Class	Abstract
Products And Peripherals	
23001 PNP1 : The Latest MCUs, MPUs, Analog and Timing Products from Microchip: 12 Months Ahead	This class provides an overview of Microchip's latest and future PIC® and AVR® MCUs, SAM MCUs and MPUs, as well as analog and timing products. Attendees will receive an introduction to new features, new technologies, and what new products they can expect from Microchip in the next 12 months.
23002 PNP2 : The Latest Ethernet, USB, Secure Elements, Wireless, and PoE Products from Microchip: 12 Months Ahead	This class provides an overview of Microchip's latest and future connectivity products for Ethernet, USB, Secure Elements, Wireless, and Power over Ethernet products. Attendees will receive an introduction to new features, new technologies, and what new products they can expect from Microchip in the next 12 months.
23003 PNP3 : No Experience? No Problem! Getting Started with PIC® and AVR® MCUs	Do you want to see how easy it is to create a PIC® or AVR® MCU project even though you have no experience? Even if you have little or no embedded programming experience this hands-on class will show you how to use Microchip's Code Configurator (MCC) to quickly create projects on either the PIC or AVR MCU platform without writing any code! We will with start with a blank MPLAB® X project and walk you through the steps of quickly creating projects using both architectures so you can easily see what the differences are. Labs will cover several examples including the use of Core Independent Peripherals (CIPS) which are fundamental building blocks for complex solutions. This class is an excellent primer for more advanced classes using MCC or CIPs.
23004 PNP4 : Create Unique Digital and Analog Functionality by Interconnecting Core Independent Peripherals (CIPs)	This class will show how to create a FSK demodulator, high-resolution PWM, WS2812B RGB LED protocol, ultrasonic range detector, metal detector, AC Sine direct drive and switch-mode power supply by interconnecting multiple Core Independent Peripherals (CIPs). Examples will be shown using PIC® and SAM MCUs. The CIP interconnections and circuit wave-forms will be presented along with live demonstrations of several of these designs. Exposure to these real-world examples will help you to apply CIPs in your project to reduce component count and improve system performance by replacing firmware overhead with CIP hardware.
23005 PNP5 : NVRAM and EEPROM Selection and Design	For the users of microcontrollers, there is an impressive range of features and memory sizes available. But, for those times when the data storage requirements aren’t cost effective for an MCU’s internal storage or require better endurance, there is a wide selection of external memories that can quickly and easily fit the need. This class is an overview of external non-volatile memories. We will discuss the different types, how they operate and why some can wear out, and discuss some of the tradeoffs between the various types in applications where they fit best.
23006 PNP6 : dsPIC® DSC Dual Core Application Development Tips and Tricks	This class will introduce the new dsPIC33C Dual CPU (Master-Slave) architecture. We will discuss the MasterCore-Slave CPU operation and the mailbox peripheral Master-Slave-Interface (MSI) which is used to communicate between the master and the slave cores. We will also discuss the new peripherals designed on the dsPIC33C families, such as protocol UART, high-resolution PWM with fine edge placement and CAN-FD, flexible oscillator, etc. We will discuss the advantages of dual CPUs, and how it is useful in applications such as motor control, digital power supplies, etc. Finally, we will discuss how to create master and slave projects and how to debug/program two projects in a dual core environment using MPLAB® X IDE.

23007 PNP7 : Timing and Frequency Applications, Specifications and Solutions	Microchip has the world's broadest portfolio of timing and frequency devices: from large atomic clocks that provide the world's time via GNSS, to miniature crystal and MEMS oscillators used within smart-sensors to remotely connect and synchronize any type of device. Choosing the right solution can be overwhelming, especially for newly emerging applications. This lecture will discuss the key specifications and what they mean to help engineers choose the right solution. Furthermore, this lecture will discuss several applications and their frequency/timing requirements: autonomous vehicles, smart connected devices, seismic exploration, phased array radars, satellite communications modems, and 5G communication networks. After attending this class, you will be able to choose the best clock solution for your product, reducing time-to-market and achieving reliability, performance and cost-effectiveness.
23008 FPGA1 : Getting Started with Microchip FPGAs	This class introduces Microchip's IGLOO2 and SmartFusion2 low-density FPGA families, and the PolarFire® mid-range density FPGA family and target applications. The presentation will include the architectural details of each family, available IP blocks including microprocessor cores, development tools and the design ecosystem to implement designs. Following the lecture, the instructor will demonstrate the FPGA design flow using the Microchip Libero® SoC toolset.
23009 FPGA2 : Using Microchip FPGAs in Low-Power Applications	Microchip PolarFire® FPGAs offer the industry's lowest-power FPGA fabric and 12.7G transceivers and the smallest footprint packaging at mid-range FPGA densities, enabling high-performance in small, power-constrained applications. This class will include an overview the PolarFire FPGA family and describe how to estimate and verify the power consumption of a design. Following the lecture, the instructor will demonstrate how to use the power estimation tools to estimate the power requirements of a low-power transceiver design using the Microchip power analysis tools, and measure the power on a Microchip development kit.
Dev Tools	
23011 DEV1 : Microchip Development Tools: Today and Tomorrow	This introductory-level course offers an overview of Microchip's development tool offerings, a quick review of integration roadmaps and new features in IDEs, compilers, starter kits, programmers, debuggers and other new products. Third party hardware and software tools will also be covered. Presented by Development Tools marketing , this is an interactive session, where attendee participation is crucial and mutually beneficial to both presenters and attendees.
23012 DEV2 : MPLAB® X IDE Essentials	This class covers getting started with MPLAB® X IDE for customers new to the MPLAB IDE ecosystem, which supports PIC®, AVR®, dsPIC®, and SAM devices. The entire project life cycle is covered: creation, editing and debugging. Demonstrations will be shown throughout the class and provided as projects that can be run as self-study after the class.
23013 DEV3 : MPLAB® X IDE Advanced Debugging and Features	This class covers advanced features and debugging within the MPLAB® X IDE ecosystem. We will show how complex break points, trace, code coverage, and the MPLAB® Data Visualizer can be used to more effectively debug your project and increase your productivity. Demonstrations will be shown throughout the class and provided as projects that can be run as self-study after the class.
23014 DEV4 : MPLAB® Code Configurator (MCC) for Simplified Embedded Software Development	The MPLAB® Code Configurator (MCC) is a free plug-in of MPLAB® X IDE, which provides an easy setup and configuration experience for supported microcontrollers. In this class, you will learn to navigate and manage project settings with MCC, set up and configure peripherals including Core Independent Peripherals, and choose from a wide variety of software libraries. MCC will generate optimized driver code tailored to your requirements, which is automatically integrated into new or existing embedded projects. Learn how to leverage the power of MCC to quickly develop an embedded application and get your project off the ground in minimal time!

