QUESTION 1.

Z

1 In a particular computer system, real numbers are stored using floating-point rep



- 8 bits for the mantissa, followed by
- 8 bits for the exponent

Two's complement form is used for both mantissa and exponent.

(a) (i) A real number is stored as the following two bytes:

			Man	tissa								Expo	onent			
0	0	1	0	1	0	0	0		0	0	0	0	0	0	1	1
		Calcu	ulate ti	ne der	nary v	alue c	of this	numb	er. Sh	ow yo	our wo	rking.	I			
																[3]
	(ii)	Expla	ain wh	y the f	loatin	g-poin	ıt num	ıber ir	n part	(a)(i)	is not	norm	alised			
																[2]
	(iii)	Norm	nalise	the flo	ating-	point	numb	er in I	oart (a	a)(i).						
			Man	tissa								Expo	onent			

[2]

(b)	(i)			arges this fo		tive r	numbe	r tha	t can	be w	ritten	as a	norma	alis		
			Man	tissa								Expo	onent			
						ı										[2]
	(ii)			smalle this fo		sitive	numb	er tha	at car	n be w	vritten	as a	norma	alised	floati	ng-point
			Man	tissa								Ехро	onent			
								_								[2]
	(iii)	If a p	ositive	numl	ber is	adde	d to th	e nun	nber i	n part	(b)(i)	explai	in wha	ıt will l	nappe	n.
																[2]
(c)	A st	udent	writes	s a pro	ogram	to ou	tout n	umbe	rs usi	na the	follow	/ina ca	ode:			
(-)		x ←			9							9				
		FOR	i ←	0 T(X + (100	0										
		0	UTPU		J•⊥											
		ENDF	'OR													
	The	stude	nt is s	surpris	sed to	see t	hat the	e prog	gram (output	s the f	ollowir	ng sec	quence	e:	
	0.0	0.1	0.2	0.299	9999	0.3	99999	9								
	Ехр	lain w	hy this	outp	ut has	occu	rred.									
					•••••			•••••					•••••			

1 In a particular computer system, real numbers are stored using floating-point rep-



- 8 bits for the mantissa, followed by
- 4 bits for the exponent

Two's complement form is used for both mantissa and exponent.

Calculate the denary value of this number. Show your working. (ii) Give the normalised binary pattern for +3.5. Show your working.	(i)	A re	al nur	mber is	store	d as t	he foll	owing	12-bi	t bina	ry patt	ern:		
(ii) Give the normalised binary pattern for +3.5. Show your working.		0	1	1	0	1	0	0	0		0	0	1	1
ii) Give the normalised binary pattern for +3.5. Show your working.		Calc	ulate	the de	nary v	alue	of this	numb	er. Sh	ow y	our wo	rking.	•	
ii) Give the normalised binary pattern for +3.5. Show your working.														
ii) Give the normalised binary pattern for +3.5. Show your working.														
(ii) Give the normalised binary pattern for +3.5. Show your working.														
Give the normalised binary pattern for +3.5. Show your working.														
(ii) Give the normalised binary pattern for +3.5. Show your working.														
	įii)	Give	the r	normali	ised bi	inary	patter	n for +	3.5. S	how	your w	orking	J.	
			•••••											
(iii) Give the normalised binary pattern for –3.5. Show your working.														
	ii)	Give	the r	normali	ised bi	inary	patter	n for –	3.5. S	how	your w	orking	 -	

.....[3]

The	num	aber of bits available to represent a real number is increased to 16.
(b)	(i)	If the system were to use the extra 4 bits for the mantissa, state what the effect on the numbers that can be represented.
		[1]
	(ii)	If the system were to use the extra 4 bits for the exponent instead, state what the effect would be on the numbers that can be represented.
(c)	Δet	udent enters the following expression into an interpreter:
(0)	7. 3.	OUTPUT (0.1 + 0.2)
	The	student is surprised to see the following output:
	0.30	000000000001
	Ехр	lain why this output has occurred.
		[3]

QUESTION 3.

