



**HIGHER SCHOOL CERTIFICATE EXAMINATION**

**1995**  
**APPLIED STUDIES**

**1 UNIT**

*Time allowed—Two hours  
(Plus 5 minutes' reading time)*

**DIRECTIONS TO CANDIDATES**

- Attempt **THREE** questions.
- Each question is worth 20 marks.
- Board-approved calculators may be used.
- Answer each question in a *separate* Writing Booklet.

**QUESTION 1. Applications of Computer-Controlled Systems****Marks**(a) Give an example, by means of block diagrams, of: **4**

- (i) an open-loop system;
- (ii) a closed-loop system.

(b) The table shows a list of devices in a computer-controlled system. **2**

| <i>Device</i>   |
|-----------------|
| Thermostat      |
| Motor           |
| Solenoid        |
| Phototransistor |
| Strain gauge    |
| Microphone      |
| Relays          |
| Controllers     |

- (i) From the list, select TWO sensors and state what is measured by each sensor.
- (ii) From the list, name TWO actuators or effectors.

(c) Design a system for an automatic door-opener in a small shopping centre. **5**

Show by means of a diagram and explanation:

- (i) the sensors and actuators you would use to control the movement of the door;
- (ii) how to avoid occurrences such as people being trapped by the door and dogs activating the door;
- (iii) what should happen in case of an emergency such as fire.

## QUESTION 1. (Continued)

**Marks**

- (d) (i) Describe a model of a computer-controlled system that you have assembled. Identify: **5**
- key components
  - the function of the system.
- Do NOT use the system described in part (c) above.
- (ii) Write down the algorithm used by the model.

- (e) The introduction of computer-controlled systems has revolutionized many areas of society. Answer the following question in relation to an area that you have studied. **4**

A new computer-controlled system has been introduced into a workplace.

Describe:

- (i) TWO changes in work practice;
- (ii) TWO consequences for the individuals employed there.

**QUESTION 2. Applied Mathematical Skills****Marks**

- (a) At a small boutique brewery, a machine fills twenty bottles of beer each minute. These bottles move along a conveyor belt to a packing station where Sandy packs them into boxes of twelve. **6**

Sandy can pack three boxes every two minutes, so after one hour there is a backlog of bottles waiting to be packed. At that time, Kim is also put onto packing bottles. Kim can pack one box every minute.

How long will it take before the two of them together can clear the backlog? Show all necessary working.

- (b) The following table shows the consumer price index (CPI) in Australia at the beginning of each year from 1991 to 1995. **3**

| <i>Year</i> | <i>CPI</i> |
|-------------|------------|
| 1991        | 105.5      |
| 1992        | 107.1      |
| 1993        | 107.4      |
| 1994        | 108.8      |
| 1995        | 111.1      |

The rate of inflation is the percentage increase in CPI over the course of a year.

In which year was the rate of inflation greatest? Show your working.

- (c) (i) At the beginning of 1991, Chris bought a block of land in the country for \$96 500. She sold the block at the beginning of 1995 for \$148 000. What was the average annual rate of increase of the price of the block? **5**

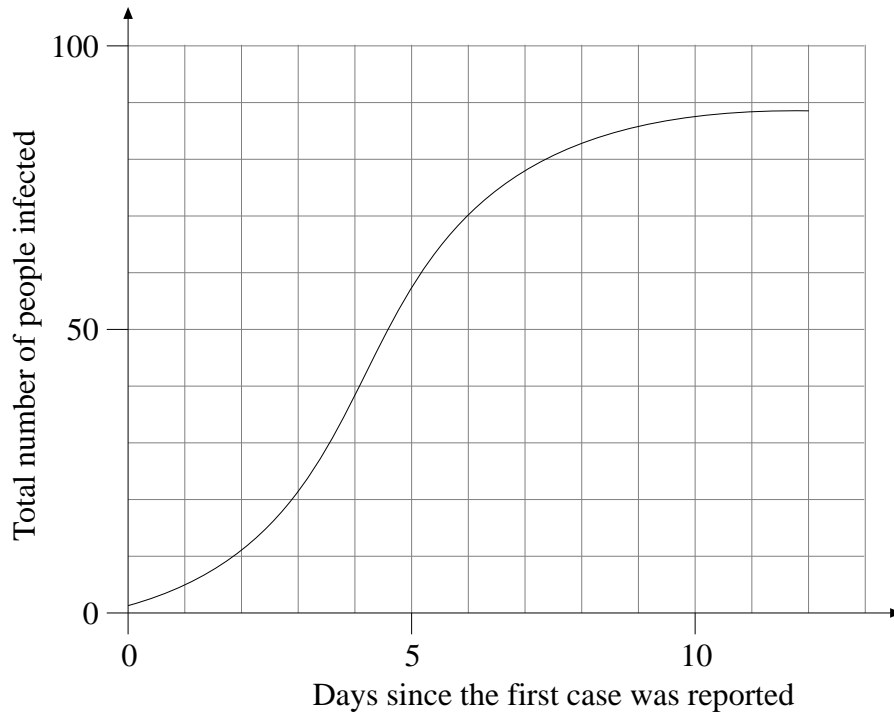
You may use the formula  $C = C_0 \left(1 + \frac{r}{100}\right)^n$ .