23016 DEV6 : MPLAB® Harmony v3 Fundamentals	MPLAB® Harmony v3 is an extension of the MPLAB IDE ecosystem that simplifies development of embedded firmware for Microchip 32-bit SAM and PIC32 microcontroller devices. It includes an easy to use Graphical User Interface (GUI) for selection, configuration, and generation of starter code, peripheral libraries, and extensive middleware. This class provides an introduction to MPLAB Harmony v3, an overview of what it is comprised, and an explanation of how it differs from MPLAB Harmony v2. Attendees will gain an understanding of key concepts, supported development models, and what resources are available for further learning. This class is recommended as a prerequisite to the MPLAB Harmony 3 hands-on lab classes and is a good introduction to MPLAB Harmony before attending classes focused on specific middleware stacks.
23017 DEV7 : Creating Simple Embedded Applications with 32-bit MCUs/MPUs Using the MPLAB® Harmony v3 Peripheral Libraries	MPLAB® Harmony v3 provides graphical tools and easy to understand peripheral libraries that simplify the use of Microchip's 32-bit microcontrollers and microprocessors. In this hands-on class, you will learn to navigate and manage project settings with MPLAB® Harmony Configurator (MHC), set up and configure peripherals, and generate optimized code tailored to your requirements, which is automatically integrated into new or existing embedded projects. Learn how to leverage the MPLAB® Harmony power to quickly develop an embedded application and get your project off the ground in minimal time!
23018 DEV8 : Creating Advanced Embedded Applications with 32-bit MCUs/MPUs using the MPLAB® Harmony v3 Software Framework	MPLAB® Harmony is a modular framework that provides inter-operable firmware libraries for 32-bit microcontroller and microprocessor application development. This class shows how the MPLAB® Harmony drivers, system services and middleware enables you to rapidly develop bare-metal and RTOS applications.
23019 DEV9 : Designing an Efficient FreeRTOS™ Application Using MPLAB® Harmony v3 Framework	This class will introduce you to the process of designing FreeRTOS™ applications using the MPLAB® Harmony Framework. We will demonstrate appropriate design patterns and how to implement them within Harmony. We will take advantage of peripheral drivers and APIs available from FreeRTOS and Harmony to optimize application design.
Firmware Design and Compilers	
23021 FRM2 : Advanced Concepts of the C Programming Language	Take your C programming skills to new heights! The objective of this class is to enable you to use advanced C programming language constructs and techniques to create more structured and portable code. You will be able to create structures, unions, and bit fields. You will use advanced pointer concepts to allow very flexible data access and create arrays of pointers, arrays of structures and unions, and pointers to arrays of structures and unions. You will create nested structures and unions along with flexible 'typedef' methods to set up data structures and variables. Function pointers are an important concept of the C programming language and you will use arrays and structures of function pointers to create portable and flexible state machines. Finally, dereferenced double pointers are discussed in detail. This class includes seven instructor-led hands-on labs that clearly demonstrate each concept. You will use MPLAB® X IDE with the powerful built-in simulator and Microchip XC32 C compiler to analyze the actual effect of coding implementations on variables and to see the interaction of program and data memory values. You will learn these C language topics from a non-hardware framework so that you can focus on learning the C language instead of the microcontroller architecture. The techniques taught in this class are universal ANSI-C concepts of the C programming language. Before attending this class, attendees should be proficient with the fundamentals of C programming and have experience writing embedded C firmware.

23022 FRM3 : Taming Embedded C	Using practical, concrete examples for PIC®, AVR®, and SAM microcontrollers, the enigmas of the C programming language will be explained. The hidden secrets of Microchip debugging tools will be revealed. This class in programming microcontrollers focuses heavily on technique and practical methods. This class is targeted at attendees who have some facility with programming microcontrollers in C, debugging real-world applications, and solving programming challenges. Attendees will take their programming, debugging, and problem solving to the next level using best-practice advice from experts at Microchip.
23024 FRM5 : ARM® Cortex® M0+ and M4 Basic and Advanced Peripherals Bare Metal C Coding	The objective of this class is to enable you to quickly get started with embedded development using the SAM ARM® Cortex® M0+ and M4 microcontrollers. This class enables you to start from the ground-up with code development on these devices. You will also be able to setup the clocking structure and access basic peripherals like the system interrupt controller, external pin interrupt controller, analog-to-digital converter, input/output pin control, timers and output waveform generators. You will know how to setup the digital frequency locked loop (DFLL) clocking in both open- and closed-loop modes and use the Direct Memory Access Controller to perform data transfers. You will also learn how to usethe powerful Event System to perform complex functionality without any intervention from the CPU. This lecture and instructor-led hands-on lab class focuses on using bare metal C code (no code configurator or library framework) to write code for these devices. The ATSAME54 M4 microcontroller is used in this class, but the material also applies to the peripherals on almost all SAM ARM Cortex® M0+ and M4 microcontrollers. You will use MPLAB® X IDE to program and debug hardware on the SAME54 Xplained PRO board. This is not an in-depth Cortex hardware architecture class, but manyarchitecture basics will be covered. Attendees registering for this class should have some experience using the C programming language to write firmware for embedded microcontrollers.
Linux	
23027 LNX2 : Introduction to Embedded Linux	In this class, you will explore the Microchip ATSAMA5D27-SOM1-EK1 evaluation platform running a Yocto Embedded Linux Distribution. You will be introduced to the embedded Linux boot sequence and the different components that make up a board support package. Basic concepts of Flattened Image trees and Device Tree Overlays, its need and evolution will be discussed. You will explore the tools, such as sam-ba programmer, and resources required by new users to start embedded Linux development on the Microchip wiki. The concept of user and kernel space will be introduced. This class includes hands-on exercises where you will explore the underlying hardware using different Linux tools and sub-systems. Specifically, i2c, gpio, network, device tree, udev, run-levels, start-up scripts, Linux virtual file systems - procfs, sysfs and debugfs, will be covered. You will see how to access different peripherals from user space using C and MPIO, a Python-based utility.
23028 LNX3 : Advanced Topics in Embedded Linux	In this class, you will explore two Linux concepts that are important to embedded system designers: a device tree and a device driver. You will become familiar with a device tree model, explore Linux device drivers, kernel configuration and build, deploying images on non-volatile memory, and peripheral interfaces. For the hands-on exercises, you will start with a fully functional embedded Linux distribution running on a SAMA5D27-SOM1_EK1 evaluation board. You will then connect a daughter card containing a variety of devices. You will add device driver support for these devices to the Linux kernel, modify the device tree to add the new devices to the board configuration, and write and execute user-space scripts to exercise these new peripherals.

23030 LNX5 : Exploring Linux Build Systems: Creating your first Embedded Linux System with Buildroot	In this hands-on lab class you will configure and create a bootable embedded Linux image and project development environment for the SAMA5D27-SOM1-EK1 development kit using the Buildroot build automation tool. You will explore the basics of Buildroot and more advanced features allowing you to set up a production-ready build environment to target your own hardware, and how to use the build system for application development. We will cover concepts such as build environment configuration, target package selection and customization, patching, filesystem overlays, addition of custom packages, as well as tips, tricks, and pitfalls to watch out for.
Functional Safety	
23034 FS1 : Introduction to Functional Safety	Embedded engineers are increasingly required to comply with functional safety standards. This class provides an overview of functional safety and the guidelines to follow when designing an embedded system with safety requirements. Topics include fundamental functional safety concepts, industry standards, software processes and relevant coding guidelines.
23035 FS2 : Implementing Functional Safety	This intermediate Functional Safety class covers hazard and risk analysis, safety manuals, and application examples. It also explains how an application developer can analyze and customize the contents of an FMEDA based on the application's peripheral requirements, and present high-level examples of some key safety features and common diagnostic techniques.
23204 STL : Functional Safety - 2 real world examples from concept to certification	The first part of this lecture will show the integration of SIL3 STO Safety Functions into existing Drive Controller Products - Systemtechnik LEBER has managed the integration of the safety function according to SIL3 / Ple, Cat. 3 beginning from the first concept down to the final approval. The functional safety assessment was successfully certified by TÜV NORD CERT GmbH Essen. (Notified Body 0044). The second part of this lecuture will detail how to integrate an eFuse in power distribution networks - The presentation exemplary shows the application of system engineering methods aiming for an optimal design of eFuses in an individual application environment. This includes a holistic view on the complete electrical system, from energy storage / generation through distribution by the on-board network up to the consumers.
Bootloaders	
23036 BTL1 : Bootloaders Using MCC – Device Side	This class will focus on generating a bootloader using MPLAB® X IDE and the MPLAB Code Configurator (MCC) and incorporating it into your application. We will look at the resources required, along with a review of common "gotchas" to avoid. The material in this class will also cover advanced bootloader features such as checking for an existing valid application, methods for switching between application/bootloader modes, calculation of the checksum over a specific range of memory, and fail-safe bootloading. PIC24 differences will also be presented.
23037 BTL2 : Host Design: Communication with MCC Generated Bootloader	This class will be a introduction to the knowledge required to begin developing a Host application (embedded, or software) to interact with the MCC Generator Bootloader Embedded Code command syntax, which supports a range of family devices. The core materials of this class will describe how to read and interpret a Hex file created by MPLAB® X IDE during project compilation. The class will also describe how to 'chunk' the data into sections to update end-application on embedded devices, and analyze the command chain pattern used by the existing Unified Host Java Host. Finally, this class will briefly detail how to create an initial concept, or Custom Host application by using the current Java developed Unified Host as an initial starting point for development. It will also briefly describe the communication facades leveraged by the java application.
Touch/Gesture Sensing	
23038 TNG1 : Capacitive Touch Sensing: Buttons, Sliders, Touch Pads and 3D Gesture - Overview	Touch is attractive for you and your customers - customers love the sleek design, you love the cost savings. This class will guide you through the complete touch solution portfolio from Microchip. From a single button to proximity, sliders, touch pads and even 3D gesture solutions. All to guide you to the best fitting solution for your application/device.