Z

(a) Calculate the floating-point representation of +2.5 in this system. Show your working.

1 In a particular computer system, real numbers are stored using floating-point rep



- 12 bits for the mantissa
- 4 bits for the exponent
- two's complement form for both mantissa and exponent

				Man	tissa				Expo	onen	t
•											
			•••••			 	 	 	 		
		floor				 i					
Calcula	te the	float	ing-p			ion of			v you	r worl	king.
Calcula	ite the	float	ing-p		epres	ion of				r worl	king.
Calcula	ite the	e float	ing-p			ion of			v you	r worl	king.
Calcula	ite the	e float	ing-p			ion of			v you	r worl	king.
Calcula	ite the	e float	ing-p			ion of			v you	r worl	king.
Calcula	te the	e float	ing-p			ion of			v you	r worl	king.
Calcula	ite the	float	ing-p			ion of			v you	r worl	king.
Calcula	te the	float	ing-p			ion of			v you	r worl	king.

:)	Fir	nd	the	e der	nary	v va	alue f	or the	e follo	wing	binar	y floa	ting-p	oint r	numb	er. Sh	now y	C.		
								Man	tissa								Ехро	onent		
	0	•	0	1	1	L	0	0	0	0	0	0	0	0		0	0	1	1	
	'							•	•						_					
					••••															
																				[
)	(i)		Sta	ate w	het	he													norm	_
	()								•				-		-					
	(ii)		. li i	stify					en in r											
	(,		o a.	y	y o u.	٠ ـ		. 9	··· ··· F	,	- /(-/-									
			••••			••••														г
	Th		۰۰۰۰		ob s															
)																	a and	ııne e	expon	ent.
	Sta	ate	e tv	vo e	itec	ts 1	inis n	as on	the r	numb	ers th	at ca	n be i	repre	sente	ed.				
	1			•••••	••••															
					••••					•••••							•••••			
	2				••••															
																				г

QUESTION 4.

Z

1 In a particular computer system, real numbers are stored using floating-point rep



- 8 bits for the mantissa
- 8 bits for the exponent
- two's complement form for both mantissa and exponent

		Man	tissa					Expo	onent	:	
•											
Calcul	ate the	float	ing-p	oint r	epres						
Calcul	ate the	float		oint r	epres			tem.		your	
Calcul	ate the			oint r	epres			tem.	Show	your	
Calcul	ate the			oint re	epres			tem.	Show	your	
Calcul	ate the			oint re	epres			tem.	Show	your	
Calcul	ate the			oint ro	epres			tem.	Show	your	
Calcul	ate the			oint re	epres			tem.	Show	your	
Calcul	ate the			oint re	epres			tem.	Show	your	

(c)	F	ind th	e den	ary v	alue f	or the	follo	wing	binar	y float	ting-p	oint r	numb	er. Sh	ow y	٥.		
				Man	tissa								Ехро	nent	t			
	0	1	1	1	0	0	0	0		0	0	0	0	0	1	0	0	
			<u> </u>						J			1		ı				
	•••																	
	•••													• • • • • • • • • • • • • • • • • • • •		•••••		
	•••																	[3]
(d)	(i) St	ate w	hethe	r the t	floatir	ng-po	int nu	mber	giver	in p a	art (c) is no	ormal	ised o	or not	norm	alised.
																		[1]
	(ii) Ju	ıstify y	our a	nswe	r give	n in r	oart (d)(i).									
																		[1]
(e)	G	iive th	ne bina	arv tw	o's co	omole	ment											nitude.
(-)	Ŭ.			•	tissa	-		pario			.ogai		Ехро			goo	····ag	
Γ		T		IVIAII	lissa]				Expo					
	-	T																[2]

QUESTION 5.

