INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**MICROCONTROLLERS AND PROGRAMMABLE DIGITAL SIGNAL PROCESSING**				
Course Code	BESB02				
Programme	M.Tech				
Semester	I	ES			
Course Type	Core				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	3	2
Chief Coordinator	Dr. P. Munaswamy, Professor, ECE.				
Course Faculty	Mr. K. Chaitanya, Assistant professor, ECE				

COURSE OBJECTIVES:

The course should enable the students to**:**

I	Compare and select ARM processor core based SoC with several features/peripherals based on requirements of embedded applications.
II	Identify and characterize architecture of Programmable DSP Processors
III	Develop small applications by utilizing the ARM processor core and DSP processor based platform

COURSE OUTCOMES (COs):

After completing this course the student must demonstrate the knowledge and ability to:

1	Identify and analyze the characteristics of ARM Cortex-M3 processor.
2	Understand the various Exceptions and Interrupts in Cortex-M3 processor.
3	Understand the features of LPC 17xx microcontrollers based on Cortex-M3 processor.
4	Identify and analyze the characteristics Programmable DSP Processors.
5	Understand the TMS320C6000 series DSP Processor architectures.

COURSE LEARNING OUTCOMES:

BESB02.01	Understanding the ARM Cortex-M3 processor: Applications, Programming model – Registers, Operation modes, Exceptions and Interrupts, Reset Sequence.
BESB02.02	Study the Instruction Set, Unified Assembler Language, Memory Maps, Memory Access Attributes, Permissions, Bit-Band Operations.
BESB02.03	Discuss the Unaligned and Exclusive Transfers. Pipeline, Bus Interfaces.
BESB02.04	Examine the various Exceptions, Types, Priority, Vector Tables, Interrupt Inputs and Pending behavior, Fault Exceptions
BESB02.05	Discuss the Supervisor and Pendable Service Call, Nested Vectored Interrupt Controller.
BESB02.06	Understand the Basic Configuration, SYSTICK Timer, Interrupt Sequences, Exits, Tail Chaining, Interrupt Latency.
BESB02.07	Describe the LPC 17xx microcontroller- Internal memory, GPIOs, Timers.
BESB02.08	Study the features of ADC, UART and other serial interfaces.
BESB02.09	Understand the concepts of PWM, RTC, and WDT.
BESB02.10	Describe the Programmable DSP (P-DSP) Processors: Harvard architecture, Multi port memory.
BESB02.11	Study the features of architectural structure of P-DSP- MAC unit, Barrel shifters.
BESB02.12	Understand the Introduction to TI DSP processor family.
BESB02.13	Study the VLIW architecture and TMS320C6000 series, architecture study, data paths, cross paths.
BESB02.14	Understand the Introduction to Instruction level architecture of C6000 family, Assembly Instructions memory addressing, for arithmetic, logical operations.
BESB02.15	Describe the Code Composer Studio for application development for digital signal processing, On chip peripherals, Processor benchmarking.