23039 TNG2 : Capacitive Touch Sensing: Theory and Hardware Design Considerations	In this lecture class, you will learn how system physics impact the functionality of capacitive touch sensor designs. We will cover basic design rules, tricks to overcome design challenges, and methods to avoid common pitfalls. Once the basic foundation has been formed, we will then cover more advanced topics like how to design for water tolerance and how to work around EMC requirements.
23040 TNG3 : Implementing MCU-Based Robust Touch Buttons and Sliders Using Microchip's Touch Library	In this hands-on class, attendees will learn how to work with Microchip Touch Libraries to implement capacitive touch buttons and tune for desired sensitivity and response time to achieve robust touch performance. Tuning for low power, moist conditions, and noisy conditions will also be covered.
23042 TNG5 : Designing with maXTouch® Technology Display Modules	This introductory hands-on class will guide you through how 2D capacitive maXTouch® technology touchscreen modules are integrated into customer end products. This class will help developers understand electrical, mechanical, and environmental challenges that can impact touch screen system designs and provide guidelines to overcome these obstacles. The labs used in this class will demonstrate configurability of robust touchscreen modules that are water resistant and support thick gloves. The class will use a maXTouch technology evaluation kit and maXTouch Studio Lite tool to help you better understand how the host will interact with the maXTouch device protocol. Additionally, you will learn how available drivers and easy to use debug tools, combined with Microchip's module partners' support, can simplify the process to move your designs from prototypes to production faster.
Display Technologies	
23044 GFX2 : PIC32 Graphics Development: Advanced Concepts and Techniques	Want to know how to leverage the capabilities of MPLAB® Harmony Composer Suite to maximize the capability of your PIC32 device to create rich modern graphics? Want to know about the latest applications and widget additions to MPLAB Harmony Aria Graphics Library? Then this is the right class for you! During the lecture, attendees will be exposed to features and concepts such as 8-bit palette, parallax, video, animation, multi-lingual support, input system service, display driver prototyping, image compression pros-and-cons, heap estimation, and image pre-rendering. Hands-on exercises will include advanced techniques such as frame buffer compression using 8-bit LUT, adding multi-lingual support, and leveraging the GPU for animation and parallax. The lecture will include a preview of the latest MPLAB Harmony development.
23045 GFX3 : Graphics Design/Creating Compelling User Interfaces	What is the difference between a Graphical User Interface (GUI) and how does a positive one differ from an experience that is just OK? Today Graphical User Interfaces and User Experiences are considered to be critical success factors for digital products and services. There are many elements that impact perception, usability, aesthetics and intuitive interaction. In this class we will learn from a 3rd party professional about what User Experience really is (and what is not), which parts of it can be influenced in which ways and how to integrate a user centered design approach into the technical implementation. Note this class will be co-presented by representatives from Colorfy and Coeno.
23207 TAR : Implementing modern and efficient GUIs for MCUs and MPUs	Graphical User Interfaces are ubiquitous: You find them in home appliances, medical devices, industrial automation devices, everywhere. But implementing those for resource constrained devices is challenging as you need to deal with limited RAM and flash memories while the user expects a smartphone like result. In this class you'll learn how to implement a GUI with Embedded Wizard from scratch while taking care of nowadays' best practices when it comes to render graphics on a MCU, a MPU and beyond.
Automotive Networking - CAN/LIN	

23046 AN1 : CAN Protocol and Physical Layer Basics	This class discusses the basic operation of the classical CAN (Controller Area Network), CAN FD (Flexible Data-Rate) and CAN PN (CAN Partial Networking) protocols. From there, the class will drill down to specific areas such as bit timing, arbitration, error detection and recovery, as well as other areas which contribute to the overall robustness of the CAN protocol. Beyond that, attendees will be introduced to CAN transceivers and PCB board design considerations. This is a lecture class but attendees can optionally attend the AN1L "Open Lab" session which will provide the opportunity to complete self-paced hands-on lab exercises that reinforce concepts learned in this class. The Open Lab sessions will run some afternoons and some evenings. Exact times and locations for Open Lab evening sessions will be provided in class.
23047 AN2 : LIN (Local Interconnect Network) Low-Cost Serial Bus Design for Industrial and Automotive Applications	If you need low-cost, standardized network connectivity, LIN (Local Interconnect Network) is a UART-based serial communication system that could be just right. Intended to be used for distributed electronic systems, it is finding homes in the industrial, consumer and automotive markets. We will teach you the basics of the LIN bus including the definition of the protocol and the physical layer, and also the definition of interfaces for development tools and application software. An open lab session will be offered to try out your new LIN skills. This is a lecture class but attendees can optionally attend the AN2L "Open Lab" session which will provide the opportunity to complete self-paced hands-on lab exercises that reinforce concepts learned in this class. The Open Lab sessions will run some afternoons and some evenings. Exact times and locations for Open Lab evening sessions will be provided in class.
Serial Communication - I2C/SPI	
23048 SER1 : Getting Started With I2C and SPI Communication	You have selected a microcontroller, but now you must decide how to interface with your on-board peripherals. What's the right bus for your embedded control application? In this class we will help you understand the key differences between the most common embedded peripheral serial buses, I2C and SPI, taking you from bit-level details to actual debug scenarios. You will understand how the features of each bus contribute to a robust system design, with key design tips discussed along the way. We will introduce basic debugging techniques to aid in common communication failures. This class is recommended for anyone using or planning to use I2C or SPI, or if you just want to learn more about board level serial communication, interfacing peripherals, and robust system design. This is a lecture class but attendees can optionally attend the SER1L "Open Lab" session which will provide the opportunity to complete self-paced hands-on lab exercises that reinforce concepts learned in this class. The Open Lab sessions will run some afternoons and some evenings. Exact times and locations for Open Lab evening sessions will be provided in class.
23049 SER2 : Advanced Debugging for Serial Communications (I2C/SPI/UART)	Serial protocols (I2C/SPI/UART/etc.) are an integral part of most projects and even the best of us have struggled with issues that just did not make sense. We will explore the weird and wonderful world of some more advanced debugging techniques, learn what tool best applies for each situation and how to approach a new and never-before-seen bug. All of these will be brought into focus using real life, often expensive stories on both hardware and software issues related to serial communications and protocols.
USB	
23050 USB1 : Introduction to USB 2.0 Part A: Basic Concepts and Tools	This class will provide an introduction to the basic concepts and tools of USB 2.0 such as topology, enumeration, endpoints, transfer types and classes. USB protocol analyzers, used to capture and decode USB traffic, will also be introduced.
23051 USB2 : Introduction to USB 2.0 Part B: USB Physical Layer, Practical Design Methods, Test, and Debugging	This course covers the USB 2.0 HS/FS/LS protocol, HSIC, USB BC1.2 battery charging, the USB Type-C™ connector, and power delivery all within the scope of the physical layer. Guidelines are discussed for USB high speed system design including common best practices for layout, debugging, and USB logo compliance. Potential sources of noise and other pitfalls that can degrade performance and affect USB and EMC compliance are reviewed.

