**Government of Karnataka**

# Department of Technical Education
# Board of Technical Examinations, Bengaluru

| | | | |
|---|---|---|---|
| Course Title: **ARM Controller Lab** | | Course Code | :**15EC55P** |
| Credits | : **3 Credits** | Semester | : **5** |
| Teaching Scheme in Hrs (L:T:P) | : **0:2:4** | Course Group | : **Core** |
| Type of course | : **Tutorial + Practical** | Total Contact Hours | : **78** |
| CIE | : **25 Marks** | SEE | : **50 Marks** |

## Prerequisites

Knowledge of microcontroller, programming and hardware design.

## Course Objectives

1. To study Assembly language programming ofARM7 Processor using KEIL IDE.
2. Understand the interfacing ofI/O devices to LPC2148.

## Course Outcomes

At the end of the course, the students will be able to

1. Understand the Procedure to execute assembly language programs with a simulator by using an IDE (Integrated Development Environment).
2. Develop simple assembly language programs.
3. Solve simple problems using ARM development board and embedded C.
4. Interface external peripheral devices to LPC 2148.

| Course Outcome | | CL | Linked Experiments | Linked PO | Teaching Hrs |
|---|---|---|---|---|---|
| **CO1** | Understand the Procedure to execute assembly language programs with a simulator by using an IDE (Integrated Development Environment). | ***R/U*** | Section- A E1(Study) | 1,2,3,4,10 | 6 |
| **CO2** | Analyze the various assembly language programs and simulation | ***R/U/A*** | Section- A E2-E8 | 1,2,3,4,8, 9,10 | 21 |
| **CO3** | Understand ARM development board and Procedure to flashing of embedded C programs | ***R/U*** | Section- B E1(Study) | 1,2,3,4,10 | 06 |
| **CO4** | Interface various external peripheral devices to LPC 2148. | ***R/U/A*** | Section- B E2-E11 | 1,2,3,4,8, 9,10 | 33 |
| | | | | **Two CIE/IA Tests** | **06** |
| | | | | **Total sessions including 06hrs student activity** | **78** |

**Legend:** E- Experiment, R-Remember, U-Understand, A-Application, CL-Cognitive Level, and PO-Program Outcome

## Mapping Course Outcomes with Program Outcomes

| Course Outcomes | Programme Outcomes | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | * | * | * | * | -- | -- | -- | -- | -- | * |
| CO2 | * | * | * | * | -- | -- | -- | * | * | * |
| CO3 | * | * | * | * | -- | -- | -- | -- | -- | * |
| CO4 | * | * | * | * | -- | -- | -- | * | * | * |

## Course-PO Attainment Matrix

| Course | Programme Outcomes | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| ARM Controller Lab | 3 | 3 | 3 | 3 | -- | -- | -- | 3 | 3 | 3 |

**Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Low Addressed.**

Method is to relate the level of PO with the number of hours devoted to the COs which address the given PO.
If ≥40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 3
If 25 to 40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 2
If 5 to 25% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 1
If < 5% of classroom sessions addressing a particular PO, it is considered that PO is considered not addressed.

## Course Contents

### Unit – 1: Tutorial and Graded exercises 66 Hours

| Sl. No. | SECTION - A | Duration (Hr.) |
|---|---|---|
| **Note:** a)This part to be done with a simulator by using an Integrated Development Environment (IDE).<br>b) These programs to be executed/simulated using assembly language. | | |
| 1 | (i) Familiarization of IDE and ARM development board usage<br>(ii) Familiarization of program execution. | 3 |
| 2 | Program to compute $6X^2$ -9X+2 for a given X. | 3 |
| 3 | Program to find the square of a number (1 to 10) using look up table. | 3 |
| 4 | Program to find the sum of an array of 16-bit numbers; store the 32-bit result in internal RAM. | 3 |
| 5 | Program to find the length of a null terminated string. | 3 |
| 6 | Program to sort an array of 32-bit numbers(ascending and descending) | 6 |
| 7 | Program to search and store all the negative numbers in an array of 32-bit numbers. | 3 |
| 8 | Program to count the number of ones and zeros in a 32-bit integer. | 3 |
| 9 | Program to convert hexadecimal to ASCII and vice versa. | 6 |

| SECTION- B | | |
|---|---|---|
| **a. This part should be executed with the use of ARM7 LPC2148 kit. These programs should be written and executed using embedded 'C' Programming language.** | | |
| 1 | Program to interface relay card | 6 |
| 2 | Program to generate a 50% duty cycle, 1 KHz wave and to use it for exciting a buzzer. | 3 |
| 3 | Program to blink a group of 8 LEDs with a delay. | 3 |
| 4 | Switching interface | 3 |
| 5 | Interface 4-digit seven-segment display to display any four letter word. | 3 |
| 6 | Interface stepper motor and control its speed and direction. | 3 |
| 7 | Interface DC motor. | 3 |
| 8 | Interface 2-line LCD module to output a moving message on it. | 3 |
| 9 | Read analog voltage and display its digital equivalent on array of LED. | 6 |
| | **Two Internal Assessment Tests** | 6 |
| | **Total** | **72** |