S.No	Question	Blooms Taxonomy level	Course Outcomes	Course Learning Outcomes
	UNIT-I **ARM CORTEX-M3 PROCESSOR**			
	Part - A(Short Answer Questions)			
1	List the applications of ARM Cortex M3 processor.	Remember	CO 1	BESB02.01
2	Define Operation Modes of Cortex M3 processor.	Remember	CO 1	BESB02.02
4	What is the difference between Interrupts and Exceptions?	Understand	CO 1	BESB02.03
5	What are the major address ranges in Memory Map of Cortex M3?	Remember	CO 1	BESB02.02
6	Discuss about Reset Sequence and bit banding?	Remember	CO 1	BESB02.03
7	What is nonaligned memory access?	Understand	CO 1	BESB02.03
8	Write the advantages of Unified Assembler Language (UAL).	Understand	CO 1	BESB02.02
9	Write about Permissions used in ARM Cortex M3 processor.	Understand	CO 1	BESB02.01
10	Define the Unaligned and Exclusive Transfers in Cortex M3 processor.	Understand	CO 1	BESB02.03
11	Write about Bus Interfaces in ARM Cortex M3 processor.	Understand	CO 1	BESB02.03
12	What are the major address ranges in Memory Map of Cortex M3?	Understand	CO 1	BESB02.02
13	Discuss about Reset Sequence and bit banding?	Understand	CO 1	BESB02.03
	Part - B (Long Answer Questions)			
1	Describe the evolution and main trends of the microcontroller market until the appearance of ARM Cortex core micro controllers.	Remember	CO 1	BESB02.01
2	Describe the main features of the Cortex M3 processor core: architecture, instruction set, and major internal core blocks.	Understand	CO 1	BESB02.02
3	Briefly describe the features of the Cortex M3 based microcontrollers memory organization.	Remember	CO 1	BESB02.03
4	Present briefly the characteristics of the Cortex M3 core.	Understand	CO 1	BESB02.02
5	Explain the Thumb-2 Technology and Instruction Set Architecture.	Remember	CO 1	BESB02.02
6	Explain the Cortex-M3 Processor Applications.	Understand	CO 1	BESB02.03
7	Describe the various Registers and Special Registers in Cortex M3 processor	Remember	CO 1	BESB02.03
8	Explain Pipeline mechanism in Cortex-M3 Processor	Remember	CO 1	BESB02.02
9	Describe the operating modes of Cortex-M3 Processor.	Understand	CO 1	BESB02.01
10	Explain about Exceptions and Interrupts in Cortex-M3 Processor.	Remember	CO 1	BESB02.03
S.No	**Question**	**Blooms taxonomy level**	**Course Outcomes**	**Course Learning Outcomes**
	Part - C (Analytical Questions)			
1	Describe the evolution and main trends of the microcontroller market until the appearance of ARM Cortex core micro controllers. What were the main microcontroller families and what new features they had?	Understand	CO 1	BESB02.01
2	Briefly compare the properties of Cortex M0, M3, M4, M7 cores. Characterize the capabilities of typical microcontrollers containing such cores: use a flash memory – pin count graph. Specify typical operating frequency, typical peripherals of microcontrollers with these cores	Remember	CO 1	BESB02.03
3	Describe the main features of the Cortex M3 processor core: architecture, instruction set, instruction execution, pipe-line, major internal core blocks, and operating modes! What's new comparing to the ARM7 core?	Remember	CO 1	BESB02.02