23053 USB4 : Developing USB Host and Device Applications with MPLAB® Harmony USB Stack	USB is now a standard serial communication channel to connect embedded systems to PCs or other USB devices. The USB Stack in MPLAB® Harmony allows you to easily develop a USB application on PIC32 and ATSAM USB microcontrollers. In this class you will learn how to configure the MPLAB Harmony USB Stack and use the provided APIs to exchange data between your Embedded application and a PC, and how to read and write files on an USB thumb drive connected to your USB Embedded Host application.
23054 USB5 : Fundamentals of USB Type-C™ and Power Delivery and USB Power Supply Solutions	USB Type-C™ is a new standard that can provide a designer the ability to supply system power up to 100W, high-speed data of 10 Gbps and beyond, as well as high-definition video and audio, all while using a single low-cost cable. This course is tailored to engineers who want to understand the USB Type-C interface and the USB Power Delivery Protocol with practical advice on incorporating the technology into existing applications or new designs. Attendees will be introduced to a range of USB-C features such as Alternate Modes and Power Delivery, port and cable types, and product design requirements. While USB PD provides simplifications at the user level, it creates significant power conversion design challenges. This class provides a brief overview of how USB PD works and follows with a deeper dive into power conversion specific specifications and how they impact power converter design. Design concepts are reinforced through several real-world PD applications and demos and hands on exercises.
23202 GRL : PD and Automotive Networking Solutions	USB Power Delivery Technology, we will discuss differences in real world implementations between USB PD 2.0 and USB PD 3.0 PPS charging, best practices for USB Type-C charging products, and how to check signal integrity of USB cables and connector designs on PCB's. For Automotive Ethernet,we will discuss and cover Automotive Ethernet standardization and implementation of test methods : Compliance test plans as specified in ISO, Interoperability test plans, Device-level test plans, Component-level test plans
Bluetooth	
23055 BLU1 : Introduction to Bluetooth® Low Energy (BLE): Technology and Terminology	Bluetooth® Low Energy (BLE) was created to transmit small packets of data, while consuming significantly less power than previous classic Bluetooth devices and other solutions. This class will describe general characteristics and capabilities of the BLE protocol and radios which are part of a device. You will learn the fundamental concepts that will allow you to delve into more complex concepts of follow-on classes. A developer must understand the functionality of the capabilities of BLE and how to interact with it in your application. It is recommended that this class be taken prior to taking any of the more advanced BLE classes. A system designer must have a firm grasp BLE basics to implement a custom Bluetooth low energy application.
23056 BLU2 : Simple Cable Replacement with Bluetooth® Low Energy (BLE)	If you need to replace cables in your application with BLE but do not want to make a deep dive into the complexities of the Bluetooth protocol and stack, this class is for you. In this hands-on class, you will learn how to create a serial port replacement application using BLE in 15 minutes. This class expands on the basics of BLE discussed in the BLU1 class and will cover several practical hands-on applications. This class will also provide you with information on other BLE topics such as security, pairing, bonding, power management and range. This class will use the RN4870/71 modules for the hands-on labs and will cover both module-module and module-phone communication.
23057 BLU3 : Creating Proof-of-Concept Android Apps for Bluetooth® Low Energy (BLE)	Creating professional mobile apps might be beyond the scope of most embedded design engineers, but if you just want to get started and learn to create simple proof-of-concept apps, then this class is for you. You will learn what development tools to use, how Android apps are structured, touch on key features of the Java language, and go into Bluetooth® Low Energy (BLE) support in more detail. The class will use Android phones to connect to Microchip BLE modules. The hands-on labs will cover the steps required to scan, connect, discover services, and send and receive data over a BLE connection.

23059 BLU5 : Microchip Secure UART over BLE Library Hands On	Need to quickly develop an iOS or Android application to transfer data securely between your embedded system and the phone? In this hands-on class, you will learn how to use a set of library functions that will setup a wireless UART between your board and a Smartphone without the need to deal with the low-level control of the phone's Bluetooth® protocol. In addition, you will learn how to use the security layer library inspired by modern techniques such as SSL and TLS to manage the authentication of both ends: the phone and the embedded design equipped with our ECCX08.
LAN	
23060 LAN1 : Ethernet Hardware Design, Test, and Debug From Schematic to First Packet	This class will enable an engineer with no prior Ethernet knowledge to successfully design with Ethernet PHYs, controllers, and switches. The material explained in this class will reduce time to market and board respins for 10/100/1000 Mbps Ethernet hardware designs. The functional blocks which make up the physical and MAC layers (layers 1 and 2) will be explained along with the hardware interfaces between those building blocks and your embedded system. Schematic design, board layout, test, and debug will be explained while referencing lessons learned from years of Microchip's Ethernet hardware design.
23061 LAN2 : An Introduction to EtherCAT®, EtherCAT P and the Microchip LAN9252 Slave Controller	EtherCAT® is a robust, industrial, real-time field bus protocol based on Ethernet layer 1, which offers extremely low latency and real-time synchronous I/O control distributed across a wired Ethernet network. This class will discuss the key features of EtherCAT and demonstrate the functionality of the Microchip LAN9252 EtherCAT slave controller and its use in deterministic, real-time Ethernet-based control systems. The class will also explain how EtherCAT can be used for ANY low-cost distributed embedded system that requires high-speed, real-time, time-sensitive networked communication and control, and compare its benefits to and present compelling reasons for considering its deployment over standard Ethernet. EtherCAT P is a new standard for delivering power along and communications over a single cable, thus reducing wiring complexity. This technology will also be presented and discussed during the class. The course will cover the implementation of an EtherCAT master based on a Raspberry Pi® and walk through the implementation of slaves for real-time motor control and analog and digital I/O, demonstrating the speed and ease of bringing a system up. The class will also introduce and demonstrate the use of some of the key software tools that will assist in bringing your products to market.
23062 LAN3 : A Practical Introduction to Designing with Microchip Ethernet Switches	This course will introduce the features of an Ethernet switch, its standard interfaces, and how to add a switch to your hardware design. In addition to the hardware design, we will discuss how to properly connect an MCU or MPU to the switch and configure the host networking stack as well as provide an overview of the SW offerings for the managed Ethernet switches. We will explain how to use the most common Ethernet switch management features like VLANs, QOS Control, Spanning Tree Protocol, and IGMP and how practical examples of how these features can be used in real-world applications. Also, we will touch upon the Industrial Ethernet features, e.g., timing/synchronization, redundancy, as well as the concept of the Time Sensitive Networking (TSN) standard.
Security/Encryption	
23063 SEC1 : Cryptography Primer	Attendees of this class will learn the fundamentals of cryptography. The target audience is those unfamiliar with how cryptography works or those needing a refresher. Both symmetric and asymmetric cryptography will be covered and examples will be shown on how each are used in real-world examples. It will be shown how identity is created and used for authentication, integrity, and confidentiality.
23064 SEC2 : Anatomy of a Secure System	This class will prepare you to create a secure system using a layered security approach called "defense in depth". We will discuss suggested hardware, suggested cryptographic functions, and attributes all connections should have. We will discuss a networked access control example to illustrate how to apply these concepts. While this class is still considered a beginner class in cryptography, some prior knowledge of the fundamentals of cryptography is required.

