

TUNKU ABDUL RAHMAN UNIVERSITY OF MANAGEMENT AND TECHNOLOGY

FACULTY OF COMPUTING AND INFORMATION TECHNOLOGY

ACADEMIC YEAR 2023/2024

JANUARY EXAMINATION

**AACS3064 COMPUTER SYSTEMS ARCHITECTURE**

TUESDAY, 16 JANUARY 2024

TIME: 2.00 PM – 4.00 PM (2 HOURS)

DIPLOMA IN COMPUTER SCIENCE

DIPLOMA IN INFORMATION TECHNOLOGY

DIPLOMA IN INFORMATION SYSTEMS

**Instructions to Candidates:**

Answer **ALL** questions. All questions carry equal marks.

**AACS3064 COMPUTER SYSTEMS ARCHITECTURE****Question 1**

a) Perform the following number conversions.

*(You are required to show the conversion steps clearly. Specify the reason(s) if the numbering is invalid.)*

(i)  $12.47C_{16}$  to octal number (2 marks)

(ii)  $98.75_{10}$  to hexadecimal number (2 marks)

(iii)  $45.3_6$  to decimal number (2 marks)

(iv)  $110.110_2$  to hexadecimal (2 marks)

(v)  $48.28_8$  to binary number (2 marks)

b) (i) Show how the following arithmetic operation is solved using two's complement method by a system that uses an 8-bit binary system to represent a decimal number. (3 marks)

*(You are required to show the conversion steps clearly.)*

$$-55_{10} + (-55_{10})$$

(ii) Then, verify the answer by showing in signed decimal value. (1 mark)

(iii) Does the answer have a carry and an overflow? (1 mark)

c) Given that a system is using the following:

- Excess-51 notation is applied.
- 0 sign bit is used to represent a positive number, and 9 represents a negative number.
- The implied decimal point is at the beginning of the mantissa.

(i) Show how the system converts the SEEMMMMM 94988888 to decimal sign-magnitude notation. (4 marks)

*(You are required to show the conversion steps clearly.)*

(ii) Show how the system adds the following two SEEMMMMM representations. Present the result in decimal sign-magnitude notation. (3 marks)

*(You are required to show the conversion steps clearly.)*

0 50 24680

0 51 08642

d) Convert the following binary number to IEEE754 single precision format. (3 marks)

*(You are required to show the conversion steps clearly.)*

$+1010.0101_2$

[Total: 25 marks]

**AACS3064 COMPUTER SYSTEMS ARCHITECTURE****Question 2**

- a) Assuming a Little Man Computer (LMC) model is used. Referring to Figure 1, show the steps and the changes of registers (IR, PC, MAR, MDR and A) when a simple addition of two numbers is executed. Currently, the PC points to the offset address 34. (15 marks)

RAM		
	offset address	content    instruction interpretation
<div style="border: 1px solid black; padding: 2px; display: inline-block;">34</div> PC	34	156    156 => load content from address 56
	35	257    257 => add the content from address 57
	36	356    356 => store result to address 56
	:	:
	56	012
	57	034

Figure 1: LMC

- b) Explain the **FOUR (4)** main features of Reduced Instruction Set Computer (RISC) architecture. (8 marks)
- c) Name the register for each of the following roles:
- (i) It temporarily holds the actual instruction that is currently being executed by the CPU. (1 mark)
  - (ii) It temporarily holds the address of a memory content (data or instruction). (1 mark)

[Total: 25 marks]

**Question 3**

- a) (i) By using an appropriate DEBUG command, write assembly language instructions starting from code segment address 1234H and offset 100H implementing the following high-level programming code. Assume the numbers are in signed 8-bit format. (3 marks)
- (Hints: *a, mov, div ...*)

$$y = 5 / 4$$

- (ii) Name the registers that hold the *quotient* and *remainder* for the program you have written. (2 marks)
- b) (i) Two memory addressing schemes i.e. logical address and physical address are used by the x86 microprocessor. Write a general equation of converting logical address to physical address in the Real-Mode (16-bit) memory. (2 marks)

**AACS3064 COMPUTER SYSTEMS ARCHITECTURE****Question 3 b) (Continued)**

- (ii) From the following snapshot, calculate the physical addresses of the CS:IP and SS:BP. (4 marks)

CS = 3456	DS = C842	SS = 1357	IP = AB1F	BP = 3829	SI = 230F
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Registers in CPU

- c) Interrupt can suspend a process to gain control of the processor to address an event needing immediate attention. List **FOUR (4)** uses of interrupt in a computer system. (8 marks)
- d) Identify **THREE (3)** methods to improve a system performance. (6 marks)

[Total: 25 marks]

**Question 4**

- a) Trace each line of the following assembly language instructions and record the contents of the corresponding registers from Line 5 to Line 9. (6 marks)

Line 1:	MOV	AL, 0ABh	
Line 2:	MOV	BL, 0EFh	
Line 3:	MOV	CL, 63h	
Line 4:	MOV	DL, 24h	;e.g. DL = 24h
Line 5:	XCHG	CL, DL	;CL = ?, DL = ?
Line 6:	SUB	BL, AL	;BL = ?
Line 7:	DEC	CL	;CL = ?
Line 8:	SHL	DL, 1	;DL = ?
Line 9:	OR	AL, CL	;AL = ?

