# Embedded Systems Tutorial

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1. AVR CPU Core: Chapter 7.1-7.6, Summarized in Introduction
   a. Structure of the CPU: the concept of ALU, General purpose registers, flash memory, Data SRAM, I/O memory and Stack
   b. The registers: the concept of Program counter, Stacker pointer, Status register
   c. Clock: The concept of instruction execution time in term of CPU clock
2. Interrupt: Chapter 12.4
   a. Interrupt vectors in ATmega 328: Table 12-6
   b. Know how to program interrupt in Assembly and C, which bit to enable and disenable the global interrupt
3. External Interrupt: Chapter 13
   a. Which two pins can be used as external interrupt
   b. Know how to design Circuit to trigger an external interrupt
   c. Know how to program external interrupt in Assembly and C, which bit to enable external interrupt
4. I/O Ports: Chapter 14.2.1 and Chapter 14.4
   a. Concepts of the registers DDRx, PORTx
   b. Know how to design Circuit and programming to output digital voltage on Arduino pins
5. 16-bit Timer/Counter1: Chapter 16.2-16.3 and Chapter 16.11
   a. Concepts of Timer Overflow, registers TCNT1, TCCR1B
   b. Know how to program Timer overflow interrupt to generate precise time interrupt, the concept of a prescaler, how to set a prescaler in register TCCR1B
6. Output Compare Units: Chapter 16.7-16.9.3 and Chapter 16.11
   a. Concepts of Compare Match, registers TCNT1, OCR1A and OCR1B, TCCR1A and TCCR1B
   b. Know how to Generate a Compare Match interrupt
   c. Concept of a PWM waveform
   d. Know how to generate PWM on port D using compare match interrupt and CTC mode
   e. For similarity, also check Chapter 15.9 and Chapter 17.4 for Timer0 and Timer2
   f. Know how to generate PWM on OCnx (OC1A, OC1B, OC0A, etc.) pins using fast PWM mode
7. Analog to Digital Conversion: Chapter 24-24.4 (page 237- 240), 24.7,24.9
   a. The concept of reference voltage, how to set reference voltage in register ADMUX
   b. How select channel in register ADMUX
   c. How to start a single conversion by Analog to Digital interrupt or auto conversion
   d. The usage of register ADC and the concept of left adjust, the concept of the conversion range (0V - reference voltage map to a digital number 0-1023 stored in ADC)