4	What is the Flash Accelerator Module, why is it necessary? Explain briefly its benefits and its operation!	Understand	CO 1	BESB02.03
5	Describe a typical clock tree of a Cortex M core microcontroller. Explain the meaning and necessity of each clock signal source as well as clock signal divisions.	Remember	CO 1	BESB02.02
S.No	**Question**	**Blooms taxonomy level**	**Course Outcomes**	**Course Learning Outcomes**
UNIT-II EXCEPTIONS AND INTERRUPTS				
Part – A (Short Answer Questions)				
1	What are the special registers used to indicate the value of the current running exception and interrupt?	Remember	CO 2	BESB02.04
2	What is the use of Vector Tables in Cortex-M3 Processor?	Remember	CO 2	BESB02.05
3	Define Interrupt Pending behavior in Cortex-M3 Processor.	Remember	CO 2	BESB02.05
4	List the various categories of faults exceptions in Cortex-M3 Processor.	Understand	CO 2	BESB02.06
5	Define the Supervisor Call (SVC) and Pendable Service Call (PendSV) exceptions	Remember	CO 2	BESB02.05
6	Define Interrupt Enable and Clear Enable registers of Cortex-M3 Processor.	Understand	CO 2	BESB02.06
7	Define the Interrupt Set Pending and Clear Pending registers of Cortex- M3 Processor	Remember	CO 2	BESB02.05
8	Write about Exception-masking registers of Cortex-M3 Processor.	Understand	CO 2	BESB02.06
9	What is the use of The SYSTICK Timer of Cortex-M3 Processor.	Remember	CO 2	BESB02.05
10	Discuss about Interrupt Latency of Cortex-M3 Processor.	Understand	CO 2	BESB02.04
S.No	**Question**	**Blooms taxonomy level**	**Course Outcomes**	**Course Learning Outcomes**
Part - B (Long Answer Questions)				
1	Explain about Exception Types of ARM Cortex M3 processor.	Remember	CO 2	BESB02.04
2	Explain about Interrupt Inputs and Pending Behavior in Cortex M3 processor.	Understand	CO 2	BESB02.05
3	Explain the various Fault Exceptions occur in Cortex M3 processor.	Remember	CO 2	BESB02.06
4	Describe the Supervisor and Pendable Service Call exceptions targeted at Software and operating systems.	Understand	CO 2	BESB02.04
5	Briefly describe the functionalities of Nested Vectored Interrupt Controller	Remember	CO 2	BESB02.05
6	Briefly describe SYSTICK Timer and its usages	Understand	CO 2	BESB02.05
7	Explain about Interrupt Sequences: Stacking, Vector fetch, Register Updates.	Remember	CO 2	BESB02.05
8	Explain about Exception Exits and Tail-Chaining Interrupts	Understand	CO 2	BESB02.06
9	Describe the Priority Levels of ARM Cortex M3 processor.	Remember	CO 2	BESB02.04
10	Describe the Vector Tables of ARM Cortex M3 processor	Understand	CO 2	BESB02.06
Part - C (Analytical Questions)				
1	What happens to a typical reset vector, what's the meaning of the Vector Table offset register?	Remember	CO 2	BESB02.06
2	Compare Cortex M core NVIC with ARM7 interrupt handling options! What is tail- chaining, what's happening at this time?	Understand	CO 2	BESB02.05
3	What are the roles of SVC, Pend SVC, Systick, and NMI interrupts in a Cortex M controller? What is the use of the Hard Fault Interrupt?	Remember	CO 2	BESB02.05
4	What are the priority options for Cortex M core interrupt handling?	Understand	CO 2	BESB02.04
5	What is an exception in ARM?	Remember	CO 2	BESB02.05

