

NANYANG TECHNOLOGICAL UNIVERSITY**SEMESTER 1 EXAMINATION 2023-2024****MA4832 – MICROPROCESSOR SYSTEMS**

November/December 2023

Time Allowed: 2½ hours

INSTRUCTIONS

1. This paper contains **FOUR (4)** questions and comprises **FOUR (4)** pages.
 2. Answer **ALL** questions.
 3. All questions carry equal marks.
 4. This is an **OPEN-BOOK** examination.
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1. The data bus and address bus inside ARM Cortex-M4 microcontroller have 32 lines each. Please write the solutions to the following sub-questions:
 - (a) What are the detailed steps which convert the decimal number 369 into its corresponding binary number? (5 marks)
 - (b) What are the detailed steps which convert the decimal number 0.248 into its corresponding binary number with 23 digits after the zero point? (5 marks)
 - (c) What are the detailed steps which convert the decimal number 2023 into its corresponding hexadecimal number? (5 marks)
 - (d) What is the 23-bit mantissa of the single-precision floating point, which represents the decimal number -369.248? (5 marks)
 - (e) What is the 8-bit exponent of the single-precision floating point, which represents the decimal number +369.248? (5 marks)

2. A microcontroller includes microprocessor and input/output modules. Hence, a microcontroller could input data, process data, and output data. Please refer to ARM Cortex M4 32-bit microcontroller and write the solutions to the following questions.

- (a) What are the decimal number and its corresponding hexadecimal number in R4 after the execution of the following code?

A	DCD	64	; decimal number
B	DCD	128	; decimal number
ADR	R1,	A	; get address of A
MOV	R2,	[R1], LSR #3	
ADR	R1,	B	; get address of B
MOV	R3,	[R1], LSL #3	
ORR	R4,	R2, R3	

(10 marks)

- (b) What are the decimal number and its corresponding hexadecimal number in R5 after the execution of the following code?

X	DCD	256	; decimal number
Y	DCD	16	; decimal number
ADR	R1,	X	; get address of X
LDR	R2,	[R1], LSR #1	
ADR	R1,	Y	; get address of Y
LDR	R3,	[R1], LSL #1	
MOV	R4,	#0x0000AABB	; hexadecimal number
MLA	R5,	R1, R2, R3, R4	

(10 marks)

- (c) A sensor sends the hexadecimal number of 0x78 to port A of ARM Cortex M4 microcontroller. What will be the hexadecimal number of sensory data received by the microcontroller's ALU after the execution of the following code?

PORT_A	EQU	0x4000.40AB	
MOV	r0,	=PORT_A	; r0 = 0x4000.40AB
LDR	r1,	[r0]	

(5 marks)

- 3 (a) (i) For Synchronous Serial Interface (SSI) communications what do the term MOSI and MISO mean? What is the purpose of this setting? What is the SSI register that is responsible to configure this feature. How is this register configured?

(6 marks)

- (ii) Name THREE types of possible communications errors in SSI and describe how each can happen?

(3 marks)

- (b) It is intended to use the SSI3 for communication to a sensor. Referring to the GPIOPCTL table, identify the IO pin names for the following SSI3 functions that are to be connected to on the Tiva C Series TM4C123G evaluation board.

Digital Function	IO
SSI3Clk	
SSI3Rx	
SSI3Tx	

Which J connector block on the Tiva C Series TM4C123G do these three SSI3 connections have to be connected to?

(4 marks)

- (c) The SSI3 is to be configured with the following parameters:

- Master operation
- Freescale SPI mode (SPO=1, SPH=1)
- 512 kbps bit rate
- 16 data bits
- system clock is 16 MHz

Provide the Hex Address (including offset) and the Hex Data value for the following registers.

Register	Hex Address	Hex Data value
RCGCSSI		
RCGCGPIO		
GPIOPCTRL		
GPIOAFSEL		
SSICRO		
SSICR1		

To calculate the SCR data value for the SSICRO register, take the CPSDVSR value to be 0x8.

(12 marks)

- 4 (a) A General Purpose Timer (16 Bit Timer 3A) on the TM4C123G Tiva C evaluation board has been selected to time the duration of an event. The Even CCP Pin will be used. From the Input Capture Pins table for GPTM and the Digital Function (GPIOPCTL PMCx Bit Field Encoding) table, determine the port name and number that 16 Bit Timer 3A will be connected to.

(3 marks)

- (b) (i) An interrupt service routine (ISR) for the 16 Bit Timer 3A from 4(a) is to be setup. Provide the Hex Address and Hex Data Value for the following registers that are required to enable the 16 Bit Timer 3A interrupt.

Register	Hex Address	Hex Data value
RCGCTIMER		
RCGCGPIO		
GPIOPCTRL		
GPIOAFSEL		
GPTMCFG		

(10 marks)

- (ii) The interrupt Priority for 16 Bit Timer 3A is to be set to priority value 3. Give the correct Interrupt Set Enable register (NVIC_ENn) to enable the interrupt for Timer 3A and Interrupt Priority Register NVIC_PRIn to set the priority. Provide their respective Hex Address and Hex Data value.

(4 marks)

- (c) For driving an electric motor for a conveyor belt (Bi-directional), explain why using a combination of both H-bridge drive and PWM drive is preferred to achieve the desired conveyor belt control. Discuss in terms of conveyor belt Direction Control, Speed Control, Operation control and Safety Issues.

(8 marks)

END OF PAPER

MA4832 MICROPROCESSOR SYSTEMS

Please read the following instructions carefully:

- 1. Please do not turn over the question paper until you are told to do so. Disciplinary action may be taken against you if you do so.**
2. You are not allowed to leave the examination hall unless accompanied by an invigilator. You may raise your hand if you need to communicate with the invigilator.
3. Please write your Matriculation Number on the front of the answer book.
4. Please indicate clearly in the answer book (at the appropriate place) if you are continuing the answer to a question elsewhere in the book.