- (ii) What will the block be worth in another three years if the average annual rate of increase remains the same?

## QUESTION 2. (Continued)

Marks

- (d) The following graph shows the number of people in a small town infected during the course of a measles epidemic. 6



- (i) At what time was the epidemic increasing at the greatest rate?
- (ii) What was the rate of increase at that time?
- (iii) Name this type of growth and describe its main features.
- (iv) Give another example of a situation that could be described by this type of growth.

**QUESTION 3. Mathematical Ideas****Marks**

- (a) (i) What is 'pi' ( $\pi$ )? Write a brief description. 9
- (ii) Describe in a paragraph an experimental method for finding an approximate value for pi.
- (iii) Explain the difference between a rational and an irrational number, giving TWO examples of each.

(iv)

## RESEARCHERS FINALLY SLICE THE PI

Computers have finally solved one of mathematics's longest-lasting puzzles with the discovery that the mathematical constant 'pi' has a finite number of decimal places.

It's official: pi ends at the 2 075 932 542 102nd decimal place, according to a mathematical theory laboratory in the United States.

Researchers were left open-mouthed last month when a computer given the onerous task of finding pi's last decimal place suddenly started printing 'millions of zeros' at the end of the 'irrational' number.

'After years of computation, using the most sophisticated programming, we have found that the number pi ends at a little over the two-trillionth decimal place, thereby proving that it is indeed a rational number after all', the Advanced Computer Numerics Foundation in Colorado announced.

'A supposed "proof" that pi was an irrational number had been kicking around academic circles literally for centuries, and everybody just bought into it without doing the real empirical nuts-and-bolts research to confirm it', the foundation's director, Dr Warren Tomaczewski, said in a formal statement.

'When the preliminary results started to come in, we were stunned and put the computer onto the problem full-time', he said.

'The results were the same.

'With the advent of computers there has been an ongoing race to find the last decimal place of pi and I guess it was just on the cards for us to actually do it.'

© *The Australian*, Tuesday 12 April 1994.

Why did the researchers conclude that pi is 'indeed a rational number after all'? Is this conclusion valid? Explain your answer.

(v)

Dick Loesch, spokesman for the Advanced Computer Numerics Foundation in Colorado, was contacted later to check whether the story was correct.

'No, not at all. In fact it's the best practical joke I've ever done', said the unrepentant American, adding, 'Have a nice day'.

© *The Australian*, Wednesday 13 April 1994.

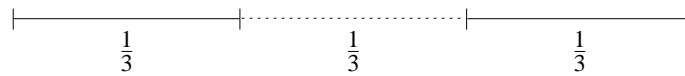
What clue(s) in the article could have alerted the journalist to the fact that a practical joke was being played?

## QUESTION 3. (Continued)

Marks

- (b) The Cantor ternary set is a fractal set formed by applying the generator

7



to the line segment



- (i) Draw the first THREE stages of the fractal.
  - (ii) Describe in words the rule for generating the fractal.
  - (iii) What will the fractal look like eventually?
  - (iv) Give TWO points that will be part of the completed fractal.
- (c)
- (i) Explain in a paragraph how a satellite stays in geostationary orbit.
  - (ii) Describe TWO reasons for keeping a satellite in geostationary orbit.

