Draft Syllabus for "Hands-on Introduction to Software Defined Radio using GNU Radio," Oct-Dec 2026

Software Defined Radio Solutions, LLC, August 14, 2026

We are an approved provider of IEEE CEU/PDH certificates.

Overview

This course is designed to help technical professionals progress from being novices with basic awareness of and no or minimal experience with software defined radio (SDR), who may see SDR as very complex and potentially frustrating, to confident SDR application developers who are familiar with SDR concepts, enabling technologies, and applications, and prepared to continue SDR-related learning as needed. Participants will have up to five weeks to complete a self-selected Capstone project and those who complete all course activities will receive a Certificate of Completion. There will be opportunities to make up any missed sessions asynchronously. In the beta-testing phase, some adaptations to the syllabus can be made to meet specific needs of participants.

Learning Objectives

Participants who complete the program will be able to:

1. Provide a working definition of SDR
2. Enumerate, and briefly describe important considerations related to, major enabling technologies and applications of SDR
3. Use selected SDR application development tools and hardware at an intermediate level
4. Collaborate on SDR application development & testing projects
5. Apply and extend their newly gained knowledge through a self-selected individual or team capstone project
6. Harness AI engines to amplify their new knowledge and skills, pre-existing in-depth knowledge, and creativity to develop SDR signal processing, source, and/or sink blocks, and/or develop SDR application flow graphs.
7. Continue learning SDR-related topics and tools as needed for their purposes.

Testimonials from Students:

- "Practical skills that I can transfer directly to my workplace."
- "Directly relevant to my job."
- "Hands-on experience was extremely helpful, especially when dealing with new hardware."
- "The labs are particularly helpful, as well as the professor's knowledge of using GRC [GNU Radio Companion SDR application development tool]."
- "[Allowed] us to really open up the realm of possibilities in SDR development."
- "The focused instruction showed me what to look for next to branch out and learn more"

US-based? Email sdrsolutionsco+sdrshortcourse@gmail.com to discuss the course and lock in $1,850 in savings: $1,000 discount, $850-value assembled, tested, ready-to-use development kit are included in the $2,450 beta-tester price

- Learn by working through interactive examples and labs with instructor support.
- As a beta tester, help us tailor the course to needs of working professionals.
- Get customized feedback to develop your expertise.
- ***Instructor has 25+ years' SDR-related education & application experience.***

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Schedule (*Hands-on*, ***Hands-on w/Hardware**, **Participatory**, Produced/Selected, **TBD**)

Week 1:

- ***Videos:***
  - Wireless Communications Overview
  - Software Defined Radio (SDR) Overview
  - FM Capture Effect Demo using GNU Radio
  - GNU Radio Companion: Tool Bar, Menus, and Keyboard Shortcuts
- ***Meeting 1 (90 minutes): Introduction and "Hello World" with the Pluto+***
  - **Introductions**
  - Course overview:
    - Policies
    - Learning objectives
    - Structure and contents
    - Surveys and informal feedback
  - **Introduction to community discussion platform**
  - **Brief Start-of-course Survey**
  - **** Work-Along Demos: Pluto+ SDR Spectrum Analyzer & FM Receiver***
  - **** Extension: Dual-band, Dual-mode Receiver***
  - Meeting recap and preview of the next meeting
- ***Meeting 2 (90 minutes): Scanning FM Receiver***
  - **Beta Tester Feedback; Exercise/Community Discussion follow-up**
  - **Q&A/Discussion**
  - Data stream observation; Python in GNU Radio; GNU Radio Python Module
  - **** Work-Along Demos: Pluto+ FM Scanner***
  - **** Extension: Dual-band, Dual-mode scanner***
  - Meeting recap and preview of the upcoming week

Week 2:

- ***Videos:***
  - **Transmitting and receiving safely using the Pluto+ (atten/load for each Tx)**
  - nanoVNA calibration and measurements
  - tinySA: how to protect and use it
  - Pluto+ Tx Linearity Measurement
- ***Meeting 1 (90 minutes): How to use test equipment and transmit using the Pluto+***
  - **Beta Tester Feedback; Survey/Exercise/Community Discussion follow-up**
  - Hardware/software SDR Development Kit review
  - **** Work-Along Demo: Receiving a signal from the tinySA***
  - **** Work-Along Demo: Pluto+ transmission and spectrum observation***
  - **** Extension: Loopback transmission and reception on Pluto+***
  - Meeting recap and preview of the next meeting
- ***Meeting 2 (90 minutes): GUI Layout plus Spectrum Sharing using the Pluto+***
  - **Beta Tester Feedback; Exercise/Community Discussion follow-up**
  - ***Work-Along Demo: Intro to GUI layout using the GUI Hint***
  - **** Work-Along Demo: Scanning dynamic spectrum access (DSA) Transmitter (observe using tinySA)***
  - **** Extension: Receive DSA Transmitter using Pluto+***
  - **Q&A/Discussion**

- Meeting recap and preview of the upcoming week

Week 3:

- ***Meeting 1 (90 minutes): GNU Radio Simulation and Debugging/Troubleshooting***
  - **Beta Tester Feedback; Exercise/Community Discussion follow-up**
  - GNU Radio Simulation and Throttle Block
  - Review of Development and Debugging Process
  - Common errors in Flow Graphs
  - **** Work-Along Demo: Using Debugging/Troubleshooting Tools on a flow graph***
  - **** Debugging Challenge: Broken DSA Tx flow graph***
  - Meeting recap and preview of the next meeting
- ***Meeting 2 (90 minutes): RF Front End (RFFE) Effects***
  - **Beta Tester Feedback; Exercise/Community Discussion follow-up & demos**
  - Brief review/overview: RFFE components, nonlinear effects, and metrics
  - **Exercise: How many definitions can you find for these RF metrics?**
  - ***Work-Along Demo: Ready-to-run nonlinear effect simulators (1-Tone/2-Tone & Tones + Tone-modulated AM)***
  - **** Extension: Add nonlinear effect simulator to Pluto+ FM Receiver***
  - Meeting recap and preview of the upcoming week

Week 4:

- ***Videos:***
  - Sampling and Quantization
  - **ADCs, DACs, specifications, and limitations, incl. BP sampling, jitter, data, sheet**
  - **Sample rate Conversion**
  - **Direct digital signal synthesis (DDS) overview & Specifications**
- ***Meeting 1 (90 minutes): Digital Modulation***
  - **Beta Tester Feedback**; **Exercise/Community Discussion follow-up & demos;**
  - Brief review/overview: Digital Modulation & Performance Metrics
  - ***Work-Along Demo: QAM with Error Vector Magnitude and BER***
  - Using hierarchical blocks and virtual source/sinks to simplify flow graphs
  - ***Hands-on Exercise: Add nonlinear RF effects and I/Q amplitude and phase imbalance to QAM simulator***
  - **** Extension: QAM link with loopback through Pluto+***
  - Meeting recap and preview of the next meeting
- ***Meeting 2 (90 minutes): Data Conversion; Sample Rate Conversion; Direct Digital Synthesis (DDS) effects***
  - **Beta Tester Feedback**; **Exercise/Community Discussion follow-up & demos;**
  - ***Work-Along Demo: Aliasing and Bandpass Sampling***
  - **** Work-Along Demo: Over-the-Air FM signal demodulation with simulated sample rate and quantizer resolution effects***
  - ***Extensions: Add sample-rate and quantization simulation to QAM flow graph***
  - ***Work-Along Demo: Simulated DDS and spurious components***
  - Meeting recap and preview of the upcoming week

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Week 5:

- ***Meeting 1 (90 minutes): Selected GNU Radio Blocks and Debugging Challenges***
  - **Mid-course Survey**
  - **Beta Tester Feedback; Exercise/Community Discussion follow-up**
  - Selected digital signal processing operations and GR blocks
  - Hierarchical blocks (Hier Blocks) and Pad Sink/Source
  - ***Hands-on Exercise: Flow Graph Debugging Challenges***
    - **** FM loopback through Pluto+***
    - **** Pluto+ FM Scanner***
  - Meeting recap and preview of the next meeting
- ***Meeting 2 (90 minutes): FFT and IFFT Applications; Capstone Project Kickoff***
  - **Beta Tester Feedback; Mid-course Survey Follow-up; Exercise/Capstone Project follow-up & demos; Q&A/Discussion**
  - FFT and IFFT review
  - Orthogonal Frequency Division Multiplexing (OFDM) Overview
  - ***Work-Along Demo: OFDM***
  - **Capstone Project topic selection (and team formation as needed).**
  - ***Extensions:***
    - **** OFDM link w/Pluto+ loop-back***
    - **** FFT-based Scanner (WBFM broadcast band segment or 2-meter amateur NBFM band segment)***
  - Meeting recap and preview of the upcoming week

