Electronics for Non-Electronic Engineers

Course No. 104-5

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 104-5 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 photoelectric 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.

CERTIFICATE PROGRAMS This course may be used to satisfy the Electronics requirement for TTi's Mechanical Design Specialist (MDS), Metrology Specialist (MSC) and Instrumentation Test Specialist (ITS) certificate programs. It may be used as an elective for any other TTi specialist certificate program.

RELATED COURSES A shorter version of Course 104-5, 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 104-5 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 participant will receive a course workbook, which contains most of the viewgraphs used during the presentation.

COURSE HOURS, CERTIFICATE AND CEUs Open courses meet seven hours per day. Upcoming presentation dates can be found on our current open course schedule. 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.

For schedules, general information and registration forms, see TTi's web site.

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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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