- b) Referring to the following sub-questions, write code snippets (pieces of code) using assembly language to display the corresponding output. See the Figure 2 sample outputs.

<u>Sample Output 1:</u>	<u>Sample Output 2:</u>	<u>Sample Output 3:</u>
Enter an option (1 or 2): 1	Enter an option (1 or 2): 2	Enter an option (1 or 2): a
0123456789	ABCDEFGHJI	Wrong option

Figure 2: Sample Outputs

If the option is 1, display the 10 numbers starting from 0 to 9. (Hints: ASCII 30h => '0')

If the option is 2, display the first 10 characters starting from A to J. (Hints: ASCII 41h => 'A')

Other than 1 and 2, display the error message "Wrong option".

- (i) Declare all the necessary messages in the data segment. (2 marks)
- (ii) Initialise the data segment. (1 mark)

**AACS3064 COMPUTER SYSTEMS ARCHITECTURE****Question 4 b) (Continued)**

- (iii) Display the message *"Enter an option (1 or 2):"*. (1 mark)
- (iv) Receive or read a single input e.g. *1*. (1 mark)
- (v) Insert a new line. (1 mark)
- (vi) Validate or check the input option (e.g. *1 or 2, or others*). (3 marks)
- (vii) Display 10 numbers if option 1 is detected. Note that the numbers **CANNOT** be encoded in a message string. (*Hints: loop, CX*) (4 marks)
- (viii) Display 10 characters if option 2 is detected. Note that the characters **CANNOT** be encoded in a message string (*Hints: loop, CX*) (4 marks)
- (ix) Display the error message *"Wrong option"* if an invalid option is detected. (1 mark)
- (x) Terminate the program. (1 mark)

[Total: 25 marks]

**AACS3064 COMPUTER SYSTEMS ARCHITECTURE****Appendix: ASCII Character Set**

00		20		40	@	60	.	80	Ç	A0	á	C0	Ł	E0	α
01	☉	21	!	41	A	61	a	81	ü	A1	í	C1	⊥	E1	β
02	●	22	“	42	B	62	b	82	é	A2	ó	C2	⌈	E2	Γ
03	♥	23	#	43	C	63	c	83	â	A3	ú	C3	⌋	E3	π
04	♦	24	\$	44	D	64	d	84	ä	A4	û	C4	—	E4	Σ
05	♣	25	%	45	E	65	e	85	à	A5	Ñ	C5	+	E5	σ
06	♠	26	&	46	F	66	f	86	å	A6	ª	C6	⌞	E6	μ
07	•	27	*	47	G	67	g	87	ç	A7	º	C7	⌏	E7	τ
08	■	28	(	48	H	68	h	88	ê	A8	¿	C8	⌌	E8	Φ
09	○	29	)	49	I	69	i	89	ë	A9	¬	C9	⌍	E9	Θ
0A	▣	2A	*	4A	J	6A	j	8A	è	AA	¬	CA	⌎	EA	Ω
0B	♂	2B	+	4B	K	6B	k	8B	ĩ	AB	½	CB	⌐	EB	Δ
0C	♀	2C	,	4C	L	6C	l	8C	î	AC	¼	CC	⌑	EC	∞
0D	♪	2D	-	4D	M	6D	m	8D	ï	AD	¡	CD	=	ED	φ
0E	♫	2E	.	4E	N	6E	n	8E	Ä	AE	«	CE	⌒	EE	ε
0F	☼	2F	/	4F	O	6F	o	8F	Å	AF	»	CF	⌓	EF	∩
10	▶	30	0	50	P	70	p	90	É	B0	☐	D0	⌔	F0	≡
11	◀	31	1	51	Q	71	q	91	æ	B1	☐	D1	⌕	F1	⊥
12	↑	32	2	52	R	72	r	92	Æ	B2	☐	D2	⌖	F2	≥
13	!!	33	3	53	S	73	s	93	ô	B3		D3	⌗	F3	≤
14	¶	34	4	54	T	74	t	94	ö	B4	†	D4	⌘	F4	{
15	§	35	5	55	U	75	u	95	ò	B5	‡	D5	⌙	F5	}
16	—	36	6	56	V	76	v	96	ù	B6	‡	D6	⌚	F6	÷
17	↕	37	7	57	W	77	w	97	û	B7	¶	D7	⌛	F7	≈
18	↑	38	8	58	X	78	x	98	ÿ	B8	¶	D8	⌜	F8	°
19	↓	39	9	59	Y	79	y	99	Ö	B9	¶	D9	⌝	F9	·
1A	→	3A	:	5A	Z	7A	z	9A	Ü	BA		DA	⌞	FA	·
1B	←	3B	;	5B	[	7B	{	9B	¢	BB	¶	DB	☐	FB	√
1C	└	3C	<	5C	\	7C		9C	£	BC	┘	DC	☐	FC	²
1D	↔	3D	=	5D	]	7D	}	9D	¥	BD	┘	DD	☐	FD	²
1E	▲	3E	>	5E	^	7E	~	9E	Ps	BE	┘	DE	☐	FE	■
1F	▼	3F	?	5F	_	7F	△	9F	f	BF	┘	DF	☐	FF	