(b)

-

2 (a) A computer system stores real numbers using floating-point representation. numbers have:



- eight bits for the mantissa
- four bits for the exponent.

The mantissa and exponent are both in two's complement form.

(i) Calculate the denary value of the following floating-point number.

			Man	tissa	a			Exponent
0	0	1	1	1	0	0	0	0 1 1 1
Show	/ you	ır wo	rkinç	g.				
Work	ing							
Answ	er .							
State	how	you	ı kno	w th	e floa	ating	-poin	number in part (a)(i) is not normalised.
Norm	alise	e the	floa	ting- _l	ooint	num	ıber i	part (a)(i).
			Man	itissa	a	_		Exponent
Write floatin	the ng-p	larç	gest numl	posi ber ir	tive n this	num forn	ber nat.	hat this system can represent as a norma
			Man	ıtissa	a			Exponent
							1	

[2]

	(ii)	Write the smallest positive number th number in this format.	at can be stored as a normalis
		Mantissa	Exponent
			[2]
(c)	The	number of bits available to represent a	real number is increased to 16.
		te the effect this has on the numbers that d in the:	can be represented, if the additional four bits are
	(i)	mantissa	
			[1]
	(ii)	exponent	
			[1]
(d)	A st	udent enters the following code into an i	
		<pre>X = 0.1 Y = 0.2 Z = 0.3 OUTPUT (X + Y + Z)</pre>	
	The	student is surprised to see the output:	
		0.600000000000001	
	Ехр	lain why this is output.	
			[3]

QUESTION 6.

(a) A computer system uses floating-point representation to store real numbers. numbers have:



- 8 bits for the mantissa
- 8 bits for the exponent

The mantissa and exponent are both in two's complement form.

(i) Calculate the denary value of the following floating-point number. It is **not** in normalised form.

			Man	tissa	a						I	Expo	nen	t		
0	0	1	0	1	0	1	0		0	0	0	0	0	1	0	1
Sł	now	your	work	ing.												
W	orkir	ng														
Ar	iswe	r														
С	onve	rt the	e der	nary i	numb	er +	7.5 i	nto a	ı norn	nalis	ed flo	oatin	g-poi	nt nu	ımbe	er.
Sł	now	your	work	ing.												
			Man	tissa	a						ı	Ехро	nen	t		
W	orkir	ng														

				Man	tissa	1						I	Expo	onen	t			
	W	orkin	ıg															
n، ا	 			ating				ar ie e	hown									
A no	 iorn	nalise			g-poii		ımbe	er is s	howr	 			Expo	onen	t			
	 iorn	nalise					ımbe	er is s	howr	0	1	1	Exp	onen	t	1	1	
	0	1	1	Man 1	tissa 1	1	1	1		0						1	1	
	0	1	1	Man 1	tissa 1	1	1			0						1	1	
	0	1	1	Man 1	tissa 1	1	1	1 Dinary	/ num	0 nber.		1	1	1	1			

QUESTION 7.

In a computer system, real numbers are stored using normalised floating-poin with:



- twelve bits for the mantissa
- four bits for the exponent.

The mantissa and exponent are both in two's complement form.

(a) Calculate the denary value for the following binary floating-point number.

Show your working.

	_	•	11 VVO														
					Man	tissa	l								Ехро	onen	t
1	0	0	1	0	1	1	1	0	0	1	1			0	1	1	1
SI	how	you	ır wo	rking].									this s			

(c)	c) (i) Write the largest positive number that can be stored as a normalis number using this format.																				
					Man	tissa	l										Exp	one	nt		
																					[2]
	(ii) Write the smallest non-zero positive number floating-point number using this format.													an I	be s	store	d as	за	norm	alis	ed
	Mantissa																Exp	one	nt		
												J									[2]
(d)																					
																					[3]

QUESTION 8.

(a) A computer stores real numbers using floating-point representation. In numbers have:



- eight bits for the mantissa
- four bits for the exponent.