## Unit – 2: Student Activities [CIE- 05 Marks] 06 Hours

| Sl. No. | Activity/mini project | Duration (Hr.) |
|---|---|---|
| **1** | Room temperature measurement, illumination control, pressure measurement, or any other activity related to sensor by using ARM. | **6** |
| **2** | Any other related activity which develop skills of the students. | |
| **3** | Some of the programs are listed below which is just a guideline for selecting the programs. Students can also select any other program with the advice of his teacher.<br>List of sample Programs:<br>1. Program for 8 bit key inputs interface<br>2. Using external interrupt, Interface switch and for every depression, count value is incremented and displayed on LED<br>3. Program for 4X4 matrix key board interface<br>4. Program for transferring any massage/text from kit to PC Using serial port. | |

**Execution Mode**

1. Every student should perform Project activity independently as assigned by the teacher based on interest of the student. Student can also choose any other similar activity with a prior approval from the concerned teacher.
2. Project activities shall be carried out throughout the semester and present the project report at the end of the semester.
3. Report-size shall be qualitative and not to exceed 6 pages;
4. Each of the activity can be carried out off-class; however, demonstration/presentation

should be done during laboratory sessions.

5. Assessment shall be made based on quality of activity, presentation/demonstration and report.
6. Assessment is made based on quality of work as prescribed by the following rubrics table.

### Institutional Activity (No marks)

The following are suggested institutional activities, to be carried out at least one during the semester. The course teacher/coordinator is expected to maintain the relevant record (Containing, Activity name, Resource persons and their details, duration, venue, student feedback, etc) pertaining to Institutional activities

| Sl. No. | Activity |
|---|---|
| 1 | Organize hands-on practice on design and simulation of H/W interfacing |
| 2 | Motivate the student to take case study on different applications on LPC2148. |

## References


1. LPC 2148 User Manual
2. http://www.ocfreaks.com


## Course Delivery

The course will be delivered through two-hour tutorials and four-hour hands-on practice per week. Tutorial shall be imparted before the conduction of the experiment. Student activities are off-class and presentation/report evaluation is during assigned lab sessions.

## Course Assessment and Evaluation Scheme

### Master Scheme

| Assessment Method | What | | To Whom | Assessment mode /Frequency /timing | Max. Marks | Evidence Collected | Course Outcomes |
|---|---|---|---|---|---|---|---|
| Direct assessment | CIE | IA | Students | Two tests+ | 10 | Blue Books | 1 to 4 |
| | | | | Record@ | 10 | Record Book | 1 to 4 |
| | | | | Activity* | 05 | Report/Sheets | 1 to 4 |
| | SEE | End exam | | End of the course | 50 | Answer Scripts at BTE | 1 to 4 |
| | | | | Total | 75 | | |
| Indirect assessment | Student feedback on course | | Students | Middle of the Course | Nil | Feedback Forms | 1 to 2 Delivery of course |
| | End of course survey | | | End of the Course | Nil | Questionnaires | 1 to 4 Effectiveness of delivery instructions & assessment methods |

**Legends:** CIE-Continuous Internal Evaluation, SEE- Semester End-exam Evaluation

+I.A. test shall be conducted as per SEE scheme of valuation. However obtained marks shall be reduced to 10 marks. Average marks of two tests shall be rounded off to the next higher digit.

Rubrics to be devised appropriately by the concerned faculty to assess Student activities.

*Students should do activity as per the list of suggested activities/ similar activities with prior approval of the teacher. Activity process must be initiated well in advance so that it can be completed well before the end of the term.

@Record Writing: Average of marks allotted for each experiment; fractional part of average shall be rounded-off to next higher integer.

## Composition of CLs

| Sl. No. | Cognitive Levels (CL) | Weightage (%) |
|---|---|---|
| **1** | Remembering | 20 |
| **2** | Understanding | 30 |
| **3** | Applying | 50 |
| | **Total** | **100** |

## Continuous Internal Evaluation (CIE) pattern

**(i) Student Activity (5 marks)**

The student activities in Unit-2 or similar activities can be assigned

**Execution Notes:**

1. Activities are assigned batch-wise (maximum of 4 students per batch); any one activity/project per batch should be assigned by the teacher based on interest of the students. Student can also choose any other similar activity with a prior approval from the concerned teacher.
2. Teacher is expected to observe and record the progress of students' activities
3. Assessment is made in accordance with the following **rubrics** table.

