Global Positioning Systems (GPS)

Course No. 173

FOR WHOM INTENDED Individuals involved in a wide range of activities where GPS systems are or could be used to enhance their activities. This would include: engineering, technical, quality, product procurement and anyone who needs to become familiar with the overall GPS system and the terminology used.

BRIEF COURSE DESCRIPTION This course provides an in-depth overview of the Global Positioning System and covers the growth of the GPS concept. Included in the course is a description of the NAVSTAR constellation and the various types of augmented GPS systems. Basic GPS components are covered, including satellites, ground stations, antennas and receivers. Emphasis is placed on signals, timing and false signals including spoofing, jamming and cryptographic concepts. A class project using a GPS receiver based in a Raspberry Pi computer and Linux code gives hands-on experience interacting with real-time GPS data.

International GPS systems such as Galileo and GLONASS are discussed. A useful appendix including information such as a Glossary and definitions is included in the course workbook as an excellent reference tool.

DIPLOMA PROGRAMS This is a recommended optional course for TTi's Electronic Telecommunications Specialist Diploma (ETS), and may be used as an optional course for any other TTi specialist diploma program.

PREREQUISITES There are no definite prerequisites for this course. However, this course is aimed toward individuals involved in a related technical field.

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

COURSE HOURS, CERTIFICATE AND CEUS 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.

Course Outline

Introduction to GPS Systems
    Military origins • GPS NAVSTAR • Space, Control and User Segments
    Current applications • Receivers • Digital Mapping
Classification, Launch Data and Status of GPS Satellites: GPS Constellation
    Block I, II, IIA, IIR, IIR-M, IIF, IIIA • Orbital Prediction and Tracking
GPS Ground Support Equipment
    Control Segment Components, Antennas
    GPS Antennas: FRPA Specs, Gain, Smart Antenna
    Monitor Stations • Master Control Stations
Atomic Clocks: What is an Atomic Clock?
    Atomic Clocks used in GPS: Cesium • Rubidium (Rb) • Hydrogen Maser
    NIST-F1 and F2 Cesium Fountain Atomic Clocks
    US Naval Observatory (USNO) Clock Ensemble
    GPS Satellite Atomic Clocks • GPS Clock for Wireless Infrastructure
Satellite Signals: Frequency Bands
    Carrier Frequency and GPS Accuracy • Signal Evolution
    GPS Satellite Frequency Bands • Signal Power from Satellites
    New Civilian GPS Signals: L2C • L5 • L1C
    How Codeless or Semi-Codeless GPS Works
    Legacy GPS Signals: Standard/Precise Positioning • Modulation
    Pseudorandom noise (PRN) • Coarse Acquisition (C/A)
    Precision (P-code) • P(Y) Code • Spread Spectrum • Signal Structure
    Navigation (NAV) Message: Legacy (LNAV) • Civilian (CNAV)
    NMEA Data Format • $GPAPB • GPRMC • NMEA2000
Time Measurement and GPS: USNO – BIPM Correlation •
    Leap Seconds • GPS System Time, Time Transfer • How GPS Receivers
        Compute UTC (USNO) • Precise Time Reference Station • Common-
        View Oscillator • NIST Time services
    Cellular Technology and GPS Time • Network Time Protocol (NTP)
Triangulation, Dilution of Precision (DOP): Coordinate Systems, ECI, ECEF
    Satellite, Receiver Locations • Triangulation • Travel Time • Distance
        Measuring • Range Measurement Calculation • Dilution of Precision
        (DOP), Types of DOP • Error and Map Problems
Differential GPS, Augmentations: Types of Differential Coverage
    Wide Area Augmentation (WAAS) • Benefits of WAAS to Civil Aviation
    Other WAAS-like Systems • Local Area Augmentation
Signal Security: GPS Dependencies • Jamming and Spoofing
    Jamming • NGA and JLOC • Banned Jamming Devices Use
    Spoofing: Detection • Anti-Spoofing (A-S) • Navigation Message
        Authentication (NMA) • NMA on the Galileo System • Authentication
    Asymmetric Encryption • Certificates • Delayed Authentication • Civilian
    Spread Spectrum Security Codes (SSSC or SC) • Future
Class Project Using GPS Receiver • Raspberry Pi • Linux Code
GPS Tracking Systems
International GPS Systems
    GLONASS, Galileo, other International GNSS systems
Agricultural Applications of GPS: Benefits, Examples
Appendix:
    Glossary • Definitions • Calibration and Uncertainty of GPS systems •
        Satellite-to-User Range Equations • DOP Equations
Conclusion, Final Review
Award of certificates for successful completion
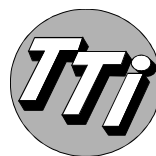
Technology Training, Inc.

(a tti group company)

Toll-free tel: 866-884-4338 (866-tti-4edu)

International Tel. 805-845-5050

E-mail: Training@ttiedu.com

www.ttiedu.com

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