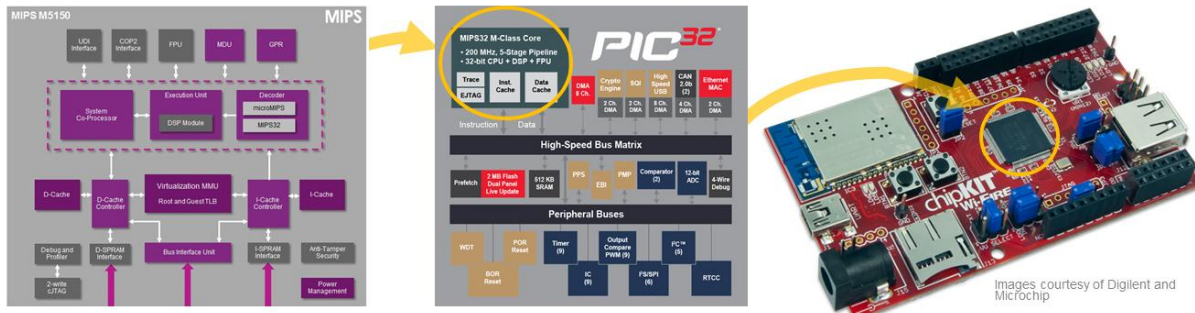


# The Connected Microcontroller Lab



## Description

This semester-long course provides an interactive and compelling start to teaching connected embedded control systems. It uses the popular Microchip PIC32MZ microcontroller based on a MIPS M5150 core, which is also used in the Imagination MIPSfpga Computer Architecture and SoC courses. It takes students through the basic microcontroller and I/O, through real-time operating system concepts and advanced processor architecture, and finally into cloud connectivity.

## Why 32-bit?

Connecting an embedded system to the cloud to create an IoT device demands significant processing resources and code support. 32 bit microcontrollers without the complexity of Linux are in the “sweet spot” of providing powerful resources whilst simplifying software issues. Industry has a growing need for embedded systems developers and the requirements for connectivity are driving a rapid transition to 32 bit.

## Target Audience

Targeted at under-graduates in Electronic Engineering or Computer Science, this is the starting point for learning about embedded systems. Presenting the key concepts in a fresh and jargon-free style, the only prerequisite is some introductory C programming knowledge.

## The Author

Dr. Alexander Dean of North Carolina State University is a member of the faculty of Electrical and Computer Engineering. He has taught how to build embedded systems using microcontrollers since 2000 and has written three textbooks on the subject.



## Content

- Embedding a computer in a system – Why and how?
- Fundamentals: MCUs vs. computers, connectivity, hardware and software.
- Software Design: Concepts, tools and debugging.
- Basic Digital I/O Ports: Reading switches and lighting LEDs.
- Basic Concurrency: Concepts, run-to-completion tasks and interrupts.
- Using Peripherals: Analog interfacing, timing & counting, communications, interfacing with Arduino shields
- Advanced Concurrency: Concepts of task pre-emption and real-time kernels, building multithreaded applications with semaphores, mutexes and queues on FreeRTOS.
- Improving CPU throughput: What’s under the hood? Processor architecture, memory systems & caches, software analysis & optimisation
- IoT: Overview, Cloud services, building a Cloud system

