Examiners' report 2009

2910102 Mathematics for computing – Zone A

General remarks

There were many excellent scripts, showing candidates were well prepared and had a very good understanding of the course. At the other end of the spectrum were a few ill-prepared candidates who obviously struggled with the material. In between these extremes were the majority of papers which were more than satisfactory. The general standard of presentation and clarity of work was commendable.

When revising for the examination it is a good idea to work through the sample paper in the subject guide which has full solutions. You can then compare your answers with those given and if your approach is very different then you can consider why and perhaps modify your method. You can learn a lot from looking at the notation and wording used in the solution and the way any mathematical definitions or proofs are included. The way you present your solution may help you clarify the problem and develop the solution, as well as make it easier for the Examiner to follow your work. Please try to ensure your answers convey your meaning clearly and correctly and show your working in full, so that the Examiner may give you marks for correct method, even if you make an error (which means your final solution is incorrect). It will help you greatly to work through other past papers as part of the revision process so that you are familiar with the type of questions that may arise on each topic, and the material and skills you need to answer them. It may also help to make a list of key points on each chapter as a revision guide, together with typical examination questions.

Comments on individual questions

Question 1

Part (a) can be done by subtracting BB6 from D12 in base 16.

In part (b) 299 can be converted into either base 2 or base 16 by the method of repeated division, but having found one of these it is possible to determine the other by considering blocks of four binary digits and their hexadecimal equivalents.

Marks were lost in part c) by considering recurring decimals such as 7/11 as if they were finite (say 0.6363), which they are not. Similarly 0.1313 is not equal to 13/99 but 0.1313… is (here the ellipsis (three dots) indicates the infinitely repeating decimal).

In part (d) some candidates stated that 0.1313 is a rational number, which is correct, but that 0.1313… is not, which is incorrect. Irrational numbers, such as pi, cannot be expressed as recurring or finite decimals.

Question 2

In part (a) the range of values of r which satisfies both constraints is r = 1, 2, 3,…50, giving elements of the set A = {2, 5, 8,…149}. In (ii) the set B consists of powers of 2 from 1 to 10.

For part (b) (i), candidates needed to know the rule for set union and set difference to create the column for B union C and combine this with the column for A. In part (ii) it is possible to draw the Venn diagram and shade the region X on it without having done part (i) at all. Part (iii) is also independent of part (i) and candidates were asked to describe the shaded region X, in terms of set operations. There are several different ways to do this correctly and marks were awarded for any valid expression, such as: the complement of (A union C), union B.

Question 3

Part (a) of this question required candidates to not only draw up a truth table for the given propositions, but also to find the truth set for each of them. This is the set of values which have an entry of 1 in the truth table. Thus for 'p or not q' the truth set is where p is false and q is true, giving n even or less than 5, or both. The set is thus {1, 2, 3, 4, 6, 8}. Similarly, for not (q implies p) the truth set is {5, 7, 9}.

For part (b) candidates lost marks for incorrect or absent labelling of gates and inputs/outputs as well as (more rarely) incorrect arrangement of gates. Many diagrams were carefully and clearly drawn and well labelled, gaining full marks. The logic table was also well done by most, but there were a few marks lost in the final part by candidates failing to deduce that 'since the columns of the table are identical the expressions are equivalent'.

Question 4

A graph is simple if it has no loops or multiple edges. It is connected if there is a path from each vertex to every other vertex. Some candidates defined the latter by saying a graph is connected if each vertex is connected to every other. A circular definition like this was not given marks.

In part (b) there are six vertices and the number of edges is found by adding up the degrees and dividing by 2 to obtain 7.

For part c) a clear and full explanation of why a graph with the given degree sequence is not simple is required. This graph has four vertices and one of them is of degree 4. There are only three other vertices this can be adjacent to, so if it has degree 4 there must be more than one edge connecting to one of the other three vertices, or a loop on this vertex. Thus the graph cannot be simple as it has either a loop or multiple edges on this vertex of degree 4.

