



2011 SAMPLE MATHEMATICAL APPLICATIONS PAPER, **Semester 1**

The external assessment requirements of this subject are listed on page 42.



Examination material: one 42-page question booklet one SACE registration number label

Approved dictionaries, notes, calculators, and computer software may be used.

Instructions to Students

- You will have 10 minutes to read the paper. You must not write in your question booklet or use a calculator 1. during this reading time but you may make notes on the scribbling paper provided.
- This paper consists of five topics. Tick the boxes by the two topics you have studied in Semester 1: 2.
 - Topic 2: Investment and Loans (Questions 1 to 5), pages 2 to 8 Topic 4: Matrices (Questions 6 to 9), pages 10 to 18 Topic 5: Optimisation (Questions 10 to 14), pages 20 to 28 Topic 6: Share Investments (Questions 15 to 19), pages 29 to 35 Topic 7: Statistics and Working with Data (Questions 20 to 23), pages 36 to 41
- Answer all questions on the two topics you have studied in Semester 1. 3.
- 4. All topics are of equal value.
- Write your answers in the spaces provided in this question booklet. There is no need to fill all the space 5. provided. Write on pages 9 and 19 if you need more space, making sure to label each answer clearly.
- Appropriate steps of logic and correct answers are required for full marks. 6.
- Show all working in this booklet. (You are strongly advised *not* to use scribbling paper. Work that you 7. consider incorrect should be crossed out with a single line.)
- 8. Use only black or blue pens for all work other than graphs and diagrams, for which you may use a sharp dark pencil.
- 9. State all answers correct to three significant figures, unless otherwise stated or as appropriate.
- 10. Diagrams, where given, are not necessarily drawn to scale.
- Complete the box on the top right-hand side of this page with information about the electronic technology you 11. are using in this examination.

12. Attach your SACE registration number label to the box at the top of this page. www.theallpapers.com

TOPIC 2: INVESTMENT AND LOANS (Questions 1 to 5)

(35 marks)

Answer all questions on this topic.

1. (a) Jay is planning to go on a holiday in 2 years' time. He calculates that he will need to save \$20000 to pay for the holiday.

Jay can afford to deposit \$2400 in an account per quarter.

What interest rate per annum, compounded quarterly on the balance of the account, will he need to obtain if he is to achieve his savings goal?



- 2. Jay returns from his holiday and wants to buy a car. He finds a car for \$16000, and researches his options for loan rates over 4 years. He narrows the loan rates down to the following two options:
 - Option 1 a nominal rate of 9.65% per annum, compounded weekly, with a \$120 set-up fee and a service fee of \$1.50 per week
 - Option 2 9.95% per annum, compounded weekly, with no additional fees.

Using effective rates, advise Jay on which of the two loan options is better.



(6 marks)

3. (a) Jay likes to plan ahead. He is 25 years old and wants to retire when he is 55, so he starts investigating superannuation. He decides he can top up his employer's payment so that \$1520 per quarter is paid into his superannuation account, which earns interest of 8.2% per annum, compounded quarterly.

Show that Jay can expect to have just over \$772000 in the account in 30 years' time.



(c) His accountant has told Jay that he should be able to draw \$19200 per quarter from his superannuation account when he retires. Jay now lives on \$9000 per quarter.

If inflation averages 2.5% per annum, what will \$9000 be equivalent to in 30 years' time? Will it be enough to maintain Jay's lifestyle? Discuss, including one key assumption.



- 4. Jay's girlfriend Mai wants to buy a home unit to live in. She is going to borrow \$125000 at an interest rate of 8.3% per annum, compounded monthly.
 - (a) Calculate the minimum fortnightly repayment that Mai will need to make if the term of the loan is 20 years.

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5. Mai's parents own a business. The business needs to borrow \$800000 to expand facilities. The \$800000 debt is to be repaid in 5 years' time by building up a sinking fund.

The interest on the debt is 9.1% per annum, payable half-yearly.

(a) Calculate the half-yearly interest.

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(c) How	much will	the lender o	f the m	oney rec	eive?				
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You may write on this page if you need more space to finish your answers. Make sure to label each answer carefully (e.g. 'Question 18(a) continued').

TOPIC 4: MATRICES (Questions 6 to 9)

(35 marks)

Answer all questions on this topic.

6. Five players (A, B, C, D, and E) are taking part in the regional finals of a snooker championship. The results of the first nine games are shown in matrix R:



(c) State one limitation of this method of determining the rankings of the players.