4

**QUESTION 4. Science and Medicine****Marks**

- (a) During the year, you studied at least one of the following diagnostic techniques: **4**
- ultrasound
  - radioisotopes
  - X-rays and CAT scans.
- (i) Referring to the technique you studied, write a brief account of the scientific principles upon which that technique is based.
- (ii) All of these diagnostic techniques produce images of parts of the body. Discuss the interpretation of these images in terms of the scientific principles outlined in part (a) (i) above.
- (iii) What limitations are there in the use of the technique that you have chosen?
- (b) Many people who have arthritis wear copper bangles, believing that this will lessen the pain in their joints. **12**
- (i) Express this belief in the form of a testable hypothesis.
- (ii) Design an experiment to test this hypothesis.
- (iii) What will be your dependent variable?
- (iv) How could you eliminate the possibility that the wearing of ANY bangle will reduce pain in the joints?
- (v) In one test, subjects are given bangles that look and feel like copper but are made of some other substance. These subjects are not told that their copper-like bangles are made of another substance. What is the purpose of this deception?
- (vi) Discuss the ethics of deceiving subjects about the nature of the bangles.
- (c) It is now possible to make exact genetic copies of animals such as cattle. **4**
- Because they are genetically identical, organs may be transplanted from one animal to another without any problem of rejection.
- Discuss the ethical issues involved in making genetic copies of rich, powerful, or gifted people so that their organs may be replaced in order to extend their lives indefinitely.



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**QUESTION 5. Scientific Research****Marks**

- (a) During the year, you have designed and performed a research project. **4**
- (i) What was the aim of your project?
  - (ii) What was your hypothesis?
  - (iii) What was the dependent variable in your project?
  - (iv) Why is it necessary to review the literature before designing the research project?
- (b) You have studied at least two examples of Australian-based research projects. **4**
- (i) Choose ONE of these and write down its name.
  - (ii) What question or questions was the project meant to answer?
  - (iii) How was the project carried out?
  - (iv) Was the use of a control appropriate in this study?  
If your answer is yes, describe how this control was implemented.  
If your answer is no, explain why it was not appropriate.

## QUESTION 5. (Continued)

Marks

- (c) Art has been taught at your school for many years by a traditionally trained teacher when a newly trained teacher arrives. This new teacher wants to introduce a radically new method of teaching basic drawing skills. 12

The head of the art faculty decides to compare the old method with the new method.

Sixty students are given an initial test (Test 1) of their drawing skills and then are randomly assigned to one of three groups of twenty students:

- group *A* in which no drawing instruction is given;
- group *B* in which drawing instruction is given using the old method taught by a traditionally trained teacher;
- group *C* in which drawing instruction is given using the new method taught by the new staff member.

At the end of the training period, a second test (Test 2) is given.

All drawings from Test 1 and Test 2 are assessed by a third experienced art teacher who does not know which group each student was in. The assessor compares each student's Test 1 drawing with their Test 2 drawing and gives each student an improvement score.

- (i) Write down the formal hypothesis of this experiment.
- (ii) What is the purpose of having group *A*? What term would you apply to this group?
- (iii) Why is the assessor not informed about the group to which each student was assigned?
- (iv) Would it be a fairer test of the teaching methods if the new teacher taught group *B* using the old method, and a traditionally trained teacher taught group *C* using the new method? Discuss.
- (v) The experiment was originally performed with only one student per group. It was found that the student who was given instruction using the old method gained the greatest improvement score. Can you draw any valid conclusion about the relative merits of the teaching methods? Give reasons for your answer.

**QUESTION 6. Significant Technological Achievements****Marks**

This question must be answered in terms of a significant technological achievement drawn from the following list.

| <i>Area</i>       | <i>Technological achievement</i>                     |   |
|-------------------|--|---|
| Agriculture       | Farm implements                                      | Genetic engineering in farm animals     |
| Electronics       | Integrated circuits                                  | Use of fibre optics                     |
| Engineering       | Pre-stressed structures and post-stressed structures | Refrigeration                           |
| Food              | Milk products  | Grape products                          |
| Manufacturing     | Robotics in motor-car manufacturing                  | Assembly-line production of white-goods |
| Materials science | PET  | Solar cells                             |
| Textiles          | 'Superwash' wool                                     | Shuttleless looms                       |
| Transport         | Electric trains                                      | Air-traffic control                     |

(a) From the above list, select ONE technological achievement you have studied. **9**

- (i) Name the achievement.
- (ii) Describe a practical activity you carried out in this area.
- (iii) Explain how the practical activity improved your understanding of the achievement.
- (iv) Discuss the subsequent effects of the achievement on TWO of the following:
  - production
  - individuals
  - society.

