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]

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)

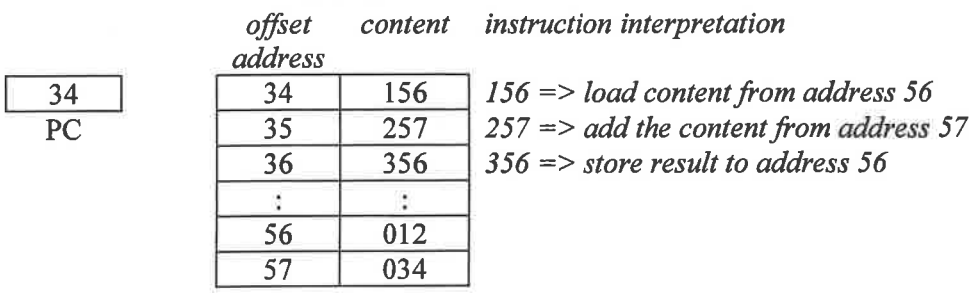

Figure 1: LMC

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)

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

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.

Sample Output 1:	*Sample Output 2:*	*Sample Output 3:*
Enter an option (1 or 2): 1	*Enter an option (1 or 2): 2*	*Enter an option (1 or 2): a*
0123456789	*ABCDEFGHIJ*	*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)

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]

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Appendix: ASCII Character Set

00		20		40	@	60	`	80	Ç	A0	á	C0	└	E0	α
01	☺	21	!	41	A	61	a	81	ü	A1	í	C1	┴	E1	ß
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	ñ	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	ï	AB	½	CB	╦	EB	δ
0C	♀	2C	,	4C	L	6C	l	8C	î	AC	¼	CC	╠	EC	∞
0D	♪	2D	-	4D	M	6D	m	8D	ì	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	û	B6	╢	D6	╓	F6	÷
17	↨	37	7	57	W	77	w	97	ù	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	ⁿ
1D	↔	3D	=	5D	]	7D	}	9D	¥	BD	╜	DD	▌	FD	²
1E	▲	3E	>	5E	^	7E	~	9E	Pts	BE	╛	DE	▐	FE	■
1F	▼	3F	?	5F	_	7F	⌂	9F	*f*	BF	┐	DF	▀	FF	