23065 SEC3 : Crypto Key Storage - Challenges and Solutions	This class explains why it is critical to protect core cryptographic key and secret material in modern connected devices. We will show how key protection is related to communication, authentication, passwords and anti-counterfeiting. There will also be an overview of the various methods by which attackers can retrieve keys, secrets and code from integrated circuits and why software security implementations so often fail. We will show how hardware security elements such as the ATECC608A can protect the keys while simplifying the system design. We will also introduce some applicable industry standard certifications.
23066 SEC4 : Authentication and Secure Communications for IoT Projects Using AWS IoT Core	This hands-on course addresses the security side of Internet of Things (IoT) projects, focusing on the authentication and secure communications issues that need to be considered when bringing a project from concept through production. Collaboratively taught by Microchip Technology Inc. and Amazon Web Services (AWS), a leader in cloud solutions, we explore provisioning, securing credentials, authentication, and secure communications from a secure element to the cloud using AWS IoT services and Amazon FreeRTOS™, an RTOS with curated cloud connectivity libraries built on the FreeRTOS kernel.
23067 SEC5 : How To Do Secure Boot and Secure Firmware Updates	This lecture class reviews and discusses secure boot and safe secure firmware updates and why they are important. We will define what secure boot is and what it is not. You will learn about secure firmware upgrades using sign, verify and encryption. Practical implementations of these effective security features will be shown in contexts including: Microchip flash microcontrollers, processors which boot from external memory, computing platforms, FPGA, and automotive applications. The ECC608A secure element and crypto co-processors are presented as enablers of secure boot and firmware upgrades. We will examine how specific attacks and unsafe operation are mitigated using secure boot and secure firmware upgrades.
23068 SEC6 : Developing Secure Applications with CryptoAuthentication Devices	This class will introduce you to some of the basic tools for developing authentication applications using the ATECCx08 secure element. In the first part of the class, you will be introduced to the CryptoAuthLib which is a Microchip developed open source library used to communicate with the secure element. You will use this library to perform secure symmetric authentication between two systems. Next, you will explore how to configure a blank ATECCx08 for specific use cases. After using the secure element to perform the cryptographic authentication, you will walk through exactly how the chip generates these magic values and actually use your computer to make the same calculations. Don’t worry; it’s easy! Finally, the lab will walk you through building and authenticating a very simple digital certificate. You will understand how certificates work after this lab!
23069 SEC7 : Developing Secure Applications with Microchip Cortex®-M23 Flash MCUs TrustZone® Enabled Devices	The lecture portion of this class introduces Microchip's ultra-low power ARM® Cortex®-M23 Flash MCUs Family with optional TrustZone® capability. After an overview of TrustZone for ARMv8-M security principles, we will present our numerous added security features which perfectly complement TrustZone technology. The lab will cover how to create and deploy a TrustZone-based software solution. We will discuss how a secure application can coexist with a non-secure one and explain best practices to develop secure solutions. We will introduce Kinibi-M from Trustonic and explain how this security framework can help secure application development.
23200 MOE : EasyPiC v8 development system & rapid prototyping	Learn how & why our EasyPIC v8 development system is the best rapid prototyping tool for 8 bit PIC MCU. Endless modularity: 5 mikroBus sockets with an ecosysytem of 650+ click boards with mikroSDK v1.0. On board wi-fi programming /debugging and its benefits. With our G2C (go to cloud) support it is very easy to do IoT rapid prototyping. State of the art power supply unit featuring all of its benefits.This board will increase in value over time, because of its careful design and the durability of our Mikroe ecosystem. This is the product of the highest quality made to ensure functionality and ergonomics over the years of usage. Future of mikroSDK and mikroE and mikroE Studio preview.

23201 ARM : Partitioning and Deploying Secure Applications for Microchip Cortex®-M23 Devices using Open-Source Tools	In the lecture portion of this class, attendees learn about Arm's Platform Security Architecture (PSA), a common security foundation for the whole IoT ecosystem. We will introduce Trusted Firmware-M (TF-M), which provides embedded developers with a reference trusted code base complying with the relevant Arm specifications. We will discuss best practices for partitioning applications into secure and non-secure parts, running on TrustZone enabled devices.In the demo portion, we will use CMSIS-Zone, an open-source tool from Arm, to manage the resources on an Arm8-M based device to enable secure/non-secure partitions. Finally, we deploy the application based on TF-M onto the device.
23210 SEM : Cryptography is not your enemy it is a real problem solver	Cryptography is not your enemy it is a real problem solver. Some modern industrial standards like the IEC62443 are defining requirements which are among others solvable with crypto - if you have the right tools and if you know how to use it properly and trustfully. We will take a journey from the basics of cryptography to the real-world-use cases like cloud or IT connections or using crypto in industrial real-time-applications. We will also answer the question what secure elements like the ATECC608 is why you should or should not use it. You will learn about the different algorithm and technologies in conjunction with example use cases to get the focus on best practices and the most major mistakes that should be avoided. We will also oversee the risks and attacks we have to consider when using this technology. It is not the objective to discuss the mathematics but we want to give you the skillset to ask the right questions when starting a design and discuss about future requirements and define target you would like to protect.
23211 ARD : Arduino cloud and security	Full Abstract still missing. ATECC608A crypto chip to establish secure connections from the ground
Internet of Things (IoT)	
23070 IoT1 : TCP/IP Introduction	In the Internet of Things, the Things must conform to the Internet, not the other way around. If you're just dipping your toes into the IoT, this class is for you. Adding network connectivity to an embedded product is complex. This class will explore the foundations of Internet communication and the Client-Server model. Routers, switches, IP and hardware addressing, DNS, DHCP, NAT, TCP and UDP transport layers, ports, sockets, and DNS will be explained. This class is meant for the engineer who has no problem setting up their own home network, but has not necessarily dove into the details of what all it takes for a client to retrieve a resource from a server.
23071 IoT2 : Small Things in a Big Network: Things to Consider When Creating Devices for the IoT	The internet's rules (RFCs) are the same for big and small machines. Constrained IoT devices prefer brevity and power conservation and thus require very efficient messaging protocols and data structures. This class will explore and contrast the usages of HTTP, MQTT, and CoAP, and HTML and JSON when working with various cloud services. We will explore how to future-safe a connected design with rapidly changing Web APIs. Some edge-connected devices are not IP based and might even be sub-GHz. We will cover the basics of that architecture along with considerations for edge nodes and internet gateways for them. Security in a constrained environment will be assumed here with the details covered in other classes.
23072 IoT3 : Wi-Fi® Introduction and Debugging Techniques	Most IoT devices end up connecting to the internet using Wi-Fi® either immediately or through a gateway. In this class you will get introduced to the basics of Wi-Fi (IEEE802.11) as a MAC layer protocol. You will also learn how to build a cheap Wi-Fi sniffer to debug your Wi-Fi environment. You will also get familiarized with the most common issues in a Wi-Fi network and how to identify them and possible solution. Additionally, you will learn how to debug upper layers issues (DHCP, TCP, UDP, etc.).