UNIT-III LPC 17XX MICROCONTROLLER				
Part - A (Short Answer Questions)				
1	What is LPC 17XX family Microcontrollers?	Remember	CO 3	BESB02.07
2	List the Applications of LPC 17XX family Microcontrollers.	Understand	CO 3	BESB02.07
3	Write about On-chip SRAM LPC 17XX Microcontrollers.	Remember	CO 3	BESB02.08
4	Discuss about the Nested Vectored Interrupt Controller (NVIC) in LPC 17XX Microcontrollers.	Understand	CO 3	BESB02.08
5	Write about the SPI serial I/O controller of LPC 17XX Microcontrollers.	Remember	CO 3	BESB02.08
6	Write about the I2C-bus serial I/O controllers of LPC 17XX Microcontrollers.	Understand	CO 3	BESB02.07
7	Discuss about General purpose 32-bit timers of LPC 17XX Microcontrollers.	Remember	CO 3	BESB02.07
8	What is the functionality of Watchdog Timer in LPC 17XX Microcontrollers?	Understand	CO 3	BESB02.08
9	Write about the Memory Protection Unit (MPU) of LPC 17XX Microcontrollers.	Remember	CO 3	BESB02.09
10	Discuss about the SSP serial I/O controller of LPC 17XX Microcontrollers.	Understand	CO 3	BESB02.08
S.No	**Question**	**Blooms taxonomy level**	**Course Outcomes**	**Course Learning Outcomes**
Part - B (Long Answer Questions)				
1	Explain the architecture of LPC 17XX Microcontroller.	Remember	CO 3	BESB02.08
2	Describe the Features and benefits of LPC 17XX Microcontroller.	Understand	CO 3	BESB02.07
3	Explain the Memory Mapping of LPC 17XX Microcontroller.	Remember	CO 3	BESB02.09
4	Describe the Features and Functionalities of LPC 17XX general purpose parallel I/O (GPIO).	Understand	CO 3	BESB02.07
5	Explain the Features and Functionalities of LPC 17XX UARTs.	Remember	CO 3	BESB02.07
6	Briefly describe the various Serial Interfaces of LPC 17XX Microcontroller.	Understand	CO 3	BESB02.08
7	Explain the Features of PWM in LPC 17XX Microcontroller	Understand	CO 3	BESB02.07
8	Briefly describe the Features of RTC in LPC 17XX Microcontroller	Remember	CO 3	BESB02.08
9	Describe the Features of WDT in LPC 17XX Microcontroller	Understand	CO 3	BESB02.09
10	Explain the General purpose DMA controller of LPC 17XX Microcontroller.	Remember	CO 3	BESB02.09
Part - C (Analytical Questions)				
1	Describe the internal architecture of the NXP LPC4300 series. What are the typical roles for the M0 and M4 core? Show an example	Remember	CO 3	BESB02.07
2	How to use USART peripherals for "printf" in a C language environment? Write down this process	Understand	CO 3	BESB02.08
3	Give an example of how to use DMA. What kinds of options are offered by a general purpose DMA block? What parameters should a programmer usually set for a DMA transmission?	Remember	CO 3	BESB02.09
4	What is the purpose of automatic address incrementation, and circular buffer option for DMA? Show an example of a typical circular buffer based peripheral handling. What is Scatter and gather type DMA operation?	Understand	CO 3	BESB02.08
5	What are the features of PWM in LPC 17xx microcontroller and mention its applications.	Remember	CO 3	BESB02.09

UNIT-IV PROGRAMMABLE DSP (P-DSP) PROCESSORS				
Part - A (Short Answer Questions)				
1	What is the role of Barrel shifter in Programmable DSP?	Understand	CO 4	BESB02.10
2	Explain guard bits in a MAC unit of Programmable DSP.	Remember	CO 4	BESB02.10
3	List the various Applications of Programmable DSP.	Understand	CO 4	BESB02.11
4	What are the types of Programmable DSPs.	Remember	CO 4	BESB02.10
5	What are the Specialized addressing modes in Programmable DSPs.	Understand	CO 4	BESB02.11
6	Write about Circular Buffers of Programmable DSPs	Remember	CO 4	BESB02.12
7	Define Harvard architecture of Programmable DSP Processors.	Understand	CO 4	BESB02.10
S.No	**Question**	**Blooms taxonomy level**	**Course Outcomes**	**Course Learning Outcomes**
8	List the architectural features of Programmable DSP Processors.	Remember	CO 4	BESB02.11
9	List the features of TI DSP processor family.	Understand	CO 4	BESB02.12
10	Write about Bit-reversed addressing of Programmable DSPs	Remember	CO 4	BESB02.10
Part – B (Long Answer Questions)				
1	Explain the implementation of 4-bit shift right barrel shifter, with a diagram.	Remember	CO 4	BESB02.10
2	Explain the MAC unit of Programmable DSP Processors.	Understand	CO 4	BESB02.11
3	Describe the Harvard architecture of Programmable DSP Processors.	Understand	CO 4	BESB02.11
4	Briefly describe the Multi port memory of Programmable DSP Processors.	Remember	CO 4	BESB02.12
5	Describe the Applications of Programmable DSP Processors	Understand	CO 4	BESB02.10
6	Explain the architectural features of Programmable DSP Processors.	Remember	CO 4	BESB02.12
7	With a neat block diagram explain ALU of DSP system.	Understand	CO 4	BESB02.11
8	Explain the features of TI DSP processor family.	Remember	CO4	BESB02.12
9	Explain about circular addressing mode of Programmable DSP Processors?	Remember	CO 4	BESB02.11
10	Consider a MAC unit whose inputs are 16 bit numbers. If 256 products are to be summed up in this MAC, how many guard bits should be provided for the accumulator to prevent overflow condition from occurring?	Understand	CO 4	BESB02.12
Part - C (Analytical Questions)				
1	Discuss the diagram of TI DSP processor.	Understand	CO 4	BESB02.12
2	Explain the basic principal of barrel shifter	Remember	CO 4	BESB02.10
3	Explain about the Multi port memory of programmable DSP processor.	Remember	CO 4	BESB02.11
4	Explain the architectural differences between DSP processors and Microprocessors.	Remember	CO 4	BESB02.11
5	Explain the function of a MAC unit and also explain how overflow and underflow conditions can be avoided in MAC operations.	Remember	CO 4	BESB02.12
UNIT-V VLIW ARCHITECTURE				
Part - A (Short Answer Questions)				
1	Draw the VLIW architecture.	Remember	CO 5	BESB02.13
2	Write the various parts of DSP TMS320C6000 processor.	Understand	CO 5	BESB02.14
3	List the advantages of VLIW architecture.	Remember	CO 5	BESB02.13

