# Course Material for Introduction to Embedded Systems Course based on **Creating Fast, Responsive and Energy-efficient Embedded Systems using the Renesas RL78 Microcontroller**

[Questions and Solutions for Exams and Quizzes](Test%20Questions/Questions%20and%20Solutions%20for%20Exams%20and%20Quizzes.docx)

[Solutions for Homework Exercises](Solutions%20to%20Exercises.docx)

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|  | **PowerPoint Slides** | **Demonstration Code** | **Additional Material** | **Projects & Solutions** |
| **1** | **Introduction** | | | |
|  | [Chapter 1](Ch1-Introduction/Ch1%20-%20Introduction.pptx) |  |  |  |
| **2** | **MCU Concepts, Infrastructure and Interfacing** | | | |
|  | [Chapter 2](Ch2-MCU%20Concepts/Ch2%20-%20MCU%20Concepts,%20Infrastructure%20and%20Interfacing.pptx) | [SwLEDDemo](Ch2-MCU%20Concepts/SwLEDDemo.zip) - Lighting LEDs and reading switches |  |  |
|  | [RDK Glyph LCD Output](Ch2-MCU%20Concepts/RDK%20Glyph%20LCD%20Output.pptx) | [LCDDemo](Ch2-MCU%20Concepts/LCDDemo.zip) – Using the LCD for text and graphics | [LCD datasheet](Manuals/RDKRL78/Okaya%20RE9664WRF-004-I02_6-1-10.pdf)  [LCD controller (ST7579) datasheet](Manuals/RDKRL78/20080316012510_ST7579_V0.9a.pdf) | [Pong game](Ch2-MCU%20Concepts/PongProject/PongProject.docx), [Solution](Ch2-MCU%20Concepts/PongProject/PongSolution.zip) |
| **3** | **RL78 CPU Core and Interrupts** | | | |
|  | [Chapter 3](Ch3-RL78%20CPU/Ch3%20-%20RL78%20Core%20and%20Interrupts.pptx) | [InterruptDemo](Ch3-RL78%20CPU/InterruptDemo.zip) - ISR which responds to switch press |  | [ISR Latency Measurement](Ch3-RL78%20CPU/InterruptProject.zip), [Solution](Ch3-RL78%20CPU/InterruptProject%20Solution.docx) |
| **4** | **Software Engineering for Embedded Systems** | | | |
|  | [Chapter 4](Ch4-SW%20Eng/Ch4%20-%20Embedded%20Software%20Engineering.pptx) |  |  |  |
| **5** | **Software Development Toolchain** | | | |
|  | [Chapter 5](Ch5-SW%20Toolchain/Ch5%20-%20SW%20Toolchain.pptx) |  | [Tips on using Applilet and IAR Embedded Workbench](Manuals/Tools/FAQ.docx)  [Applilet3 RL78 API Reference](Manuals/Tools/R20UT0758EJ0100_APPLILET.pdf)  [Renesas Flash Programmer Manual](Manuals/Tools/RFP%20Manual%20-%20r20ut0599ej0300_rfp.pdf) |  |
| **6** | **C as Implemented in Assembly Language** | | | |
|  | [Chapter 6](Ch6-C%20As%20Implemented/Ch6-C%20As%20Implemented.pptx) | [C Examples](Ch6-C%20As%20Implemented/C_Examples.zip) - Code compiled to assembly language |  |  |
| **7** | **Converting Between the Analog and Digital Domains** | | | |
|  | [Chapter 7](Ch7-Analog%20to%20Digital/Ch7%20-%20Analog%20Interfacing.pptx) | [ADCDemo](Ch7-Analog%20to%20Digital/ADCDemo.zip) - Voltage Meter using ADC in one-shot mode with software trigger, channel select |  | [Digital Oscilloscope](Ch7-Analog%20to%20Digital/ADCProject/ADCProject.docx), [Solution](Ch7-Analog%20to%20Digital/ADCProject/ADCProjectSolution.zip) |
|  |  | [ADCDemo2](Ch7-Analog%20to%20Digital/ADCDemo2.zip) – Voltage/Current/Power Meter using ADC with software trigger, channel scan |  |  |
|  |  | [DACDemo](Ch7-Analog%20to%20Digital/DAC_Demo.zip) – “Computer sound” audio generator |  |  |
| **8** | **Serial Communications** | | | |