23073 IoT4 : Get on the Google Cloud in Minutes Using PIC®/AVR® MCU-based IoT Solutions	The IoT solution is widely used for connecting simple sensors/actuators to securely exchange data to and from the cloud. Data visualization and processing render meaning to the exchanged information. This class will demonstrate how easy it is to create IoT sensor/actuator nodes, integrate them with the Cloud and view the data in real time using the comprehensive microchip solution that covers all aspects of security and data integrity. The development platform of your choice will be available: PIC-IoT WG or AVR-IoT WG development board. You will create a smart, secure and connected application using the PIC®/AVR® MCU IoT node with on-board ATECC608A secure element and WINC1510 Wi-Fi® module. Finally, you will learn to add new sensors/actuators to the PIC/AVR MCU IoT node to exchange data over the Google Cloud.
23074 IoT5 : The Google Cloud Demystified	As an embedded control developer, you have learned how to publish your IoT sensor data to the Cloud, but you might still be wondering what happens to it once it's on the “other” side. How can I visualize it? Where is it really now? Is it stored? Google provides many services and tools by arcane names, some enable analytics, others connect to home automation platforms and/or promise powerful machine learning, but how do you apply them to your data? In this class you will learn from the actual developers at Google (and partner Leverege) how the Google Cloud Platform can benefit your applications and help you develop the most advanced IoT applications with ease. Demos will be provided using the PIC-IoT and AVR-IoT development kits.
23075 IoT6 : Simplifying TCP/IP Applications with MPLAB® Harmony	If you don’t know how TCP/IP works but you have to add network connectivity to your product, this is the right class for you. We will teach you the basics of TCP/IP, how the client-server model works, what ports and sockets are and how applications use them to create TCP/IP connections. The class will also teach you the fundamentals of network analysis with the well-known tool Wireshark. The hands-on part of the class utilizes Microchip's 32-bit MCUs with MPLAB® Harmony. You can learn the architecture and the fundamentals of the Harmony TCP/IP stack to interface your TCP/IP application with some common stack APIs. To make your life easier, the FreeRTOS™ task schedular is used to simplify your application programming.
23076 IoT7 : Controlling Your Embedded IoT Device Using Amazon Alexa	This class will show how to use a voice-controlled digital assistant (Amazon’s “Alexa” or Google’s “Google Assist”) to control your custom, Wi-Fi® based embedded device. The class will focus on the Amazon AWS ecosystem and will show you how to enable any embedded Wi-Fi “end device” to be controlled by a voice digital assistant (the lab will use the Amazon Echo or Amazon Dot for the voice control). You will learn how to create voice “skills” for your end device (turning things on/off, up down, etc.). You will develop the skills using Amazon’s voice simulator and then use voice commands to a local Amazon Echo/Dot to control your Wi-Fi based end device during this lab. During this class you will be exposed to elements including MQTT, JSON/Javascript, and the overall Amazon AWS ecosystem. Attendees who take this class may also be interested in class SEC4 - Authentication and Secure Connections for IoT projects using AWS IoT.
23077 IoT8 : Simple Linux Based IoT Edge Node	Linux is used in many embedded devices from security cameras to home appliances. This class will teach you how to build a Linux edge node that is smart and connected to the cloud. You will learn the different requirements to connect to popular cloud vendors such as AWS, Google and Azure. You will also learn how to write a simple Python application that reads data from sensors available on real-world designs and sends this data to the cloud for fast prototyping. In the lab you will utilize the SAMA5 MPU to connect to the Azure cloud platform.

23078 IoT9 : Bridging Sensor to the Cloud Using 802.15.4 Mesh Network	The 802.15.4 protocol is one of the de-facto standards in the world of networking. It covers both the 2.4 GHz and subGHz spectrums. The SAMR30 transceiver operates in the Sub-GHz spectrum. Wi-Fi® is currently the dominant protocol used in IoT applications. However, multi-protocol networks, including Wi-Fi and 15.4, are becoming more common. During this class you will learn how to develop a wireless sensor network based on 802.15.4. A Wi-Fi gateway and a cloud-based server will also be used. The end-nodes will be deployed in a MESH type topology. The labs will feature Microchip's IEEE 802.15.4 compliant single-chip solution that combines an ARM® Cortex®-M0+ based 32-bit microcontroller and RF transceiver, the Xplained Pro development platform and the Studio 7 IDE.
23079 IoT10 : LoRa® Basics - Introduction to LoRaWAN™	The LoRa® technology was created to transmit small packets of data over very long distances. The technology is extending the reach of IoT by combining long-range wireless connectivity with low power. This class will describe the general characteristics and capabilities of the LoRa technology and the LoRaWAN™ protocol. It will also demonstrate how simple peer-to-peer communication can be enabled using LoRa technology for long-distance communication between two devices. Attendees will learn the fundamental concepts that will allow them to delve into more complex concepts and labs of the more in-depth LoRa protocol hands-on class.
23080 IoT11 : Securely Connect Your IoT Device with LoRaWAN™ Protocol to The Things Network	Using a technical hands-on approach, this class will address the challenges when building an IoT system, such as system integration, power consumption optimization, provisioning, security, RF performance and operations. Solutions will be provided using the SAM R34 - the industry's lowest power LoRa® SiP MCU, the Microchip LoRaWAN™ stack, and the ECC608 Secure Element. This class will cover real use cases, such as energy management, street lighting, smart home and smart building and tracking. The class will walk through connecting a LoRaWAN-enabled endpoint through a LoRaWAN gateway to The Things Networks servers and finally to an end application.
23203 AWS : Amazon Web Services, solutions from node to gateway	There is no one-size-fits-all approach to developing cloud-connected systems. To enable the creation of smart, connected and secure designs, Microchip has expanded its collaboration with Amazon Web Services (AWS) to support cloud-connected embedded systems from the node to the cloud. Supporting AWS IoT Greengrass, Amazon FreeRTOS and AWS IoT Core, Microchip provides all the components, tools, software and support needed to rapidly develop secure cloud-connected systems. Learn how this collaboration builds end-to-end IoT solutions for everything from edge node applications to the gateway. This remote management includes over-the-air (OTA) updates to device deployed across many locations.
23205 SP : Security Aspects for IoT projects	The security of IoT has been highlighted as one of the critical factors for the success of the deployment in the major digital transformation opportunity we are living. In this talk we go over the concept of IoT security from two angles.First we describe state-of-the-art approach at IoT security as a process, with three major phases: design, implementation and operation. For each phase it is necessary to highlight threats and assets, define roles and responsibilities, and elaborate the security dimension of the project development.In the second part of the talk we look at practical aspects for implementing security in an IoT scenario. Silicon devices today offer a great set of security features: secure elements, microcontrollers with trust zone, cryptographic hardware acceleration, security protocols and more. We go over these features highlighting how they can contribute to fulfilling all the security requirements of the application. Those contributions are put in perspective of attacks and threats identified in the first part.The aim of the talk is to give a comprehensive overview of the security aspects for an IoT project and the actions to be taken.

