess neither property.

Discretization

One of the fundamental distinctions between different types of signals is between continuous and discrete time. In the mathematical abstraction, the domain of a continuous-time (CT) signal is the set of real numbers (or some interval thereof), whereas the domain of a discrete-time (DT) signal is the set of integers (or some interval). What these integers represent depends on the nature of the signal.

DT (discrete time) signals often arise via sampling of CT (continuous time) signals, for example, a continually fluctuating voltage on a line that can be digitized by an analog-to-digital converter circuit, wherein the circuit will read the voltage level on the line, say, every 50 microseconds. The resulting stream of numbers is stored as digital data on a discrete-time signal. Computers and other digital devices are restricted to discrete time.

Quantization

If a signal is to be represented as a sequence of numbers, it is impossible to maintain arbitrarily high precision - each number in the sequence must have a finite number of digits. As a result, the values of such a signal are restricted to belong to a finite set; in other words, it is quantized.

Fourier Transform and Laplace transform.