(b) From the above list, select another technological achievement you have studied. **6**

- (i) Name the achievement.
- (ii) Describe how the achievement has (or will have) widespread application in Australia.
- (iii) How has scientific understanding advanced as a result of this achievement?
- (iv) Discuss the historical factors that influenced the development of this achievement.

## QUESTION 6. (Continued)

**Marks**

- (c) 'The more technology advances, the more we rely upon it . . .'

**5**

Discuss this statement, referring to an achievement you have studied.

In your answer:

- name the achievement;
- clearly indicate how we have come (or will come) to rely upon it.

**QUESTION 7. Statistical Methods****Marks**

- (a) The intelligence quotient (or IQ) is a way of measuring intelligence, or maybe of measuring the ability to do IQ tests. The IQs of adult Australians are normally distributed with a mean of 100 and a standard deviation of 15. **7**
- (i) Sketch a normal distribution showing this information.
  - (ii) In what range would almost all IQs lie?
  - (iii) What is the median IQ for adult Australians? What is the modal IQ? Give a reason for each answer.
  - (iv) The *weights* of adult Australians do NOT follow a normal distribution. Explain why this is so.

- (b) Late last year, a survey was conducted to measure the noise levels from aircraft using Sydney airport. The following readings were obtained at a location under the flight path. **7**

| <i>Noise levels (decibels)</i> |      |      |      |      |      |      |      |      |      |
|--------------------------------|------|------|------|------|------|------|------|------|------|
| 85.5                           | 88.0 | 89.0 | 89.5 | 90.5 | 90.5 | 91.0 | 91.0 | 92.0 | 92.5 |
| 93.0                           | 93.5 | 93.5 | 93.5 | 94.5 | 94.5 | 96.0 | 96.0 | 97.0 | 99.5 |

A previous report stated that noise levels from aircraft at this location would be about 90 decibels on average.

Use a z-test to check whether this is correct. Show all necessary working.

- (c) A teachers' group is worried that aircraft noise levels are too high for effective teaching in schools near the flight path. They want you to conduct a survey of noise levels at ten of these schools. **6**
- (i) Describe how you would select the locations of ten schools for this survey using the method of stratified random sampling.
  - (ii) At what time or times of day would you take your measurements? Give brief reasons for your answer.
  - (iii) List TWO other factors that you may have to consider in planning your survey.

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**QUESTION 8. Technology and the Consumer****Marks**

The following list indicates the consumer products or categories that students select for study in this module.

- bicycle helmets
- portable music players
- devices for heating water
- hand-held, power-driven tools
- household cleansers
- types of household insulation
- fertilizers
- irons
- sewing-machines
- cosmetics
- cameras.

- (a) (i) Name ONE product or category you have studied. **8**
- (ii) Describe the technological and scientific principles underlying the operation of the product.
- (iii) What materials are used in the main parts of the product?
- (iv) What safety features have been incorporated into this product? Give reasons for your answer.
- (v) What guarantees and/or warranties would the consumer be looking for when purchasing this product? Give reasons for your answer.
- (b) From the above list, select the *other* product or category you have studied. **6**
- (i) Name this product or category.
- (ii) Discuss TWO marketing strategies that are appropriate.
- (iii) Explain the importance of the aesthetic qualities of this product to the consumer and the manufacturer.
- (iv) Explain how ease of use has been improved in the product you have studied.



## QUESTION 8. (Continued)

Marks

- (c) Four out of five Australians eat breakfast cereals, but how healthy are they?

6

A healthy breakfast should be:

- high in dietary fibre and complex carbohydrates;
- low in fat, sugar, and salt (especially sodium).

The recommended serve per 100 g of cereal should contain:

- fibre > 3 g
- fat < 9 g
- sugar < 20 g
- sodium < 600 mg.

