

**NANYANG TECHNOLOGICAL UNIVERSITY****SEMESTER 1 EXAMINATION 2022-2023****MA4832 – MICROPROCESSOR SYSTEMS**

November/December 2022

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. ARM Cortex-M4 is a 32-bit microcontroller, which has memory for data storage and data communication. Please give solutions to the following questions:
  - (a) What are the detailed steps for converting the decimal number 56 into its corresponding binary number? (5 marks)
  - (b) What are the detailed steps for converting the decimal number 0.63 into its corresponding binary number with 6 digits after the binary point? (5 marks)
  - (c) What are the detailed steps for converting the decimal number 7986 into its corresponding hexadecimal number? (5 marks)
  - (d) What are the detailed steps for converting the decimal number -34.78 into its corresponding single-precision floating point representation? (10 marks)
2. ARM Cortex M4 is a 32-bit microcontroller, which could undertake data input, data output, logical operations, and arithmetic operations.
  - (a) What is the hexadecimal value in R0 after the execution of the following codes?

```

MOV      R1, #0x0055      ; hexadecimal number
MOV      R2, #0x0088      ; hexadecimal number
MOV      R3, #0x0009      ; hexadecimal number
MLA      R0, R1, R3, R2

```

(5 marks)

Note: Question 2 continues on page 2.

- (b) What is the decimal value in R0 after the execution of the following codes?

```

A      DCD  64      ; decimal
B      DCD  16      ; decimal
MOV    R1, B, LSR #3  ;
ADD    R0, R1, A, LSL #3  ;

```

(5 marks)

- (c) The initial value of R1 is 0xAAAA. What should be the value of MASK so that the value of R1 will become 0xBBB after the execution of the following codes:

```

MOV    R1, #0xAAAA
MOVW   R2, MASK
ORR    R1, R1, R2

```

(5 marks)

- (d) ARM Cortex M4 outputs 0xAB (i.e., one byte) as a control signal to a motor which has a connection with the microcontroller's portA for data communication. What will be the data received by the motor after the execution of the following codes?

```

ADDRESS    EQU  0x4000.40FF
MOV        r0, ADDRESS      ; r0 = 0x4000.40FF
MOV        r1, #0xAB         ; hexadecimal number
STR        r1, [r0]          ;

```

(10 marks)

- 3 (a) (i) The GPIO DATA register has a GPIO address masking feature. What is the function of this feature when wanting to change the contents of a register (e.g., GPIO Port C)? How is the bit mask achieved? How is this masking function helpful?

(6 marks)

- (ii) What is the address of the GPIO PCTL register and its respective hex value if a programmer wants to configure PF0 as SSI1Rx and PF1 as SSI1Tx? (Use APB)

(4 marks)

Note: Question 3 continues on page 3.

- (b) Discuss and compare the communications protocol between UART and SSI. What are the functions and features of each communications protocol? What can cause errors in the communications using each respective communications protocol. Name a communication situation where each communication protocol is ideally suited for that communication application. State your reasons why they are ideal. Use the suggested template below to provide your answers in your answer booklet.

	UART	SSI
Communications functions and features		
Possible problems that can cause communications errors		
Suggest an application for this communication protocol		

(9 marks)

- (c) An SSI device is to be connected to a Tiva TM4C123G using the SSI2 connection and operated with the following functions;

- Master operation
- Freescale SPI mode (SPO=0, SPH=1)
- 400kbps bit rate
- 7 data bits
- System clock is 40Mhz

Determine the address and value of these two registers. Show your calculations to work out the bit value of the SCR and CPSDVSR.

Register	Address	Value
SSICR0		
SSICPSR		

(6 marks)

- 4 (a) A GPTM 16/32-Bit Timer 4 (Timer A) is to be configured in periodic mode using 16-Bit timer configuration. Provide the following register addresses and values to setup the correct configuration.

Use the following conditions for GPTMTAMR register:

- Bit (11:8) set to value 0
- Timer A begins as soon as it is enabled.
- Match interrupt is disabled.
- Timer counts up.
- Capture compare mode enabled

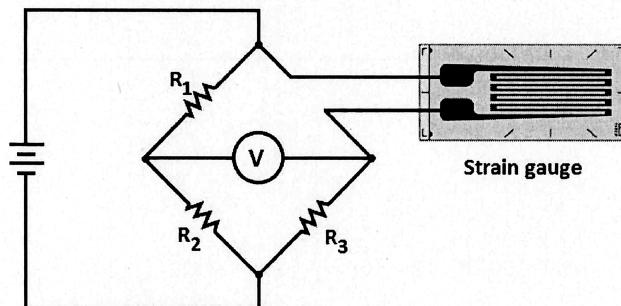
Note: Question 4 continues on page 4.

- Edge count mode
- Assume Timer A has already been disabled in the GPTMCTL register bit 0 and the timer is ready for configuration.

Register	Address	Value
<b>RCGCTIMER</b>		
<b>RCGCGPIO</b>		
<b>GPIOPCTL</b>		
<b>GPTMCFG</b>		
<b>GPTMTAMR</b>		

(10 marks)

- (b) A strain gauge is connected to a wheatstone bridge circuit as shown in Figure 1. The output voltage V of the circuit is required to be sampled using an ADC from the Microcontroller. The output voltage of this analogue signal will be in the milli-voltage range.

Figure: 1

Should the output voltage V of the wheatstone bridge be connected to the ADC in single-ended ADC or differential ADC mode? Describe the advantages for the connection mode you chose. Name one drawback of your choice. Suggest a suitable I/O port and number on the TIVA TM4C123G board that you could connect the strain gauge to the ADC port. Name the register and bit number that are used to configure this I/O port to either the single-ended or the differential ADC mode.

(8 marks)

- (c) To drive a brushed DC motor at a desired speed, it is required to configure PWM Generator 1 with a 2 kHz frequency, a 70 % duty cycle on the M1PWM0 pin, and a 30 % duty cycle on the M1PWM1 pin. The PWM clock has been configured to 10Mhz. Provide the following register addresses and values to setup the correct configuration. The GPIOPCTL register address have already been provided.

Register	Address	Value
<b>GPIOPCTL</b>	0x4000.752C	
<b>PWM1LOAD</b>		
<b>PWM1CMPA</b>		
<b>PWM1CMPB</b>		

(7 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.