GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Electronics and Communication
Subject Code: BE05000351
Subject Name: Subject Name: Advance Microcontroller

WEF Academic Year :	2024-25
Semester :	5
Category of the Course :	Professional Core Course

Course Outcome :

After Completion of the Course, Student will able to :

No	Course Outcomes	RBT Level*
01	Explain architecture and programming model of ARM 7TDMI	UN
02	Learn and analyse assembly language programs for ARM microcontroller	UN, AN
03	Develop Embedded C language program for interfacing I/O devices with ARM microcontroller and use it	AN, AP
04	Exemplify memory management system of ARM and different versions of ARM	UN
05	Design ARM based system to solve real life challenges	CR

Teaching and Examination Scheme :

Teaching/Learning Scheme in hrs/semester					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Practical			
L	T	P	PBL*	TH	TH/30	ESE (E)	PA (M)	PA (I)	PBL(I)	ESE (V)	
45	0	30	45	120	4	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content :

Sr. No.	Course Content	Total Hrs	% Weightage
1	ARM Introduction Types of computer Architectures, ISA's and ARM, Difference between RISC and CISC, RISC Design philosophy, ARM Design Philosophy, ARM processor family, Embedded System Software and Hardware	6	10
2	ARM Architecture and pipeline structure The Acorn RISC Machine, ARM Core data flow model, Architectural inheritance, The ARM7TDMI programmer's model: General purpose registers, CPSR, SPSR, ARM memory map, data format, load and store architecture, ARM 3 stage Pipeline, ARM 5 stage Pipeline, Pipeline Hazards, Data forwarding - a hardware solution, Stack implementation in ARM, Endianness, condition codes. Processor core Vs CPU core, ARM7TDMI Interface signals	8	20
3	ARM7TDMI assembly language instructions and programming Different Types of Instructions, ARM Instruction set, data processing instructions. Shift Operations, shift Operations using RS lower byte, Immediate value encoding. Data processing Instructions. Addressing modes with examples. Instruction Timing, Swap Instructions, Swap Register related Instructions, Loading Constants. Program Control Flow, Control Flow Instructions, B & BL instructions, BX instruction. Interrupts and Exceptions, Exception Handlers, Reset Handling. Aborts, software Interrupt Instruction, undefined instruction exception. Interrupt Latency, Multiply Instructions, Thumb state, Thumb Programmers model, Thumb Implementation, Thumb Applications. Thumb Instructions, Interrupt processing. Interrupt Handling schemes, Examples of Interrupt Handlers, Co-processor instructions	10	25
4	Embedded C Programming for ARM: ARM Development Environment Embedded Software, Advanced C concepts: masking, pointer aliasing, structure arrangement, bit-fields, unaligned data and Endianness, Division, floating point, Inline functions and inline assembly, function pointers and callbacks, Portability issues. C programs for General purpose I/O, general purpose timer, PWM Modulator, UART, I2C Interface, SPI Interface, ADC, DAC	10	20

5	Cache and Memory Management and Protection Memory Technologies, Need for memory Hierarchy, Hierarchical Memory Organization, Virtual Memory. Cache Memory, Mapping Functions. Cache Design, Unified or split cache, multiple level of caches, ARM cache features, coprocessor 15 for system control. Processes, Memory Map, Protected Systems, ARM systems with MPU, memory Protection Unit (MPU). Physical Vs Virtual Memory, Paging, Segmentation. MMU Advantage, virtual memory translation, Multitasking with MMU, MMU organization, Tightly coupled Memory (TCM).	6	15
6	ARM Peripherals and versions AMBA Overview, Typical AMBA Based Microcontroller, AHB bus features, AHB Bus transfers, APB bus transfers, APB bridge. Overview of ARM Versions: ARMv5, ARMv6, ARM v7 (Cortex family R: Real time A: Application and M: Microcontroller), ARM big.LITTLE Technology, ARMv8.	5	10
	Total	**45**	**100**

This syllabus is mapped with following United Nation's Sustainable Development Goals:

SDG 3 - Good Health and Well-being
SDG 4 - Quality Education.
SDG 7 – Clean and affordable energy,
SDG 8 - Decent Work and Economic Growth,
SDG 9 - Industry, Innovation and Infrastructure,
SDG 11 - Sustainable Cities and Communities,
SDG 12 - Responsible Consumption and Production,
SDG 13 -Climate Action

Relevant BIS standards:

IS 13252 (Part 1) – Safety of Information Technology Equipment
IS 616 – Safety of Electrical Equipment
IS/IEC 60529 – Degrees of Protection (IP Code) for embedded hardware enclosures
IS 14700 series – Electromagnetic Compatibility (EMC)
Also explore other relevant Indian and international standards.

Reference Book :

[1] ARM Assembly Language Programming & Architecture By. Muhammad Ali Mazidi, Kindle edition
[2] Arm Assembly Language, Fundamentals and Techniques, 2nd edition, William Hohl, Christppher Hinds, CRC Press.
[3] Arm System Developer's Guide, Designing and Optimizing Software, Andrew N. Sloss, Dominic Symes, Chris Wwight, Elsevier
[4] Arm System-on-chip Architecture, 2nd Edition, Steve Furber, Pearson publication
[5] Embedded Systems By. Lyla Das, Pearson publication
[6] Manuals and Technical Documents from the ARM Inc, web site.

Suggested Course Practical List :

1. To write and simulate ARM assembly language programs for data transfer, arithmetic and logical operations.
2. To write and simulate C Programs for ARM microprocessor/microcontroller on related IDEs.
3. To interface LED with ARM microprocessor/microcontroller and write program to blink LED at the interval of 1 second
4. To interface switch with ARM microprocessor/microcontroller and write program in C language to read status of the switch
5. To interface LCD with ARM microprocessor/ microcontroller. Write and execute programs in C language for displaying text messages and numbers on LCD.
6. To interface DC motor with ARM microprocessor/ microcontroller. Write program to rotate DC motor in clockwise and anticlockwise direction with different speed
7. To interface Stepper motor with ARM microprocessor/ microcontroller. Write program to rotate motor in half step and full step mode
8. Programming ARM microprocessor/ microcontroller for wireless connectivity.
9. Write program to control devices using wireless connectivity.
10. Write program to read analog value from sensors (light, temperature, humidity etc.) using ARM microprocessor/microcontroller and upload data on cloud.
11. Student mini project based on ARM microprocessor/microcontroller.

List of Laboratory/Learning Resources Required:

- NPTEL Video lecture on https://nptel.ac.in/courses/117106111/
- Micropython
- Any ARM microcontroller/microprocessor based board with relevant IDE.

Activities suggested under Self-learning/Team Work:

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numericals based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters

9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software

Note:
1. All the suggested activity should be related to the subject.
2. The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.

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