Possible Structure for Intermediate Course in Embedded Systems/Microcontrollers,

making use of PIC 16 Series Microcontrollers; Assembler-Based

tjw rev. 16.6.07

This lecture plan gives suggestions for building an intermediate course or module based on the book *Designing Embedded Systems with PIC Microcontrollers,* by Tim Wilmshurst. This course assumes a basic knowledge of microcontrollers and embedded concepts, and focuses on application of peripherals to build larger systems. The course can be restructured in many different ways. The pace of delivery will depend on the aptitude of the group, and their level of study.

Notes:
1. This schedule runs directly from the *Introductory Course in Embedded Systems/Microcontrollers*, or similar. It can be part of the same course, or as a stand-alone course in a later year.
2. For maximum benefit from this course, it needs to have suitable equipment for students to undertake practical work on. It is assumed that appropriate practical work is running in parallel to the lectures. The book uses the Derbot AGV. Numerous other systems are available. Whatever is used, the Derbot designs and example programs still provide valuable resource material.
3. After the first topic, the sequence is flexible. Not all topics need to be covered, and the order is in some cases flexible.

Lecture	Topic	Book Pages	Program examples/ exercises
1	**The Larger Microcontroller:** Review of concept of microcontrollers as core + peripherals + memory. The 16F87XA group of microcontrollers, their memory maps, peripheral set and interrupt structure. Example minimum circuit – Derbot Build Stage 1 (Fig. 7.22) or equivalent.	Ch 7, pp 145-154, 175	-
2	**Test and Commission** (customize to the hardware and download tools in use)**:** The challenge of testing an embedded system, oscilloscope and logic analyser, In Circuit Emulators, on-chip debuggers. The Microchip In-Circuit Debugger (ICD 2)	Ch 7, pp 165-173	Program Examples 7.1
3	**The Human Interface – Keypads and Displays:** Keypad structure, interconnection and driving routines. 7-segment led characters, common anode/ cathode connection and multiplexed driving. PIC-based drive routines.	Ch 8, pp 184-198	Program Examples 8.1 & 8.2
4	**Liquid Crystal Displays:** LCD concepts, the HD44780 display driver and its derivatives. Interfacing to a microcontroller.	Ch 8, pp 199-203	Program Example 8.3
5	**Issues of Interfacing:** Survey of simple sensors and actuators, their interface. Interfacing logic signals, applying Schmitt trigger, input protection and simple filtering.	Ch 8, pp 203-221	Program Example 8.4

	Example complete circuit – Derbot Build Stage 2 (Fig. 8.29) or equivalent.		
6	**Taking Timing Further:** Review of Counter/Timer principles, the 16F87XA Timer 1. Using Timer 0 and Timer 1 to generate repetitive interrupts. Timer 2, comparator and PR2 register. The Capture/ Compare/ PWM Modules in capture and compare modes.	Ch 9, pp 225-237	Program Examples 9.1 & 9.3
7	**Pulse Width Modulation (PWM):** The Principle of PWM. Generating PWM Signals in Hardware - the 16F87XA PWM. PWM Applied for Motor Control and Digital to Analog conversion. Generating PWM in Software.	Ch 9, pp 237-252	Program Examples 9.2- 9.4
8	**Starting with Serial:** Basic concepts, synchronous vs asynchronous. Simple synchronous links, SPI & Microwire. The 16 Series MSSP serial port.	Ch 10, pp 263-275	Program Example 10.1
9	**The Inter-Integrated Circuit Bus (I^2C):** Main I^2C features, signal characteristics, and physical interconnection. The MSSP Configured for I^2C in slave and master mode.	Ch 10, pp 275-292	Program Examples 10.2 & 10.3
10	**Asynchronous Communications:** The 16F87XA USART, control registers and applications.	Ch 10, pp 293-302	Program Example 10.4
11	**Data Acquisition:** Concept of the Data Acquisition system and the A to D converter. PIC 16 Series implementation, the ADC module. Block diagram, the analog input model, controlling and applying the ADC.	Ch 11, pp 304-321	Program Example 11.1
12	**Expansion Time**		