|  | [Chapter 8](Ch8-Serial%20Comm/Ch8%20-%20Serial%20Communications.pptx) | [SerialTxDemo](Ch8-Serial%20Comm/SerialTxDemo.zip) – Transmit potentiometer value out serial port  [SerialRxDemo](Ch8-Serial%20Comm/SerialRxDemo.zip) - Display received potentiometer value on LCD (from SerialTxDemo) |  | [Serial Password Validator](Ch8-Serial%20Comm/SerialProject/SerialProject.docx), Solution |
|  |  | [LCDAccelDemo](Ch8-Serial%20Comm/LCDAccelDemo.zip) – SPI and I2C | [I2C-Bus Specification](file:///C:\Users\Alex\Documents\Teaching\Book%20Writin'\RL78%20Book\Release%20Package\Manuals\RDKRL78\I2C-BusSpec-V2.1.pdf) |  |
| **9** | **Timer Peripherals** | | | |
|  | [Chapter 9](Ch9-Timers/Ch9-Timers.pptx) | [IntervalTimerDemo](Ch9-Timers/IntervalTimerDemo.zip) – Scans LEDs 1-6 |  | [White Noise Audio Generation with PWM Project](Ch9-Timers/PWMProject/PWM-WNG-Project.docx), [Solution](Ch9-Timers/PWMProject/PWM-WNG-Solution.zip) |
|  |  | [TimerDemo](Ch9-Timers/TimerDemo.zip) – Anemometer to measure wind speed |  |  |
|  |  | [ADCTimerDemo](Ch9-Timers/ADCTimerDemo.zip) – Energy Meter (builds on ADCDemo2) |  |  |
| **10** | **Peripherals for Robustness and Performance** | | | |
|  | [Chapter 10](Ch10-Peripherals%20for%20R%20and%20P/Ch10-PRP.pptx) | [DTC and ELC Demos](Ch10-Peripherals%20for%20R%20and%20P/Code/DTC.zip) |  |  |
| **11** | **Task Schedulers and Optimizing for Responsiveness** | | | |
|  | [Chapter 11](Ch11-Responsiveness/Ch11%20-%20Responsiveness%20and%20Schedulers.pptx) |  |  |  |
|  | [Run-To-Completion Scheduler](Ch11-Responsiveness/RTC%20Scheduler.pptx) | [RTCSchedDemo](Ch11-Responsiveness/RTCSched.zip) – flashes LEDs and updates LCD with RTC Scheduler |  | Scheduler Project |
|  | [Analysis of Real-Time Systems](Ch11-Responsiveness/Analysis%20of%20Real-Time%20Systems.pptx) |  |  |  |
| **12** | **Optimizing for Program Speed** | | | |
|  | Chapter 12 | [Profiler Demo](Ch12-Opt%20for%20Speed/ProfilerDemo.zip) |  | [Graphics Speed Optimization Project](Ch12-Opt%20for%20Speed/SpeedOptProject/SpeedOptProject.docx), solution |
| **13** | **Optimizing for Low Energy and Low Power** | | | |
|  | [Chapter 13](Ch13-Opt%20for%20Energy%20and%20Power/Ch13%20-%20Power%20and%20Energy%20Analysis%20and%20Optimization.pptx) | [StopHaltDemo](file:///C:\Users\Alex\Documents\Teaching\Book%20Writin'\RL78%20Book\Release%20Package\Ch13-Opt%20for%20Energy%20and%20Power\StopHaltDemo.zip) – Measures MCU current in different modes |  | [Energy Optimization Project](Ch13-Opt%20for%20Energy%20and%20Power/EnergyOptProject/EnergyOptProject.docx), [solution](Ch13-Opt%20for%20Energy%20and%20Power/EnergyOptProject/EnergyOptProjectSolution.zip) |
|  |  | [PowerDemo](Ch13-Opt%20for%20Energy%20and%20Power/PowerDemo.zip) – Shows how to measure RDK current drawn from USB connection and compute power as various peripherals are disabled | [RDK schematic](Manuals/RDKRL78/YRDKRL78G14_SCH_2.pdf) |  |
|  |  | [VMinDemo](Ch13-Opt%20for%20Energy%20and%20Power/VMinDemo.zip) – Builds on PowerDemo to help evaluate minimum operating voltage for RDK and its components |  |  |
|  |  | [EnergyDemo](Ch13-Opt%20for%20Energy%20and%20Power/EnergyDemo.zip) – Uses ultracapacitor to measure RDK energy use | [Ultracapacitor information](http://industrial.panasonic.com/www-ctlg/tech/tABC0000_WW.html) |  |