UNIVERSITY OF KENT

DIVISION OF COMPUTING, ENGINEERING AND MATHEMATICAL SCIENCES

LEVEL 4 EXAMINATION

Foundations of Computing I

MAY/JUNE 2022

Paper Instructions
The paper contains FIVE questions. Answer FOUR questions.
Notes to Candidates
This is an open book examination to be completed and submitted within 24 hours.
This examination is designed to take **two hours** but you can take longer if you wish. Please ensure that you submit your answer booklet within 24 hours of the exam release time.
As you will have access to resources to complete your assessment, any content you use from external source materials should be cited. Full academic referencing is not required.
You are reminded of your responsibility to act with honesty, integrity and fairness in completing assessment requirements for your course, and to demonstrate good academic practice when undertaking this assessment.
This is an individual piece of work and collusion with others is strictly prohibited.
Plagiarism detection software will be in use.
Breaches of academic integrity will be considered to be academic misconduct.
Where the University believes that academic misconduct has taken place the University will investigate the case and apply academic penalties as published in Annex 10 of the Credit Framework.
Attachment: Normal Distribution Table provided at the end of the paper.

1. (a) Find the sum to infinity for the series $12 + 6 + 3 + \cdots$

[4 marks]

(b) Determine the values of a, b, c and d:

$$(2 + 3x)^a = 16 + bx + 216x^2 + 216x^c + dx^4$$

[8 marks]

(c) $f(x) = x^2 + 6x - 4$

$g(x) = 4x - x^2$

(i) Find the two values of x for which $f(x)$ and $g(x)$ coincide

(ii) Find the values of $f(x)$ when this occurs

$$\boxed{\begin{array}{c} ax^2 + bx + c = 0 \\[1em] \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a} \end{array}}$$

[8 marks]

2. A series is defined by $S_n = \sum_{r=1}^{n} 5^r$

(a) Find the first 3 terms of the series

[6 marks]

(b) Use the method of induction to prove that $S_n = \frac{5}{4}(5^n - 1)$

[14 marks]

3. (a) Sketch the distribution $N(0,1)$ and state the 2σ rule for Normal variables

[4 marks]

(b) State the conditions under which a normal distribution can be used as an approximation to a Poisson distribution. State the values of μ and σ when $\lambda = 49$

[3 marks]

(c) The number of visitors to a small tourist attraction follows a Poisson distribution with mean $\lambda = 49$ per day when it is open. The attraction opens 250 days per year.

(i) Find the probability that on any particular day there will be more than 55 visitors

[5 marks]

(ii) On how many days per year will there be more than 55 visitors?

[2 marks]

(iii) What is the chance that there will be between 45 and 55 visitors (inclusive) on any particular day?

[6 marks]

4. (a) L is a language with $L = \{r^o 101^o r^o 10\}$. Which of the following strings are contained within L?

(i) 101011010

(ii) 11101110

(iii) 0101010

(iv) 10110

(v) 1010101010

[10 marks]

(b) Three sets are defined as follows:

M = {natural numbers < 20}

P = {prime numbers ≤ 20}

Q = {odd numbers < 20}

(i) List the members of $M \cap P$

(ii) Find the members of P which are not in set Q

(iii) Find the members of Q which are not in set P

[6 marks]

(c) Create a set comprehension for the set $F = \{1,2,4,8,16\}$

[4 marks]

5. (a) (i) What is the maximum positive number that can be stored in 8-bit 2's complement form

(ii) Convert $+97$ and -58 into 8-bit 2's complement form

(iii) Perform the 2's complement calculations for $97 + 58$ and $97 - 58$, show your working

(iv) Using your calculations as examples, show how an overflow can be detected

[10 marks]

(b) (i) Write the numbers 12457 and 2987 in BCD format

(ii) Perform the calculation $12457 + 2987$ using BCD arithmetic. Show your working

[10 marks]

Normal Distribution - $\Phi(z)$

$P(Z < z)$ for $Z \sim N(0,1)$

$$Z = \frac{x - \mu}{\sigma}$$

z	0	1	2	3	4	5	6	7	8	9
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.99036	.99061	.99086	.99111	.99134	.99158
2.4	.99180	.99202	.99224	.99245	.99266	.99286	.99305	.99324	.99343	.99361
2.5	.99379	.99396	.99413	.99430	.99446	.99461	.99477	.99492	.99506	.99520
2.6	.99534	.99547	.99560	.99573	.99585	.99598	.99609	.99621	.99632	.99643
2.7	.99653	.99664	.99674	.99683	.99693	.99702	.99711	.99720	.99728	.99736
2.8	.99744	.99752	.99760	.99767	.99774	.99781	.99788	.99795	.99801	.99807
2.9	.99813	.99819	.99825	.99831	.99836	.99841	.99846	.99851	.99856	.99861
3.0	.99865	.99869	.99874	.99878	.99882	.99886	.99889	.99893	.99896	.99900
3.1	$.9^{3}032$	$.9^{3}065$	$.9^{3}096$	$.9^{3}126$	$.9^{3}155$	$.9^{3}184$	$.9^{3}211$	$.9^{3}238$	$.9^{3}264$	$.9^{3}289$
3.2	$.9^{3}313$	$.9^{3}336$	$.9^{3}359$	$.9^{3}381$	$.9^{3}402$	$.9^{3}423$	$.9^{3}443$	$.9^{3}462$	$.9^{3}481$	$.9^{3}449$
3.3	$.9^{3}663$	$.9^{3}534$	$.9^{3}550$	$.9^{3}566$	$.9^{3}581$	$.9^{3}596$	$.9^{3}610$	$.9^{3}624$	$.9^{3}638$	$.9^{3}651$
3.4	$.9^{3}663$	$.9^{3}675$	$.9^{3}687$	$.9^{3}698$	$.9^{3}709$	$.9^{3}720$	$.9^{3}730$	$.9^{3}740$	$.9^{3}749$	$.9^{3}758$
3.5	$.9^{3}767$	$.9^{3}776$	$.9^{3}784$	$.9^{3}792$	$.9^{3}800$	$.9^{3}807$	$.9^{3}815$	$.9^{3}822$	$.9^{3}828$	$.9^{3}835$
3.6	$.9^{3}841$	$.9^{3}847$	$.9^{3}853$	$.9^{3}858$	$.9^{3}864$	$.9^{3}869$	$.9^{3}874$	$.9^{3}879$	$.9^{3}883$	$.9^{3}888$
3.7	$.9^{3}892$	$.9^{3}896$	$.9^{3}90$	$.9^{4}04$	$.9^{4}08$	$.9^{4}12$	$.9^{4}15$	$.9^{4}18$	$.9^{4}22$	$.9^{4}25$
3.8	$.9^{4}28$	$.9^{4}31$	$.9^{4}33$	$.9^{4}36$	$.9^{4}38$	$.9^{4}41$	$.9^{4}43$	$.9^{4}46$	$.9^{4}48$	$.9^{4}50$
3.9	$.9^{4}52$	$.9^{4}54$	$.9^{4}56$	$.9^{4}58$	$.9^{4}59$	$.9^{4}61$	$.9^{4}63$	$.9^{4}64$	$.9^{4}66$	$.9^{4}67$