Department of Technical Education
DIPLOMA COURSE IN ELECTRONICS AND COMMUNICATION ENGINEERING
Sixth Semester
ARM MICROCONTROLLER

Contact Hours/Week : 04   **Contact Hours/Semester : 64**

CONTENTS	No. Of Hrs.
Unit-I	
1.ARM Embedded Systems	05
2 ARM Processor Fundamentals	05
3.ARM Instruction Set	10
Unit-II	
4.Introduction to THUMB	02
5.ARM Programming	11
6.LPC 2148 CPU	07
Unit-III	
7.LPC 2148 Peripherals	20
Tests & assignments	**04**
Total	**64 Hrs**

GENERAL EDUCATIONAL OBJECTIVES:

1. **Know the architectural features of ARM7 family of microcontrollers.**
2. **Study the Instruction set of ARM**
3. **Study the hardware features from the programmer's point of view.**
4. Achieving competency in assembly as well as C programming of ARM.
    5. Developing simple systems(software + hardware) using LPC2148

ARM Embedded Systems: ARM Design philosophy, Embedded System Hardware, Embedded System Software

ARM Processor Fundamentals: Registers, Program Status Register, Pipeline, Introduction to exceptions

ARM Instruction Set: Data processing Instructions, Branch Instructions, Load, store instructions, Software Interrupt Instruction, Program Status Register Instructions, Loading Constants, Conditional Executions.

Introduction to THUMB Instructions: Differences, Register usage, ARM Thumb Interworking,

ARM Programming : Structure of assembly module, Subroutines in assembly, exception handling, interrupts, stack for interrupts, interrupt handling schemes, using inline assembly in C, Embedded assembly in C, ISRs in C.

LPC2148 ARM CPU: Salient features of LPC 2148, Pin Description of 2148 CPU, Architectural Overview - Memory Mapping -Block Diagram, features of different blocks.

LPC 2148 – Peripherals: Description of General Purpose Input/Output Ports (GPIO) & Pin control Block. Features, Pin description, register description & operation of PLL , timers, PWM,RTC,ADC,DAC & SPI

SPECIFIC INSTRUCTIONAL OBJECTIVES:

1   ARM EMBEDDED SYSTEM (05Hrs)
   1.1 List the special features of ARM processor design(1.2 of Andrew Sloss)
   1.2 The features of ARM instruction set which makes ARM suitable for Embedded systems.(1.2.1 of Andrew Sloss)
   1.3 Study the structure of a typical embedded device based on ARM(figure 1.2 of AS)
   1.4 Know the ARM bus terminology.(1.3.1 of AS)
   1.5 Brief discussion on AMBA Bus.(1.3.2 of AS)
   1.6 Know the role of memory and interrupt controllers(1.3 .4 of AS)
   1.7 Know the role of software components in an embedded system(1.4 of AS)
   1.8 list the applications of ARM processors

2   ARM PROCESSOR FUNDAMENTALS(05Hrs)
   2.1 Data flow model of ARM core
   2.2 The register file of ARM, know the function of LR,PC and SP registers
   2.3 Know the structure of CPSR register. The function of conditional flag bits, interrupt mask bits and mode bit with examples.
   2.4 A brief introduction into the different processor modes.- Banked registers
   2.5 Explanation of 3-staged pipelining of ARM-7 with an example.
   2.6 A brief introduction to exceptions, interrupts and the vector table(2.4 of AS)
   2.7 Action on entering and leaving an exception

3   ARM INSTRUCTION SET(Refer William Hohl & Andrew Sloss)(10Hrs)
   3.1 Data processing instructions -MOV & MVN instructions, Barrel shifter – its operation with examples
   3.2 Arithmetic instructions like ADD,ADC,RSB,SUB,SBC and RSC with examples. Using barrel shifter with arithmetic instructions.
   3.3 Logical instructions like AND,ORR,EOR,BIC with examples.
   3.4 Comparison instructions like CMP,TEQ,TST,CMN instructions with examples.
   3.5 Branch instructions like B and BL with examples.
   3.6 load and store instructions-LDR,LDRB,LDRH,LDRSB,LDRSH,STR,STRB,STRH,LDM and STM with examples-pre and post indexed with/without write back-addressing modes for multiple data transfer. Stack operations using STM and LDM instructions.
   3.7 Looping with B and BL instructions with examples

3.8 SWAP, software interrupt and PSR instructions.
3.9 Loading constants with pseudo instructions.
3.10 Conditional execution of ARM instructions.