The following figures for a 100 g serving are supplied by manufacturers in their nutrition panels.

| <i>Brand</i> | <i>Fibre</i><br>(g) | <i>Fat</i><br>(g) | <i>Sugar</i><br>(g) | <i>Sodium</i><br>(mg) |
|--------------|---------------------|-------------------|---------------------|-----------------------|
| A            | 9.3                 | 1.4               | 18.2                | 295                   |
| B            | 2.9                 | 0.5               | 14.4                | 475                   |
| C            | 1.3                 | 0.4               | 39.0                | 736                   |
| D            | 3.1                 | 0.5               | 35.0                | 666                   |
| E            | 1.7                 | 1.5               | 44.0                | 413                   |
| F            | 7.1                 | 5.1               | 18.6                | 124                   |
| G            | 12.2                | 2.7               | 2.3                 | 270                   |
| H            | 10.1                | 1.4               | 2.5                 | 340                   |
| I            | 12.9                | 9.0               | <1                  | 5                     |
| J            | 7.5                 | 2.9               | 15.0                | 112                   |
| K            | 29.0                | 2.2               | 13.5                | 895                   |
| L            | 1.2                 | 0.3               | 10.7                | 1008                  |

From the table given, answer the following questions.

- (i) You have been diagnosed as susceptible to heart disease. You need to reduce your intake of fat and sodium.

Which breakfast cereal would you choose? Give reasons for your choice.

- (ii) Which two cereals may be the *least* healthy choice? Give reasons for your answer.
- (iii) Manufacturers include the table of contents on products such as cereals? Why do they now do this?

**QUESTION 9. Technology of Communication Systems****Marks**

- (a) 'In the 1800s, the arrival of cargo-carrying sailing-ships was unpredictable. To gain advantage over their rivals, merchants established spotting-stations overlooking the coast. News of the approach of a ship was relayed to the merchant house by a variety of systems.' **7**

Discuss this statement by:

- (i) suggesting ONE system that may have been used to communicate the information;
  - (ii) explaining TWO limitations of this system;
  - (iii) describing why the system was an appropriate technology;
  - (iv) explaining what may have been sources of noise in the system.
- (b) Communications often involve the combination of several systems; for example, video conferencing uses telephone and video systems. Discuss another combination of systems, and explain the advantages gained by users. **4**

- (c) From the following list, select ONE communication system: **9**

- telephone
  - television
  - radio
  - computer networks.
- (i) Name the system you have studied. You must refer to this system in answering the rest of the question.
  - (ii) Name and describe ONE encoding-device.
  - (iii) Name and describe ONE decoding-device.
  - (iv) Describe the form in which the data are transmitted.
  - (v) How is the problem of noise dealt with by the system?
  - (vi) List and discuss TWO effects of the introduction of and improvements in silicon-chip technology.
  - (vii) Explain how the system has directly changed lifestyles in the wider community.

**QUESTION 10. The Environment****Marks**

- (a) Last year, during the most severe drought on record, the water engineers in a small town stated that the town had enough pure water to last for seven years, although other towns in the region were running dry. The catchment area is sparsely populated farmland with no industrial activity. **6**

Two months later the residents complained that the water from their taps was undrinkable, with a foul taste and smell.

- (i) Suggest a reason why the water is foul, even though the main storage dam is still 80% full.
  - (ii) How would you confirm your suspicions?
  - (iii) Some time later, local fishermen notice trout dying in the main storage dam. It is discovered that the fish have been the victims of oxygen depletion. What sorts of measures do you advise to:
    1. avoid future eutrophication events?
    2. treat the water to remove the foul taste and smell?
- (b) One of the global environment issues of particular importance to the rural sector in Australia is soil salination. **6**
- (i) Using scientific principles, briefly discuss the causes of salination and relate this to geographical areas of Australia that are particularly adversely affected.
  - (ii) Discuss how this process might be arrested and the land returned to productive and sustainable farming.
  - (iii) A company decides that 'there is money in salt' and develops a business with a turnover of \$500 million per year. The degraded land is returned to productive agriculture. Suggest TWO business activities that may contribute to profitability while addressing the problems caused by salination.
- (c) You have undertaken research into an environmental issue of particular concern to your local community. **8**
- (i) In the context of the slogan 'think globally, act locally', discuss how the issue you investigated relates to wider environmental concerns.
  - (ii) Discuss research methods (and the underlying scientific principles) that you used to address your local issue.
  - (iii) Discuss particular solutions that you might suggest to solve your local problem.
  - (iv) How might these solutions contribute productively to the local economy?

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