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# Electronics for Non-Electronic Engineers

## Course No. 104/105

**FOR WHOM INTENDED** This course is ideal for individuals whose primary formal training is not in the field of electronic engineering. Individuals with training in electronics have found course 104/105 to be an excellent refresher. Electrical controls and electronics are incorporated in almost every technical activity, and all technical personnel have to deal, at least to some extent, with some aspects of electrical engineering. A basic understanding of electronics is essential to better perform their main function.

**OBJECTIVES** To help participants to understand the concepts and terminology of electronics. It is not an in-depth electronics course but rather a course aimed at individuals who require an intensive review of basic principals, without the assumption of any prior knowledge of the topic. The course is fast paced and as non-mathematical as possible.

**BRIEF COURSE DESCRIPTION** (See [course outline](#), over.) The course covers basic concepts of electrical theory, starting with the simple DC circuit and Ohm's Law. It describes the basic components encountered in electrical circuits, such as resistors, capacitors, inductors etc. The course discusses behavior of inductors and gives examples of circuit theory, including LCR circuits and filters, also transient RL circuit analysis. Resonant circuits and their applications are covered. Sinusoidal and non-sinusoidal waveforms are discussed as they apply to electrical technology.

The basic theory of transformers and their various types: power, current, potential and transformers used in measurement systems are discussed, as are rectifier and filter circuits. Instrumentation is covered next, including measuring devices such as ohmmeters and voltmeters, before covering polyphase circuits used in power distribution.

Moving from electricity to basic electronics, we cover the theory of solid state electronics including semiconductor physics, diodes, transistors, FETs, thyristors and photo-electric devices. The course presents amplifiers, including the various applications of power amplifiers, negative feedback etc. This leads to the study of oscillators.

The course then delves into digital electronics, discussing numbering systems and binary arithmetic and then examining primitive logic functions and Boolean algebra. An introduction to digital troubleshooting is followed by presentations on state diagrams, tables and machines, and on analog-to-digital and digital-to-analog conversion. Integrated circuits are discussed, along with memory and IC applications. The course concludes by looking at hybrid circuits.

An appendix provides material for further study in related mathematics, including vectors, phasors, RMS and scientific and engineering notation. Additional material regarding Electro-Static Discharge is also provided.

**DIPLOMA PROGRAMS** This course is required for TTI's [Electronic Design Specialist \(EDS\)](#), [Electronic Telecommunications Specialist \(ETS\)](#), and [Mechanical Design Specialist \(MDS\)](#) Diploma Programs. It may be used to satisfy the 104 requirement of the [Dynamic Test Specialist \(DTS\)](#), [Instrumentation Test Specialist \(ITS\)](#) or [Metrology/Calibration Specialist \(MCS\)](#) diploma programs. It may be used as an optional course for any other TTI Specialist Diploma Program.

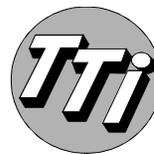
**RELATED COURSES** [Course 103](#) introduces the basics of electronics. A shorter version of Course 104/105, [Course 104-3](#) omits the material on digital electronics shown in the right-hand column, on the reverse. [Course 105, Understanding Digital Electronics](#), covers the same material on digital electronics in greater depth and with additional topics. Either Course 104-3, Course 104/105 or Course 105 may be presented on-site, at your facility.

**PREREQUISITES** There are no definite prerequisites. However, this course is meant for individuals working in a technical field other than electronics. An understanding of basic algebra will be useful.

**TEXT** Each student will receive 180 days access to the online electronic course workbook. Renewals and printed textbooks are available for an additional fee.

### **COURSE HOURS, CERTIFICATE AND CEUs**

OnDemand Internet course 104/105 features over sixteen hours of video as well as more in-depth reading material. Class hours/days for on-site courses can vary from 14–35 hours over 2–5 days as requested by our clients. Upon successful course completion, each participant receives a certificate of completion and one Continuing Education Unit (CEU) for every ten class hours.



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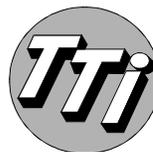
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## Course Outline No. 104-5