4. INTRODUCTION TO THUMB(02Hrs)
4.1 Differences between ARM and THUMB instruction set
4.2 To know the register usage in THUMB
4.3ARM-THUMB interworking with BX and BLX instructions.

5. ARM PROGRAMMING(11Hrs)
5.1 General structure of an assembly language, Meaning of AREA,ENTRY directives
5.2 Subroutines using assembly-different methods of passing parameters with example programs, ARM APCS specification for register usage.
5.3Exception handling, ARM processor exceptions and modes, Vector table, Exception priorities, link register offsets(9.1of Andrew Sloss)
5.4Interrupts, standard design practices in assigning interrupts, interrupt latency, IRQ and FIQ exceptions-examples,
5.5Enabling and disabling of FIQ and IRQ exceptions with example code
5.6Basic interrupt stack design and implementation- examples for stack implementation in user, supervisor and IRQ modes.
5.7Listing of different interrupt handling schemes , process of writing a non nested interrupt handler
5.8 Using inline assembler in C, inline assembly syntax, restrictions on inline assembly operations
5.9Embedded assembler, Embedded assembly syntax, Restrictions on embedded assembly operations, calling between C and assembly
5.10 Method of Writing Interrupt service routines in C with examples.

6   LPC 2148 CPU(Ref: LPC 214X data sheet Rev.04-17/11/08) -07 Hrs.
6.1To know the salient features of LPC 2148 microcontroller
6.2Know the block diagram of LPC 2148 microcontroller
6.3know the function of pins of LPC 2148 microcontroller
6.4 Know the features of on chip program memory and on chip static RAM
6.5 study of the memory map
6.6 The functional features of Interrupt controller, pin connect block, DAC, ADC , USB controller,UART,I2C,SPI,SSP controllers, general purpose timers, Watch dog timers, RTC& Pulse width modulator
6.7Study the feature of system control units like PLL, Brown out detector, reset and wake up timer, code security, External interrupt inputs, Memory mapping control, Power control, APB bus

7. LPC 2148 PERIPHERALS(20Hrs)

7.1 Pin Connect Block-its purpose, Register description

7.2 GPIO: Features, Application, Pin description, Register description, examples

7.3 PLL: Introduction, Register description, PLL frequency
calculation, procedure for determining PLL settings, examples for PLL
configuration

7.4 SPI : Data transfer, master operation, slave operation, pin description, register description, block diagram of SPI solution

7.5 Timers: Architecture of timer module, Register description, examples.

7.6 PWM: Introduction, register description, rules for single/double edge controlled PWM outputs.

7.7 RTC: Introduction, architecture, register description, RTC interrupts, usage, Prescaler-Examples of prescaler usage.

7.8 ADC: Pin description, register description, operation

7.9 DAC: Pin description, register description, operation

Text Books
1) 1. ARM ASSEMBLY LANGUAGE FUNDAMENTALS & TECHNIQUES-
William Hohl, CRC Press
2) LPC 2148 USER MANUAL
3) ARM- SYSTEM DEVELOPER'S GUIDSE – Andrew Sloss, Elesveir
Publications

REFERENCE BOOKS:
1. IN SIDE R'S GUIDE TO PHILIPS ARM7 BASED MICROCONTROLLERS-
hitex.co.uk
2. ARM Programming Techniques – from ARM website
3. Embedded Systems a contemprorary Design Tool, First Edition by Peckol,
Wiley India Publications
4. ARM- System On chip Architechture by Steve Furber, Pearson Education