## Structure of the materials

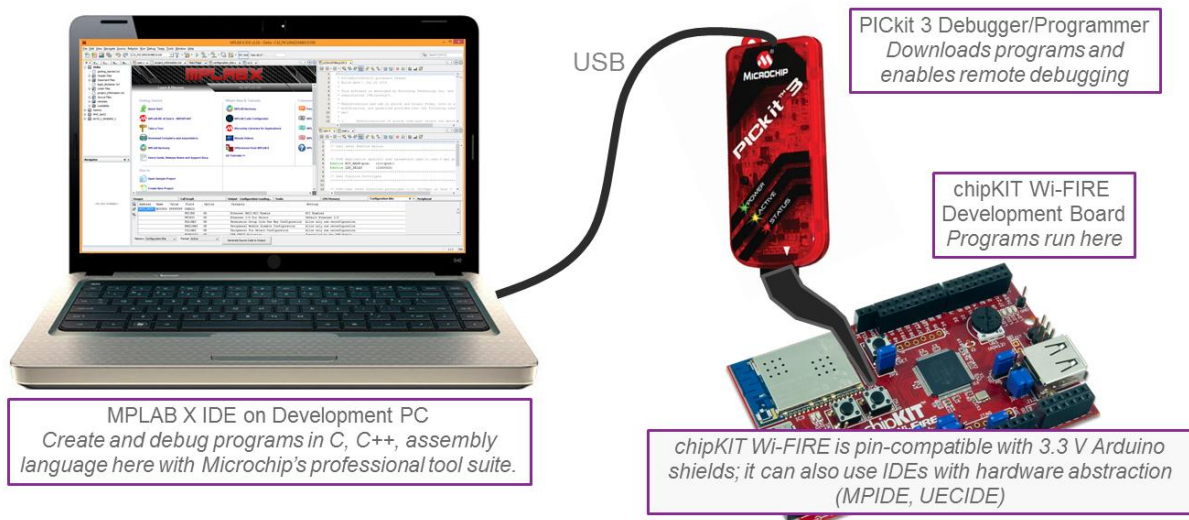
(in .pdf/.ppt/.doc formats to enable creative use)

- Presentation Slides for each module
- Student guide
- Exercises
- Tests
- Solutions
- Instructor's Guide

## Supporting Materials & Events

- The popular textbook Digital Design and Computer Architecture by Harris & Harris provides a deeper insight into the MIPS architecture and includes a chapter on the PIC32 MCU.
- [Other relevant textbooks](#)
- Tutorial videos of the Workshop given by Alex Dean: will be available Q4'16
- Global Workshop Programme: to be announced on [Events page](#).

## Development Environment



## Required Tools

### Hardware

- Digilent [chipKIT Wi-FIRE board](#) using Microchip's PIC32MZ MCU  
- Growth capability to create great projects: powerful 200MHz MCU board, WiFi, and Arduino-shield expandability
- [ChipKIT Basic I/O Shield](#)
- Microchip [PICkit 3 In-Circuit Debugger](#)

### Software

- Microchip MPLAB X IDE for Assembly and C Programming – full version, free of charge [download](#)
- Microchip MPLAB Harmony Integrated Software Framework - free of charge [download](#)
- Imagination Technologies' [FlowCloud](#) communications software, cloud service (free accounts up to 5 nodes), and messaging
- FreeRTOS – free of charge download from [www.freertos.org](http://www.freertos.org)

## Support

- **Microchip** forums:  
[PIC32 Topics](#)  
[Developer Help](#)
- **Digilent** forums:  
[chipKIT](#)  
[Add-On Boards](#)
- The **MIPS** insider forum [here](#) has a thread specifically for technical questions about Connected MCU Lab.
- The **IUP** forum [here](#) for questions and discussion about teaching and projects.

## User Licence

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2. Complete the first section: 'the Community Registration'
3. Tick the box marked 'Join Imagination University Programme' and complete the additional information

Do you also want to register for  
the Imagination University  
Programme?  Yes

4. A verification email will be sent to your inbox for activation.  
(Please check your spam filter because occasionally these mails are intercepted!)
5. To download teaching materials, visit the IUP page - Teaching Resources  
<http://community.imgtec.com/university/resources/>
6. Request the package(s) you want, accept the Licence Agreement, and give some details about how you plan to use the materials.
7. We then receive a request to approve the download, and normally action this within 48 hours. Once approved, you will receive an e-mail saying you can now make the download.

Please feel free circulate this information to anyone who might be interested and keep an eye on our webpages for further information such as workshops and updated packages.

## Partners

We have worked closely with Digilent and Microchip who have given wonderful support to this course.



## Available Languages (estimated release date)

- English
- Simplified Chinese (October 2016)

## Press Releases & Blogs

- [Press Release](#)
- [Course philosophy by Alex Dean](#)
- [Electronics Weekly](#)