**(ii) Model of rubrics for assessing student activity (for every student)**

| Dimension | Scale | | | | | Marks (Example) |
|---|---|---|---|---|---|---|
| | 1 Unsatisfactory | 2 Developing | 3 Satisfactory | 4 Good | 5 Exemplary | |
| 1. Research and gathering information | Does not collect information relate to topic | Collects very limited information, some relate to topic | Collects basic information, most refer to the topic | Collects more information, most refer to the topic | Collects a great deals of information, all refer to the topic | 3 |
| 2. Full-fills team roles and duties | Does not perform any duties assigned to the team role | Performs very little duties | Performs nearly all duties | Performs almost all duties | Performs all duties of assigned team roles | 2 |
| 3. Shares work equality | Always relies on others to do the work | Rarely does the assigned work, often needs reminding | Usually does the assigned work, rarely needs reminding | Always does the assigned work, rarely needs reminding. | Always does the assigned work, without needing reminding | 5 |
| 4. Listen to other team mates | Is always talking, never allows anyone to else to speak | Usually does most of the talking, rarely allows others to speak | Listens, but sometimes talk too much, | Listens and talks a little more than needed. | Listens and talks a fare amount | 3 |
| | | | | | **Total marks** | ceil(13/4)= 4 |

**(iii) CIE/IA Tests (10 Marks)**

Two tests have to be conducted in accordance SEE pattern and the marks shall be scaled down to 10. Average of two tests, rounding-off any fractional part to next higher integer, shall be considered for CIE/IA.

**(iv) Record Evaluation (10 Marks)**

Every experiment shall be assigned marks for a scale of 10 after its conduction based on student's performance and quality of write-up. Average of them, by rounding-off any fractional part to next higher integer, shall be considered for CIE/IA.

### Semester End-exam Evaluation (SEE) Scheme

| Sl. No. | Scheme | Max. Marks |
|---|---|---|
| 1 | Writing and execution/simulation of any one open-ended ALP | 05 |
| 2 | Writing any one C program from graded exercises | 15 |
| 3 | Flash programming and result | 25 |
| 4 | Viva-voce | 05 |
| **TOTAL** | | **50** |

**Note:**
1. Candidate is expected to submit the Lab record for the examination
2. Student shall not be allowed to conduct directly

## Laboratory Resource Requirements

Hardware Requirement: For a batch of 20 students

| Sl. No. | Equipment | Quantity |
|---|---|---|
| 1 | Computers | 20 |
| 2 | LPC2148 Development Board/Kit | 10 |
| 3 | Dual trace oscilloscope. | 05 |
| 4 | All interfacing modules one per each kit and other related accessories | 10 |
| 5 | Digital multimeter | 05 |

## Model Questions for Practice and Semester End Examination

N**ote:** The questions in the question bank are indicative but not exhaustive.

### Section - A

1. Write and execute an assembly Program to compute $6X^2$ -9X+2 for a given X.
2. Write and execute an assembly Program to Find the square of a number (1 to 10) using look up table
3. Write and execute an assembly Program to find Sum of an array of 16 bit numbers and to store the 32 bit result in internal RAM
4. Write and execute an assembly Program to Find the length of a null terminated string
5. Write and execute an assembly Program to arrange a series of 32 bit numbers in ascending/descending order.
6. Write and execute an assembly Program to search and store all the negative numbers in an array of 32-bit numbers.
7. Write and execute an assembly Program to count the number of ones and zeros in a 32-bit integer.

### Section - B

1. Write embedded ‘C’Program to interface relay card
2. Write embedded ‘C’Program to generate a 50% duty cycle, 1 KHz wave and to use it for exciting a buzzer.
3. Write embedded ‘C’Program to blink a group of 8 LEDs with a delay.
4. Write embedded ‘C’Program to interface Switching interface
5. Write embedded ‘C’Program to Interface 4-digit seven-segment display to display any four letter word.
6. Write embedded ‘C’Program to interface Stepper motor and control its speed.
7. Write embedded ‘C’Program to interface Stepper motor and control its direction.
8. Write embedded ‘C’Program to interface DC motor and control its speed using PWM.
9. Write embedded ‘C’Program to Interface 2-line LCD module to output a moving message on it.
10. Write embedded ‘C’Program to demonstrate single edge PWM.
11. Write embedded ‘C’Program to generate triangular wave using DAC.
12. Write embedded ‘C’Program to generate sine wave using DAC.
13. Write embedded ‘C’Program to Read analog voltage and display its digital equivalent on array of LED.

**End**