Understanding Digital Electronics

Course No. 105

FOR WHOM INTENDED This course is intended for individuals whose primary formal training is not in the field of electronic engineering. Digital 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 digital electronics.

OBJECTIVES To help participants to understand the concepts and terminology of digital electronics. It is not an in-depth digital 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 The course starts with an introduction to the fundamental concepts of analog versus digital, and covers the physics and basic electrical theory needed to understand the later portion of the course. The instructor then reviews semiconductors, such as diodes and transistors, before covering logic functions such as AND, NOT, OR, NOR, NAND, etc. A brief review is made of numbering systems: binary, decimal, octal and hexadecimal; binary arithmetic and Boolean Algebra are covered next. After Karnaugh maps, the course covers complex digital circuits, combinational and then sequential. Next is an overview of digital troubleshooting, and an introduction to state diagrams, tables and machines.

The course then covers digital applications: analog to digital conversion, digital voltmeters, multiplexing, digital oscilloscopes. Next, integrated circuit fabrication, memory technology, circuit board manufacturing processes, IC applications, hybrid circuits and electronics packaging are discussed. The course concludes with a brief overview of technologies of the future.

CERTIFICATE PROGRAMS: This course is required for TTi's Electronic Design Specialist (EDS) certificate program. It may be used as an elective for any other TTi Specialist Certificate Program.

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 set of course notes, which will contain copies of 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.

Course Outline

Fundamental Concepts
- Analog versus Digital • Atoms, Molecules, and Crystals • Conductors, Insulators
- Voltage • Current • Resistance • Capacitance • Inductance

Semiconductors: Diodes • Transistors

Primitive Logic Functions: NOT, AND, OR, XOR, NAND, NOR, XNOR

Numbering Systems: Binary • Decimal • Octal • Hexadecimal

Binary Arithmetic
- Binary Addition and Subtraction • Signed Binary Numbers • Binary Multiplication

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: Minimization Using Karnaugh Maps
- Grouping Minterms • Incompletely Specified Functions

Complex Circuits from Primitive Logic Elements
- Combinational Circuits: Sum-of-Products Form • Simplifying Logic Circuits • Designing Combinational Logic Circuits • Basic Characteristics of Digital Integrated Circuits • Troubleshooting • Internal Digital IC Faults • External Faults • Programmable Logic
- Sequential Circuits: Latches • Clock Signals and Clocked Flip-Flops • Flip-Flop Timing Considerations • Flip-Flop Applications • Detecting and Input Sequence • Serial Data Transfer • Microcomputer Applications Analyzing Sequential Circuits

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

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
- Integrated Circuits verses Discrete Components
- Basic Operational Characteristics and Parameters • TTL Circuits • Practical Considerations in Use of TTL• CMOS Circuits • Comparing CMOS and TTL Characteristics • Interfacing Logic Families

Memory: 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

Technologies of the Future: Reconfigurable Hardware • Optical Interconnect • Optical Memories • Protein Switches and Memories
- Electromagnetic Transistors • Diamond Substrates • Conductive Adhesives • Superconductors • Nano-technology

Summary, Final Exam • Award of Certificates for Successful Completion

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