The mantissa and exponent are both stored in two's complement format.

(i) Calculate the denary value of the following floating-point number.Show your working.

			Man	tissa	l			Exponent								
0	0	1	1	0	1	1	1		0	1	0	1				
Work	ing															
Ansv	ver .													[3]		
State	e why	the	float	ing-p	oint	num	ber ir	n part (a)(i) is not	norn	nalis	ed.			[-]		
														[1]		
Give	the 1	loatii	ng-po	oint r	numb	er in	part	t (a)(i) in normalis	ed tw	vo's c	comp	leme	ent forma	at.		
			Man	tissa	ı				I	Expo	nen	t				
-																

[2]

(b)	(i)	Convert the denary number +11.625 into a normalised floating-point num															
		Show your working.															
		Working															
			Mar		Exponent												
																	[0]
	/::\	Convert t	ha danar		ah ar	11 6	oe ii	nto o	norm	oliooo	l floot	ina n	oint n	umb	٥,		[3]
	(ii)	Convert to Show you			iibei -	-11.04	23 II	iiio a	HOHH	aliseu	i iioai	.ii ig-p	OIIILI	iuiiib	€I.		
		Working															
		working															
			Mar		Exponent												
			1	1				l				1					[3]





The student is surprised to see that the interpreter outputs the following:

0.080000000000000002

Explain why the interpreter outputs this value.

QUESTION 9.

1 Real numbers are stored using floating-point representation in a computer system



This representation uses:

- 8 bits for the mantissa, followed by
- 4 bits for the exponent.

Two's complement form is used for both the mantissa and the exponent.

(a) (i) A real number is stored as a 12-bit normalised binary number as follows:

					wan	ussa	l		Exponent								
		0	1	0	1	0	0	1	0		0	0	1	0			
	Cá	alcı	ulate	the	dena	ry va	ılue f	or th	is bir	ary number. Sho	w yoı	ur wo	rking] .			
	W	ork	king .														
	De	ena	ary va	alue													
(i	i) Ca	alcı	ulate	the	norm	alise	d bir	nary i	numk	er for -3.75. Sho	w yo	ur wo	orkin	g.			
					Man	tissa	1			Exponent							
				•									'				
	W	ork	king .														
								•••••									
	•••																
٦	he nu	ımk	oer o	f bits	ava	ilable	to re	epres	sent a	a real number is i	ncrea	ased	to 16	.			
										e exponent by 4							

(c)	State why some binary representations can lead to rounding errors.
(d)	Complete the following descriptions by inserting the two missing terms.
	can occur in the exponent of a floating-point number, when the
	exponent has become too large to be represented using the number of bits available.
	A calculation results in a number so small that it cannot be represented by the number of bits
	available. This is called[2]

QUESTION 10.

~

8 (a) The following 16-bit binary pattern represents a floating-point number complement form. The twelve most significant bits are used for the mantissa least significant bits are used for the exponent.



Mos sigi	st nificant	bit											sigı	nifica	nı ↓
0	1	1	1	0	0	0	0	0	0	0	0	1	1	0	1
(i)	Identify	/ the b	oinary	value	of the										[1]
(ii)	Identify	/ the b	oinary	value	of the	manti	issa.								
(iii)	State v	vhethe	er the	numb	er stor	ed is	oositiv	e or n					oice.		[1]
()	Positiv														
	Justific	ation													
															[2]
(iv)	Conve	rt the I	binary	floatii	ng-poi	nt nun	nber ir	n part	(a) in	to den	ary. S	how y	our w	orking	
	Workin	g													
				•••••			•••••		•••••		•••••			•••••	
	Donar														
	Denary	, valut	∍												[3]

(b)	The number of bits used for the exponent is increased to eight, and the num for the mantissa is decreased to eight.	
	State the effects of this change.	
		رد. ادرا

BLANK PAGE



BLANK PAGE