- Introduction: Review of a typical electronic circuit  
Schematic Diagram of a Radio Receiver • Symbols, Abbreviations  
Path of Signals through Circuit • Block Diagram
- Electrical Fundamentals Review: Electrostatic Field and Potentials  
Charge • Conductors, Insulators • Current, Voltage • Ohm's Law  
EMF • Resistors • Series Circuits • Network Theorems  
Alternating Current • Non-Sinusoidal Waveforms • Square Waves  
Harmonics • Analog vs. Digital Waveforms • Examples
- Capacitors and Inductors • Transient R-C and R-L Circuits • Examples
- Reactances in Series and Parallel: Inductive and Capacitive Reactance • Phasor Diagrams • Impedances in Series or Parallel • Parallel Reactance • Examples
- Series and Parallel Resonance: Resonant Frequency  
Q of a Series Circuit • Bandwidth of Series R-L-C Circuit  
Parallel Resonance • Filters
- Transformers: Construction • Equivalent Circuit • Turns Ratio • Power Relationships, Efficiency • Impedance Matching • Loosely coupled, Single and Double Tuned
- Instrumentation: Average and RMS Values of Common Waveforms  
Decibels • Log vs. Linear Scales • Precision and Accuracy • Errors • Output Impedance, Loading • Power Transfer, Impedance Matching • Meters • Oscilloscopes • Measuring Voltage, Current, Time, Frequency, Phase  
Digital Oscilloscopes • Ohmmeters • Function Generator • Safety, Grounds
- Polyphase Circuits: Phasor Voltages • Three-phase Generators  
Power Distribution • Local Power Distribution Systems
- Semiconductor Physics: N-type and P-type Doping • Diffusion
- Diodes: Alloy Junction Diode • Planar Technology (Diffusing) • P-N Junction Behavior • Junction Barrier • Biasing  
Diode types: Rectifier, Signal, Zener, Tuned • Voltage Reg.
- Transistors and Biasing: NPN Transistor • Amplifier Gain  
Common Base, Common Emitter, Common Collector Circuits
- Field Effect Transistors (FETs): JFET • Channel Depletion • MOSFET  
N-channel Enhancement and Depletion • Transfer Characteristics
- Thyristors: Operation of SCR • I-V Characteristics of a Typical SCR
- Photo-electric Devices: Photo-voltaic Cells/Solar Cells  
Photo Conductive Diodes • Photo-transistors • PIN Diodes  
High Gain Light Detector • LASCR • LED
- Rectifiers and Filters: Power Supply with a Regulator  
Half and Full Wave Rectifiers • Bridge Rectifier • Filters  
Capacitive Load • Power Supply Loading • Filter Choke
- Amplifier Fundamentals and Considerations: How Transistors Amplify  
Transistor voltage, Power Gain and Operating Point  
Base Bias Adjustment • Operating Point Stabilization  
Bypass Capacitor • Signal Clipping • Classes • Coupling Methods  
Resistive-Capacitance (RC) Coupling • Direct Coupling  
Frequency Response • Distortion • Slewing Rate
- Tuned Amplifiers: AM and FM IF Bandwidths • IF Amplifier Stage  
Detector and AGC Circuit • RF Amplifiers • Sensitivity
- Oscillators: Kinds of Oscillators • Positive Feedback • Configurations  
Transistor Hartley, Colpitts or Clapp Oscillator • Crystal Oscillator  
RC Oscillators
- Feedback: Types of Negative Feedback • Voltage Shunt Feedback  
Input Impedance • Voltage Series
- Differential Amplifiers: One Input • Two Different Inputs  
Two Identical Inputs • Common Mode Rejection
- Operational Amplifiers: Characteristics • Mini-DIP Integrated Circuit  
External Feedback • Op Amp Circuits: Inverting or Non-inverting  
Follower • Summing Amplifier • Gain and Frequency Response  
Basic Cautions
- Numbering Systems and Binary Arithmetic: Binary • Decimal • Octal • Hexadecimal • Binary Addition and Subtraction  
Signed Binary Numbers • Binary Multiplication
- Primitive Logic Functions  
NOT, AND, OR, XOR, NAND, NOR, XNOR
- Boolean Algebra: Constants and Variables • Truth Tables  
Algebraic Representation of Logic Circuits  
Circuits from Boolean Expressions • DeMorgan's Theorems  
Universality of NAND gates and NOR gates  
Karnaugh Maps
- Introduction to Digital Troubleshooting  
Classification of Faults: Intermittent versus Permanent • External versus Internal • Parametric versus Logic  
Static versus Dynamic  
Test Equipment • Static and Dynamic Measurements  
Fault Localization, Fault Isolation  
Testing for Dynamic Faults
- State Diagrams, Tables, and Machines  
Coin-Operated Vending Machine  
State Diagram for Controller • State Table for Controller  
State Machines-Moore, Mealy • State Assignment  
Binary Encoded State Assignment  
Minimized Boolean Equations
- Interfacing with the Analog World: Digital-to-Analog Conversion  
D/A-Converter Circuitry • DAC Specifications  
Analog-to-Digital Conversion • Data Acquisition  
Digital Voltmeter • Sample-and-Hold Circuits • Multiplexing  
Digital Storage Oscilloscope
- Integrated Circuits: Fabrication Process • Packaging Process  
Noise Immunity • Power Dissipation • Propagation Delay  
Speed-Power Product
- Memory: Technology • General Memory Operations  
Memory Considerations • ROM • RAM • Static RAM (SRAM)  
Dynamic RAM (DRAM) • Programmable Logic Devices (PLDs) • Magnetic and Optical Memories  
Digital System Application
- Integrated Circuit Applications: Gate Array Devices  
Standard Cell Devices • Full Custom Devices  
Circuit Board Technology • Subtractive Process  
Additive Process • Single-sided Boards  
Surface Mount Technology • Double-sided Boards  
Multilayer Boards • Backplanes and Motherboards
- Hybrid Circuits: Hybrid Substrates • Thick-Film Process  
Thin-Film Process • Assembly Process • Packaging Process
- Appendix: Mathematical Fundamentals  
Scientific and Engineering Notation • Vectors  
Understanding RMS • AC Circuits • Phasors • Impedance
- Summary, Discussion • Final quiz  
Award of Certificates for Successful Completion



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