23206 MOZ : Improve Your IoT Products with Mozilla's Open Source WebThings Framework	Both businesses and consumers have a hard time understanding how to take advantage of IoT devices -- what works with what? Are my data secure and protected? Am I in control? Mozilla has built an open source web of things framework (part of our participation in the W3C WoT interest group) to engage both developers and industry in its mission to improve privacy, security, and interoperability around IoT. Our decentralized framework helps break the vertical "cloud integration" paradigm (where each vendor builds a proprietary silo) and instead gives users ownership and control of their IoT data.
23208 TER : Smart Metering System Example based on Terranova DLMS/COSEM protocol communication Libraries	A class about how to implement a smart and secure metering system using the TSM Libraries from Terranova. The scenario is composed by a simple client/server application exchanging metering information using standard DLMS/COSEM protocol over tcp/ip.To concentrate the focus on the final application and less on firmware development, the metering server will run over a SAMA5D27 running Linux and exploiting the built-in hardware crypto engine to secure the protocol data.
23209 WIT : Secure over-the-air update solution using containers (FullMetalUpdate) and automation framework for testing (WitekioLab) applied to a LoraWan scenario.	Witekio will introduce FullMetalUpdate, its secure open source over-the-air update solution, and WitekioLab, its in-house tool for automated and continuous testing of embedded systems. Both presentations will be supported by a set of demos showcasing Witekio's implementation of a LoraWan gateway on the latest Microchip ATSAMA5D27-WLSOM1-EK1 development kit and making use of multiple Microchip Lora RN2483 Mote development boards for sensor nodes.FullMetalUpdate - A secure open source over-the-air update solution using containers. In this talk, we will introduce FullMetalUpdate, a fully integrated open source solution that offers a brand new approach to system updates by using Yocto to generate containers and OSTree to deploy them. FullMetalUpdate is based on hawkBit for the update management server, Yocto for the build server, OSTree for the deployment, runC for the container runtime, and systemd for the life cycle management of the containers. WitekioLab - Automated and continuous testing. This talk introduces WitekioLab (name STC), a tool developed by Witekio to facilitate automated and continuous testing of embedded devices. Users can continuously verify that their product's feature set continues to work throughout development and ensure that issues are identified as soon as they appear. By eliminating the 'testing barrier', more robust products can get to market quicker and save companies weeks of effort at the end of a development cycle.
Analog and Mixed Signal	
23081 AMS1 : Analog Simulations Using the MPLAB® Mindi™ Analog Simulator	An analog simulator can help to reduce design cycle times by allowing an engineer to explore and understand the circuit's behavior, details, and nuances - mitigating risks from non-testable specifications and functionality due to costs and time. This hands-on class will teach you how to use the MPLAB® Mindi™ analog simulator platform, which provides optimized SIMetrix and SIMPLIS simulation tools for developing and qualifying both mixed signal and power supply circuits for your design needs using Microchip's analog portfolio.
23082 AMS2 : Sensor System Design 1: Using Analog Techniques for Sensor Data Processing, A Practical Design Study	The course will demonstrate techniques to accurately extract a low level signal from background noise and wandering baseline using signal processing in the analog domain. The course will demonstrate a practical design from design requirements to prototype using Microchip's analog simulation tools and based on an ECG front end. We will begin with initial design requirements and an explanation of why these constraints exist. Solutions to these constraints will also be discussed. We will then demonstrate a simulation of the design using the MPLAB® Mindi™ analog simulator thereby demonstrating the capabilities of the simulator, Microchip libraries, component selection, etc. This section will also cover filters and amplifiers. The final section will cover the implementation including any constraints. It will touch upon PCB layout, thermal considerations, EMI, and the testing of the design. Note that there are other MASTERs classes for in-depth information on these areas of PCB Design.

23083 AMS3 : Sensor System Design 2: Interfacing of Analog Sensors to Digital Controllers	This class provides an overview of interfacing an analog sensor to a digital controller in your application. Once the sensor requirements have been defined in your application, the focus is on obtaining the sensor data in an effective manner. This class covers key signal conditional concepts such as filtering, aliasing and anti aliasing filters, oversampling and ADC requirements. This class will include a number of real-world application examples to demonstrate the topics.
Motor Control	
23086 MC1 : Beginner's Guide to Sensored and Sensorless BLDC Motor Control Using Microchip's 8-bit and 16-bit Device	Having problems with sensored and sensorless BLDC motor control and don't know where to start? Overwhelmed with complicated and complex motor control solutions that are available? This class is designed for engineers who wants to learn embedded motor control who have little or no background on motor control. The purpose of this class is to introduce the theory and algorithm behind BLDC motor control, how to implement a sensored 3-phase BLDC motor control on an 8-bit MCU (PIC18F Family) and sensorless 3-phase BLDC motor control with Back-EMF filtering using the majority function of a 16-bit MCU (dsPIC® DSC). This class serves as preparation for the DSC Motor Control Workshop. The class is divided into 3 parts: lecture on BLDC motor control theory, demonstration of 8-bit Motor Control Implementation, and 16-bit motor control implementation. A demo will show the step-by-step implementation of a BLDC motor drive using the MPLAB® Code Configurator (MCC) for an 8-bit sensored control and digital BEMF filtering routine for the 16-bit sensorless control. The controls will be implemented on dsPICDEM™ MCLV-2 Development Board with a PIC18F and dsPIC33 PIM, respectively.
23088 MC3 : dsPIC® Digital Signal Controllers (DSCs) Motor Control Workshop	This 4 hour workshop class is for those aiming for a clear understanding of 3-phase brushless permanent magnet motors and their control at the fundamental level. BLDC (Brushless DC) and permanent magnet synchronous motor (PMSM) designs are reviewed along with the classic control algorithms used for each. The material covers the dsPIC33xx architecture and motor control peripherals, along with an in-depth look at the Microchip demo board, MCLV-2. The workshop will also provide three hands-on labs using a dsPIC33CK256MP506, which will cover sensored BLDC (six step) control, sensorless BLDC (six step) control and sensorless PMSM (Field Oriented) control. These labs will also use a new high-speed "X2CScope" virtual oscilloscope for tuning and control purposes. This class provides a foundation from which further motor control refinements and control techniques can be explored with confidence.
23089 MC4 : Workshop on Field Oriented Control and Vectored Windmilling of PMSM Motors on 32-bit ARM® Cortex® M4 MCUs	The primary objective of this class is to help attendees understand and visualize the concepts of Field Oriented Control (FOC) and vectored windmilling of PMSM Motor. Field oriented control enables efficient, noise free and improved control dynamics of a permanent magnet motor and vectored windmilling allows for an "On-the-Fly" sensorless start of an already spinning motor without any additional sensors. In addition, this class covers motor control specific features of SAME54 (32-bit ARM® Cortex® M4 based) microcontroller. This class allows a hands-on opportunity to experience the sensorless FOC of PMSM using PLL estimator on SAME54 powered by Microchip's all new and easy to use MPLAB® Harmony 3 embedded software framework.
23090 MC5 : Advanced Stepper Motor Control Using dsPIC33CK Device	Stepper motors have a unique advantage of running in "open loop mode" (where coils are energized in a timely manner) and still perform position control. While such a mode of operation is simple, it is grossly inadequate for demanding applications such as 3-D printers where any vibration or overshoot will degrade the quality of performance. For controlled operation and for faster response, (bipolar) stepper motors should use sophisticated current control, which can be easily accomplished using the high-speed PWM and ADC from the latest dsPIC33CK generation devices. This class will cover the various control schemes of stepper motors (open and closed current control) and how they are achieved using dsPIC33CK devices.

