2910102 Mathematics for computing

Examiner's report: Zone B

General remarks

These scripts showed that most of the candidates had a thorough understanding of the syllabus and the ability to apply their knowledge and skills in the appropriate context. They were well prepared and demonstrated that they had a good grasp of the subject and had revised well.

When revising for the exam 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 which 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 exam questions.

Comments on individual questions

Question 1

This question required candidates to transfer numbers from binary to hexadecimal and back as well as to add and subtract numbers in hex and binary. They were aided by the given conversion table showing the first 16 hexadecimal numbers and their binary equivalents. However some candidates in part (a) (iii) and (iv) did not carry out the computation in the specified base, but converted everything to another base in order to perform the arithmetic, such as base ten. For this they lost some marks.

In part (b) a formal definition of a rational number is required, such as a number which can be expressed in the form m/n where m and n are integers and n is not equal to zero. It is not sufficient to just say a rational number is a fraction. Any repeating (or finite) decimal can be expressed as a rational number, including the repeating decimal in the question. There is a standard technique for finding the fractional equivalent of a repeating decimal which candidates should make sure they are familiar with. In this case, as the repeating block is of length two, the number must be multiplied by 10 ^ 2. This method hinges on the fact that the repeating part of the decimal is infinite, whereas some candidates truncate it, rendering their solution meaningless. Putting three or more dots (….) at the end is sufficient to indicate that the decimal repeats infinitely.

Question 2

Part (a) contained an error. It asked candidates to describe the set A by the rule of inclusion method when the set was already described in those terms. Marks were given for just reproducing the set description, and for describing the set A by the listing method. Similarly candidates were asked to describe set B by the listing method when it was already defined in that way. Marks were awarded for either the listing method or the rule of inclusion method of describing set B.

Part (b) was well done by the majority of candidates. A membership table for three sets, P, Q and R was required and this needed to have 8 rows in it with entries such as 0 0 0, 0 0 1.

Columns for: P complement; P complement union R and finally X are required. The entries of one in this final column correspond to shading in that corresponding region in the Venn diagram showing three sets intersecting in the most general way. Doing this creates the shading for the set X.

Question 3

In the first part of this question candidates were asked to translate from the English to the symbolic logical equivalent compound propositions. This skill (and translating back in the other direction) needs to be practised beforehand. Any statement using the words "if….then" is usually translated using the logical "implies" symbol.

The truth table for q implies p is not the one usually learnt by candidates. The subject guide has the table for p implies q. Candidates should have enough understanding of the "implies" connective to produce the table for q implies p.

Part (b) was well done on the whole with many accurate and fully labelled logic networks showing the gates in the correct order. The final part of the question could be done using a truth table showing both columns are indentical or, more rarely seen, using the rules of logic.

Question 4

The majority of candidates calculated the first four terms of the sequence correctly by substituting 1,2,3 and 4 for k, in the formula 5k-1. They were also able to work out that the solution to the equation 2999=5k-1 is k=600. Not so many were able to split the sum of the series "5k-1" into the separate parts 5xsigma k –sigma1" and thus obtain the expression 5n(n+1)/2 –n. This gives the sum of the series when 100 is substituted for n.

Part (b) involved a proof by induction, difficult for many candidates, who are advised to learn the format and layout of a general induction proof and complete as much of that as possible.

Question 5

The first part of this question on functions involved a function not yet met in this context, the function that counted the number of letters in a given name. This function is only one to one when there are no two or more candidates with the same number of letters in their name. The function could not be onto because there are no names with an infinite number (or even a very large number) of letters, whereas the co-domain is all of the positive integers from 1 up to infinity. Thus the range and the co-domain are not equal. Whether or not the function is one to one and/or onto is a question which arises virtually every year and is well worth preparing for. A clear understanding of the concepts of domain, range and co-domain is necessary for this as well as the ability to find and interpret these according to the particular example.

Part (b) required further demonstration of candidates' understanding of when a function has an inverse or if not why – which essentially means knowing what is meant by one to one and onto properties.

Question 6

There are a few basic definitions in each chapter of the subject guide which are key to understanding the concepts in that section. These should be noted and learnt as part of the revision process. The definitions of a simple and a connected graph fall into this category – as does the definition of a tree for example.

Part (b) involved drawing the complete graph K5 and counting numbers of edges and paths in it. This idea was then extended to Kn.

Question 7

The subsets of a set S can be described by binary strings in a unique way. If a set has 6 distinct elements then binary strings of length 6 are needed. If the 6 elements of S are ordered then the presence of the first element of S in the subset is indicated by a one in the first place in the binary string, and its absence by a zero in that place. This continues for all six elements of s and all six positions in the binary string. It is the position of the one or zero in the binary string that is crucial to this mapping. Candidates often miss marks due to insufficient explanation although they clearly know how the process works as they can easily translate a binary string into the relevant subset and vice versa. There are 2^n subsets of a set with n elements, so in this case there were 2^6 subsets.

In part (b) a relation was defined on S and the digraph requested. Most candidates showed the relation between the vowels e and i correctly but some failed to include the vertices for g,r,b,l which should be shown in the digraph too. This was therefore not an equivalence relation since these elements are not related to themselves (there are no loops on these vertices). The formal definitions for reflexivity, symmetry and transitivity should be revised before the exam and candidates should be able to reproduce them, with appropriate counter examples where required in the exam.

Question 8

This question specifically stated that the letters in the word could only be used once. Therefore factorials were the appropriate way of calculating possible arrangements. The Venn diagram needed to contain the two overlapping sets E and B with the numbers in each region indicating the number of possible arrangements in each set. Candidates did not always subtract the number in the intersection from the number they had found in part (ii) and (iii) to produce the correct number to go in the region corresponding to the sets B-E and E-B.

In part (b) if the relevant diagram had been drawn with the correct numbers (including those in the overlapping region) the probabilities followed directly. Candidates should prepare for this type of probability question as well as those using counting methods more directly.

Question 9

The graph G was easily drawn. A handful of candidates did not appear to know that a spanning tree contains all the vertices of G but has no cycles, and thus could not produce a spanning tree. In fact there were only two non-somorphic spanning trees of G to find. Then it is a question of adding another vertex and edge to each of these in all possible places and finally eliminating the isomorphic ones to do part (iv).

Part (b) was a standard binary search tree with the record 5000 at its root. Candidates should ensure they can calculate the record numbers at each level and also calculate the height of a binary tree needed to store a certain number of records, and thus the maximum number of comparisons which would need to be made.

Question 10

The first part of this question was very well done, being a straightforward question on matrix arithmetic. It may be helpful for candidates, when faced with a matrix multiplication such as BC or CB, to check what the dimensions of the resulting matrix will be so they do not make an error and miss a row or column.

Part (b) was a standard question involving Gaussian elimination. Marks were given for method. Many candidates lost a mark as they did not fully reduce the matrix to one with ones on the leading diagonal, but left other numbers there. It is helpful if the row operations employed are clearly labelled and the order of transformations is shown, so any errors can be worked through and credit given.