4	Write the disadvantages of VLIW architecture.	Understand	CO 5	BESB02.13
5	What are the different buses of DSP TMS320C6000 processor and their functions?	Remember	CO 5	BESB02.14
6	List the addressing modes of DSP TMS320C6000.	Understand	CO 5	BESB02.13
7	What is pipelining technique?	Remember	CO 5	BESB02.14
8	What are the different stages in pipelining?	Understand	CO 5	BESB02.14
9	Write about the Code Composer Studio.	Remember	CO 5	BESB02.15
10	List the on-chip peripherals of DSP TMS320C6000 processor.	Understand	CO 5	BESB02.14
S.No	**Question**	**Blooms taxonomy level**	**Course Outcomes**	**Course Learning Outcomes**
Part - B (Long Answer Questions)				
1	Explain the VLIW architecture with a neat diagram.	Remember	CO 5	BESB02.13
	Describe the advantages and disadvantages of VLIW architecture.	Understand		BESB02.13
2	Explain various addressing modes of a digital signal processor TMS320C6000 series.	Remember	CO 5	BESB02.14
3	Explain the architecture of DSP TMS320C6000 processor with a neat diagram	Remember	CO 5	BESB02.14
4	Describe the Architectural details and features of a DSP TMS320C6000 processor.	Understand	CO 5	BESB02.14
5	Explain about logical instructions of DSP TMS320C6000 processor.	Remember	CO 5	BESB02.14
6	Explain about arithmetic instructions of DSP TMS320C6000 processor.	Understand	CO 5	BESB02.14
7	Explain what is meant by instruction pipelining. How pipelining increases the throughput efficiency.	Remember	CO 5	BESB02.13
8	Describe the various on-chip peripherals of DSP TMS320C6000 processor.	Remember	CO 5	BESB02.14
9	Write about the Assembly Language Instructions of DSP TMS320C6000 processor.	Understand	CO 5	BESB02.14
10	Explain the VLIW architecture with a neat diagram.	Remember	CO 5	BESB02.13
Part - C (Analytical Questions)				
1	Briefly explain about program control unit of TMS320C6000processor	Remember	CO 5	BESB02.14
2	Explain the assembly instructions memory addressing of VLIW processor with examples.	Understand	CO 5	BESB02.13
3	Explain in detail about the on chip peripherals and processor benchmarking.	Remember	CO 5	BESB02.13
4	Write short notes on (a) Direct Memory Access (b) Flash Memory Interface to DSP Processor.	Remember	CO 5	BESB02.13
5	Explain the logical operations Code Composer Studio for application development of digital signal processing	Remember	CO 5	BESB02.15

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