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Decision 2

Report on the Examination

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General

Once again the general performance of students was very pleasing and on the whole solutions were presented clearly and legibly; hopefully the model tableau for the Simplex method will illustrate how this should be displayed when less guidance is given in the future. Basic algorithms appeared to be well understood by most students; however, when students are asked to explain or to show why a particular result is true the responses are often quite poor.

The labelling procedure in Network Flows is also becoming more familiar to students and most are now using the correct method to indicate potential increases and decreases on their network diagrams; backward arrows to show existing flows and forward arrows to indicate potential flows. Those students who use single arrows with amended values, or values with no arrows at all, score no marks.

Question 1

(a) Almost every student calculated the earliest start times and latest finish times correctly.

(b) At least one critical path was found correctly by almost everyone and most students found the two critical paths.

(c) Greater care should be taken when drawing diagrams of this type, preferably ***using a ruler***. The most common error in the cascade diagram was the omission of slack for the non-critical activities; others tried to show activities starting as late as possible. Some tried to insert activity J as two sections, so occasionally the diagram resembled a histogram.

(d) Those students who made errors in their earliest start times and latest finish times for *J* were given credit for writing down an inequality based on their values. Quite a large number of students did not realise the need to use the difference between the latest finish time and earliest start time for J only and so had a totally incorrect inequality.

Question 2

Most students were able to apply the Hungarian algorithm correctly, reducing the rows first then the columns. Some students reduced the rows but then totally ignored the need to reduce the columns before applying the algorithm thus losing valuable marks. There are still, a few students who insist on crossing out values in the given table rather than producing a new matrix for each stage of the algorithm. This should be discouraged since it makes the examiner's task almost impossible and students are unlikely to score many marks for this approach; it needs to be clear that the columns have been reduced first and this can only be done with a sequence of tables. ***Despite comments in previous reports this message does not seem to have been relayed to teachers and their students.***
This question was an easier one of its type requiring only one augmentation, but there were **two** possible ways of allocating the five people to the five tasks and some students missed the second one. Despite obtaining more than one matching, some students thought these had different completion times.

Question 3

The printed grids seemed to improve the overall presentation of the Simplex method this year and, because students generally took more care, the overall accuracy seemed much better, particularly in the first tableau.

(a) Some students omitted slack variables by writing all 0s in the s and t columns.

(b) The pivot from the bottom row of the y-column was usually identified correctly, but careless arithmetic prevented a few from scoring full marks.

(c)(i) Many students seemed so concerned with the explanation as to why the maximum had been achieved that they forgot to write down the maximum value of P. Many students seemed confused between the terms "positive" and "non-negative" and lost the mark for the explanation.

(c)(ii) Quite a few students selected the wrong value as their new pivot, and scored no further marks in the question. Those students who found the next pivot correctly often made at least one arithmetic slip and so only the strongest students completed the second iteration correctly. Part of the expected interpretation was to stat that the maximum value of P had now been reached, but very few students realised this. The values of P, x, y and z needed to be stated but some neglected to state that $z=0$, even when their previous tableau was correct.

Question 4

(a)(i) Explanations rarely scored full marks. In order to show that the game has a stable solution, it was expected that the maximum values in the columns would be indicated before finding the minimum value of these maxima. The maximum of the row minima also needed to be found. Some statement should then have been made indicating that these two values were equal and hence that the game has a stable solution. Quite a few students felt that all they needed to do was to draw arrows pointing to –3 when more detail was required. A few chose to solve the problem using an argument based on dominance, but the explanations were rarely adequate to earn more than a single method mark.

(ii) It was encouraging to see many students correctly identify the play-safe strategy for each player.

(iii) Only the better students stated the correct value of the game for **Bill**, despite the bold type; as you might expect weaker students gave the value as – 3, and others gave the value as 0, possibly confused by the term “zero-sum game”.

(b) *A large number of students were not prepared for this part of the question.*
(i) A large number deleted the first column and scored only a couple of method marks for the rest of this question. Some who realised that the computer should not play C_2 spoiled their answers by writing such things as “each of the other strategies is better”.

(ii) The better students managed to use the values in the table correctly to find correct expressions for the expected gains for Roza for the two remaining strategies. A few ignored the dominance from part(b)(i) and attempted to solve the problem graphically using three lines; some successfully, others not.

(iii) Some poor algebra, usually when removing brackets, prevented some from finding the correct value of p, but most marks were lost for having the incorrect pair of simultaneous equations.

(iii) Those who scored full marks in parts (b)(ii) and (iii) were usually able to obtain the correct value of the game for Roza.

Question 5

Sadly, many students seemed unprepared for this maximin problem. Some used the analysis in part (a) to help them focus on the maximin idea, but it was quite common to see students score no marks on part (a) and full marks on part (b) or vice versa.

Stronger students made good use of the table and, apart from a few arithmetic slips, those who knew what was meant by “maximin” scored full marks for completing the table of values, thus indicating a good understanding of dynamic programming in this context. It was necessary at some stage to see mention of the word “minimum” when making the comparisons in the “Calculation” column. Those with the correct values in the table were almost always successful in writing down the optimal order.

Those who simply added values trying to find the maximum (or minimum) total cost over the three years scored no marks at all.

Question 6

(a)(i) Many students were able to show the correct working to give the value of the cut.

(ii) Far fewer were successful in finding the three values of the remaining cuts in the table.

(iii) Some thought that the “maximum” cut was needed to give the maximum flow and others wrote “maximum flow $\leq$ minimum cut”. The 29 value had been given to help students and this proved valuable for those who had been unable to find the 3 correct values in the table.

(iv) Those with a maximum flow of 29 were usually able to draw correct flows along the given edges, although some gave at least one value greater than the capacities on the original network.

(b)
Some missed the vital point of supplementing the flows by 4 along SC and AT and made no further progress. It was good to see many students trying to set out their solution in a logical manner and once again the diagram and table clearly helped. There are still many students unfamiliar with the “labelling procedure” who fail to show both potential forward **and** backward flows on their network. Students are advised to use the table to show what new flows have been introduced and to modify both the forward and backward flows in their network. The previous values should be clear to the examiner when such modification is made. Marks are awarded for the initial flow and it is very difficult to credit students for their original values if they have been obliterated during augmentation.

Some credit was given to students who had used flow augmentation correctly but had failed to find a maximum flow equal to 33, if they interpreted their flows correctly on the final diagram.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the [Results statistics](#) page of the AQA Website. UMS conversion calculator www.aqa.org.uk/umsconversion