Week 6:

- ***Videos***
  - **Antennas**
  - **Radio-Wave Propagation**
  - **Diversity Combining**
- ***Meeting 1 (90 minutes): Custom Blocks and AI-Assisted Development***
  - **Beta Tester Feedback**; **Exercise/Community Discussion follow-up & demos;**
  - ***Work-Along Demo: GR Python block (from GR Wiki Tutorials)***
  - ***Hands-on Exercise: AI-assisted Python block development, testing, and debugging (Example AI-generated code and SW test harness provided)***
  - **** Hands-on Exercise: Testing and using new block with over-the-air signals***
  - ***Extension: Add block to OFDM demo flow graph***
  - Out-of-Tree (OOT) Modules
  - Meeting recap and preview of the next meeting
- ***Meeting 2 (90 minutes): Team Project: Diversity Combiner and Test Harness***
  - **Beta Tester Feedback**; **Exercise/Community Discussion follow-up & demos;**
  - ****Work-Along Demo: Manual Diversity Combining and Beamforming -- GR/Pluto+ Signal reinforcement and cancellation by adding signals from two antennas with phase and/or amplitude weighting***
  - **** Team Project: Diversity Combiners and HW/SW Test Harnesses***
  - **** Extension: Diversity-enabled FM receiver/scanner on Pluto+***
  - Meeting recap and preview of the upcoming week

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Week 7:

- ***Videos***
  - **Phased Arrays**
  - **Beamforming**
- ***Meeting 1 (90 minutes): Phased Arrays and Beamforming***
  - **Beta Tester Feedback**; **Exercise/Community Discussion follow-up & demos;**
  - ***Work-Along Demo: Phased Array Simulation***
  - **** Work-Along Demo: Beamforming receiver on Pluto+***
  - **** Extension: Test interference rejection capability as a function of array geometry and transmitter location***
  - Meeting recap and preview of the next meeting
- ***Meeting 2 (90 minutes): Multiple Co-Channel Reception***
  - **Beta Tester Feedback**; **Exercise/Community Discussion follow-up & demos;**
  - Selected Advanced SDR & GNU Radio topics
  - **** Work-Along Exercise: Based on Beamforming Receiver, Build and Test Multiple-Co-Channel-Signal Receiver with Selectable Outputs for Each Audio Channel***
  - **** Extension: Increase maximum number of channels received?***
  - Meeting recap and preview of the upcoming week

Week 8:

- ***Videos:***
  - Resources for Continued Experimentation
  - **Case study: Review of SDR hardware data sheet or data sheets**
  - **Examples of other general-purpose and specialized SDR software and hardware**
- ***Meeting 1 (90 minutes): Capstone Project Reports and Admin Items***
  - **Link to End-of-Course Survey**
  - **Link to IEEE Course Evaluation Form (Required for SDRS and IEEE CEU/PDH Certificates)**
  - **Link to Quiz (only required for IEEE CEU Certificate)**
  - **Capstone Project Reports**
  - **Beta Tester Feedback**; **Exercise/Community Discussion follow-up & demos;**
  - Brief Summary of Selected Research by Instructors
  - Resources for Further Learning and Mentoring:
    - Publicly available Internet resources
    - Consulting options
  - Meeting recap and preview of next meeting
- ***Meeting 2 (90 minutes):***
  - **End-of-Course Survey Follow-Up**
  - **Capstone Project follow up**
  - **Beta Tester Feedback**; **Exercise/Community Discussion follow-up & demos;**
    - **Course Structure and Contents**
    - **Suggestions for Course**
    - **Follow-on Options**
  - Recap of Resources for Continued Learning and Mentoring
  - **How to request course completion certificates**