23091 MC6 : Open Source Graphical Programming and Rapid Prototyping Using SCILAB/X2C for 8/16 and 32-bit MCUs from Microchip	This class is for those who want to model and simulate systems and then run auto-generated code on a target microcontroller from the same tool set. It scales across many target uCs and system types, but is particularly relevant to motor control. The powerful combination of tool features enables rapid development and verification of practical system performance against the theoretical prediction. An introduction into SCILAB/X2C and the capabilities of the tools is given. Then, motor control demos for different uC platforms are shown to simulate and then spin brushless motors running advanced sensor-less algorithms. The integrated real time X2C virtual oscilloscope (available separately as a MPLAB® X IDE plugin) will be used to measure target variables, aid debugging and verify practical system performance. The efficient, scaleable tool set can be used to develop numerous systems. Participants will learn how to configure the tools, develop a model, simulate an application, generate code and verify system performance. This class is a prerequisite for the MC7 hands-on class.
23092 MC7 : Open Source Graphical Programming and Rapid Prototyping Hands-on Class Using SCILAB/X2C for 8/16 and 32-bit MCUs from Microchip	In this class you will do a hands-on training based on what you have learned in the SCILAB/X2C lecture class. In the first part you will work with a basic demo to get familiar with the software packages and the capabilities of the tools. You will learn how to setup a framework project in MPLAB® X IDE using MCC, how to develop a model, simulate the model on the PC and how to generate code that executes on the target platform. X2C will be used to tune parameters online in real-time and verify the behavior of the real application. In the second example, a high end motor control demo of a sensorless field oriented control PMSM motor will be used to simulate a complete motor control application. Once the model is programmed onto the MCLV-2 board, real-time signals are monitored and controlled and observer parameters are tuned for optimal performance. The MC6 class is a mandatory prerequisite for this class.
Power Supplies and Power Conversion	
23093 PC1 : Fundamentals of Switch-Mode Power Converters	Switch-mode power converters are widely used primarily because of their high efficiency and small size. To some, switch-mode converters are mysterious devices yet the basic principles of switch-mode converters are fairly simple. This introductory class presents the principles and concepts of switch-mode converters and lays the foundation needed for the more advanced power conversion classes. The class starts with the fundamental principles of energy storage and processing common to all switch-mode converters, inductor volt-second and capacitor charge balance. Using these principles and a “follow the energy” approach, the operation of the most common switch-mode converters is explained. Converters discussed in some detail include the buck, boost, and flyback converters. After this class it is suggested that those interested in switch-mode power take the PC2 which provides an introduction to feedback and control loops for switch-mode power converters. Note: this class will be taught by a representative from Embedded Power Labs.
23094 PC2 : Fundamentals of Switch-Mode Power Converter Control	This class provides an introduction to applying feedback and control concepts to make practical analog control circuits for switch-mode power converters. While 23nnn PC1 is not a prerequisite, this class builds on the concepts presented in that class. The class starts with a review of feedback and the desirable characteristics of a control loop. Then the control loop of the buck converter is examined, leading to the design equations for the error amplifier/compensator. The K-factor method is introduced as a way to quickly get a stable and well performing feedback loop. The last part of the class is an overview of current mode control and its advantages. While there is a fair amount of algebra, the focus of the discussion is on understanding the concepts and principles. After this class those interested in designing power converter control loops with digital control should take the PC3 class, which provides in-depth information on how to design digital controllers for switch-mode power converters. Note: this class will be taught by a representative from Embedded Power Labs.

23095 PC3 : Fundamentals of Digital Switched-Mode Power Converter Control	This technical session is aimed at firmware engineers and embedded systems programmers who need to learn the foundation principles needed for fully digital compensator design and implementation. This session covers all topics necessary to design stable digital control loops on dsPIC® DSC devices. Topics such as discrete time control systems, Z transforms and linear difference equation coefficient calculations are presented in a step-by-step manner and additional, specific aspects and challenges of discrete time domain signal generation, sampling processes and number conversion are discussed and supported by live demos. The material covered will also be necessary for understanding many of the other technical sessions at the conference.
23097 PC5 : Fundamentals of Power Integrity in Embedded Systems	Technology in the digital world continues to move swiftly towards higher performance and capabilities. Even relatively simple user interfaces today are equipped with SuperSpeed USB or Gigabit Ethernet interfaces in conjunction with powerful graphics controllers interconnected with high performance MPUs or FPGAs and their external high-speed memory blocks in extremely small footprints. With increasing complexity and performance, the dominance of high-frequency specific aspects are significantly impacting the design of the entire power distribution network (PDN). Complementary to classes SIG2 on signal integrity and PNP10 about specific pitfalls in MPU designs, this class is introducing fundamental power integrity related design aspects covering PCB and chip-level influences, component selection of individual voltage regulator modules (VRM) and decoupling aspects of their high-speed loads to achieve maximum system reliability and performance. Modelling and physical dependencies will be shown on live demonstrators.
23098 PC6 : Practical Aspects in Power Integrity: Topology Selection and Step-by-Step VRM and PDN Design for Flat-Impedance	Foundational theory needed for flat-impedance PDN design is first summarized and condensed in a few simple equations. The flat-impedance VRM and PDN design procedure is exemplified using a Peak Current Mode Controller while the design process is supported by experimental data. The decoupling capacitors selection process for flat-Z PDN profile is illustrated by measurements from a concept board. VRM output resistance programming using inductor DCR as a current sensor is addressed, and relevant design equations are explained. The design process is validated by measurements from a constant-frequency hysteretic regulator board. The effects of L/DCR time constant mismatches in the current sensing network on the VRM output impedance are also analyzed. Measurements of VRM output impedance characteristics under different control topologies are shown and the implications on output capacitor size to achieve VRM flat-impedance profile are discussed.
23100 PC8 : Advanced SMPS Design Using Programmable Mixed Signal Controllers	Many new fields of application such as advanced lighting, energy storage or advanced cross-system power management in industry 4.0 applications require power supply solutions which are more intelligent and adaptive to their environments. These solutions can also help system integrators to reduce cost by increasing reliability and reducing efforts for maintenance. In this class we will focus on software-configurable analog PWM controller architectures, their target applications and design tools provided to build customized single- and multi-block switched-mode power supply stages using Microchip's latest graphical design tools. This course will guide you step by step through the design process of creating customized on-chip power control blocks for advanced applications focusing on DC/DC converters and LED lighting. In addition we will offer an Open Lab evening class with the ability to play with the material you learned about in that class. Details on the open lab session will be provided during class.
23102 PC10 : Developing Power Management Solutions for Battery Powered, IoT and Embedded Systems Using the MPLAB® Mindi™ Analog Simulator	This class starts by identifying power management requirements for common battery powered, IoT and embedded applications. Power system solutions for each are identified and compared for performance, complexity and size. The selected solution will be modeled using the MPLAB® Mindi™ analog simulator to validate that it meets the key requirements.

23103 PC11 : Power over Ethernet (PoE) Design Considerations	As a result of the Microsemi acquisition, Microchip now offers Power over Ethernet (PoE) solutions, including both Power Sourcing Equipment (PSE) and Powered Device (PD) solutions. This course will offer an introduction to PoE technology and to the new IEEE802.3bt Standard. In addition the course will offer detailed PD design techniques intended to help the PD designer avoid common pitfalls. Topics will include design techniques for isolation, EMI, thermal, line transformer, layout and noise as well as DC/DC design tips for cost vs. efficiency considerations.
23104 PC12 : Fundamentals of Wireless Power	Wireless power transfer techniques are widely used to transfer power from one system to another in a wide range of applications. Qi is the most widely adopted wireless charging standard and it has proliferated into nearly all consumer cell phone brands. Qi's broad market adoption and open standards make Qi an ideal choice for IOT and other portable device where non-contact, connector-less charging is valuable. This class will focus on the basics of wireless charging, with an emphasis on Microchip designs. During the session, attendees will learn the basics of wireless charging, technology limitations, the Qi protocol, how to select and tune antennas, as well as implementation tips and tricks. After taking this class the student will be confident in executing basic wireless charging designs suitable for product incorporation. Note: this class will be co-presented by a representative from Würth Electronik
Batteries	
23105 BAT1 : Battery Charging Fundamentals: Battery Chemistry, Terminology, Profiles and Charging Topologies for Real-World Products	This class will introduce you to standard charge profiles for several common battery chemistries including Li-Ion, LiFePO4, NiMH and Lead Acid. We will then dismantle a number of real-world products and discuss their charging and battery requirements. Next we will learn how to read a datasheet to determine the charge parameters and become aware of common issues with the provided data. Finally we will review several charging topologies including linear, boost and buck, and discuss the pros/cons of each.
Signal Integrity and PCB Design	
23110 SIG2 : EMC Demystified	This class unravels the mystery behind the discipline of EMC and its impact on embedded systems design, with particular emphasis on microcontroller based applications. Intuitive relationships, rules of thumb, and a minimum of math are used to guide the participant through the fundamentals of EMC from both an RF emission and immunity perspective. The effects of noise on microcontroller performance are presented and demonstrated through case studies and live demos. Various hardware and software techniques to help avoid and/or resolve real-world EMC problems are discussed. After this class, you will be able to design new products with EMC in mind, reducing the likelihood of EMC related issues later in the process. You will also be able to better understand and mitigate EMC problems in existing product designs.