There are a few possible graphs which have this degree sequence and any of these was accepted.

Question 5

This was a tricky question, demanding a good understanding of the concepts of domain, co-domain and range, onto, one to one and invertible, as well as the ability to manipulate and calculate the expressions (x^2-1)/3 and (n+1)/3.

In part (a) f(2) is 1 and the ancestors of zero are just 1. (-1 works but is not in the domain). The range of f is {-1, 0, 1, 2} which is not equal to the co-domain so the function is not onto and thus not invertible.

In part (b) g(3) = 0 and the ancestors of zero are 1, 2, 3. Since the range of g is all integers the function is onto, but not one to one since 1, 2, 3 all have the same image. The function is thus not invertible.

Part c) was well done by most candidates.

Question 6

The first part of this question involved calculating the first three terms of the series, which were 1, 3, 6 and most candidates could manage this. The recurrence relation is of the form the n+1th term = the nth term +(n+1) and the first term = 1.Candidates were not asked for a proof by induction but just to use the result to calculate the sum of the first 200 positive integers, that is 1 + 2 + 3 +…+ 200.

In part (b) the first expression was intended to read 1 + 3 + 5 + 7 +…+ 999, which is the sum of the first 500 numbers of the form (2n-1). Full marks were given for expressing this in Sigma notation and calculating the sum to be 250,000, as well as for considering the given expression 1 + 3 + 5 + 7 + 999 and arriving at the solution 1,015.

The second expression is the sum of the first 1,000 numbers of the form (3n-2) and is 1,499,500.

Question 7

a. Each subset of S can be represented by a 3-digit binary string where the presence of a one in the first place indicates that the element 'a' is in the subset, whereas a zero indicates its absence. Likewise, in the second place the binary digit one or zero indicates whether or not the element 'b' is included in the subset and the digit in the third place indicates whether or not 'c' is included. A full definition like this is required; just giving examples of strings and the subsets to which they refer is not sufficient to gain full marks for this part of the question.

   The string corresponding to {a, c} is 101 and the string 011 represents the subset {b, c}. The total number of subsets is 2^3 = 8.

b. Some candidates did not realise that the vertices of the digraph represented sets: {a}, {b}, {a, b} and {a, b, c} and there were directed arcs between vertices when one set was a subset of the other. Thus there was an arc from {a} to {a, b} and {a, b, c} but not from {a} to {b}. This relation is reflexive, not symmetric and transitive. As it is also anti-symmetric, it is a partial order. Full explanations should be given when any of these properties hold and a counter example when any do not apply. Standard explanations are in the subject guide for this chapter, including useful notation.

Question 8

There were two different solutions to part (a). The first is for the number of 3-digit strings with repetitions and is 6^3 = 216. The second is the number of 3 digit strings without repetitions and is 6.5.4 = 120.

In part (b) the number of elements in set A is 3.5.4 = 60, in set B is 5.4.1 = 20, in A intersection B is 2.4.1 = 8 and in A union B is 60 + 20 – 8 = 72. The probabilities in the last part of the question were obtained by considering the number of elements in each set divided by the total number of 3-digit strings without repetition which is 120. If students made a mistake in the first part of section (b) and carried it through to the last part follow-on marks were awarded.

Question 9

A tree is a connected graph with no cycles and H is a spanning tree of a graph G if it contains all the vertices of G but no cycles. There are three distinct spanning trees of the given graph, each made by removing an edge from the cycle of length three in G. However, two of these are isomorphic, leaving just two non-isomorphic spanning trees of G.

In part (d) the root is 2,500, the nodes at level one are 1,250 and 3,750; the nodes at level two are 625, 1,875, 3,125 and 4,375. The height of the tree is 13.

Question 10

The first part of this matrix question required multiplication skills and was well done by most candidates.

The Gaussian elimination followed the standard method, but a few mistakes crept in. Errors were followed through in order to give follow-on marks where possible and clear labelling of row operations helped. Very few candidates performed illegal row operations. Back substitution was also well done, with very few errors.