(1 mark)

7. The quantities of merchandise sold on the 4 days of a car race are shown in matrix Q:

		Thurs.	Fri.	Sat.	Sun.	
	T-shirts	10	18	45	60	
<i>Q</i> =	Caps	27	28	82	80	
	Water bottles	46	30	11	126	

The selling price of the merchandise, in dollars, is given in matrix S:

	T-shirts	Caps	Water	
			bottles	
<i>S</i> =	25	10	5.50	

The cost price of the merchandise, in dollars, is given in matrix C:

	T-shirts	Caps	Water
			bottles
<i>C</i> =	[10	5	2]

(a) (i) Using matrix methods, calculate the profit made on each item.





(3 marks)

(b) Aussie Auto Company placed a corporate order for 20 T-shirts, 45 caps, and 100 water bottles.

	(i)	Co	onst	ruc	t a	col	lum	n r	nat	rix,	0,	, fo	r th	nis	ord	er.						



(ii) Using matrix methods, calculate the amount to be charged to Aussie Auto Company if the order is given a 12% discount.



8. King Air flights are available between the following five major cities: Adelaide (A), Brisbane (B), Canberra (C), Darwin (D), and Sydney (S).

The network below represents the available flights:





9. Children in a regional town are able to try a variety of summer sporting activities before deciding which one they want to continue playing.

The movement of a group of children over two seasons was investigated in a survey of four sporting activities: little athletics (A), basketball (B), cricket (C), and tennis (T). The aim of the survey was to help the four sporting organisations to plan for the future.

The results of the survey are shown in matrix M below:

Second season

$$M = \begin{array}{ccccc}
 & A & B & C & T \\
 & M = \begin{array}{ccccc}
 & A & B & C & T \\
 & 0.6 & 0.1 & 0.05 & 0.25 \\
 & 0.25 & 0.6 & 0.05 & 0.1 \\
 & 0.2 & 0.2 & 0.4 & 0.2 \\
 & 0.15 & 0.1 & 0.05 & 0.7 \end{array}$$
(a) What does entry $M_{2,3}$ mean?



(b) In which sporting activity were the children least loyal to the sport they first chose? Give a reason for your answer.



(1 mark)

(c) At present 160 children are participating in little athletics, 90 are playing basketball, 120 are playing cricket, and 180 are playing tennis.

Using matrix methods, calculate the approximate number of children who will be participating in each sporting activity:



(e) The local cricket association is concerned about the future of its junior competition and runs a successful campaign to encourage children to continue playing cricket.

Of the children who play cricket this season, 5% will change to little athletics next season, 5% will change to basketball, and 5% will change to tennis.

(i) Complete the new transition matrix to show this change.



You may write on this page if you need more space to finish your answers. Make sure to label each answer carefully (e.g. 'Question 18(a) continued').



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11. There have been a number of break-ins at Blue Hills Primary School. The school council therefore decides to install a security system, via the roof, for all parts of the school.

The network below shows the school site plan. T is the terminal and the other nodes are the classrooms. The arcs represent the roof line distances in metres.



Calculate the minimum length of wiring needed to connect the classrooms to the terminal.



12. The manufacturer who supplies a chain of electrical stores with dishwashers uses the following planning network for production. The times needed to complete each stage of production are given in hours.



(d) The time needed for Activity B increases from 9 to 12 hours.

Using the network below, find and state the new critical time and critical path.



13. The storage tanks in a sugar refinery are connected by a system of pipes of different capacities (shown in megalitres per hour). All the pipes have their valves opened to allow the syrup to move from Tank 5 to Tank 6. Nodes V, W, X, Y, and Z represent the pumping stations.



 (a) As the result of a breakdown in another part of the refinery, all the syrup from Tank 5 must be pumped urgently into Tank 6.

Using the diagram above, find the maximum flow that can be achieved per hour. Show all working.



(3 marks)

(b) (i) On the diagram below, indicate which pipe should be upgraded to increase the maximum flow.

6 W V 15 8 2 3 5 14 Tank 5 Tank 6 Х Y 7 6 11 14 Ζ (2 marks)

By how much should the pipe be upgraded, and by how much would the maximum flow be increased?

(ii) Describe one limitation of using this model to determine which pipe should be upgraded.

(1 mark)

- 14. Furry Friends is a company that makes a variety of gift packs for pets. The company decides to make only the following two packs, as they have sold very well:
 - Pedigree Pooch, which contains ten chockie treats, four beef chews, and two toys
 - Pampered Pup, which contains two chockie treats, two beef chews, and four toys.

Let x be the number of Pedigree Pooch gift packs sold and y be the number of Pampered Pup gift packs sold.

Furry Friends sells the Pedigree Pooch gift pack for a profit of \$5 and the Pampered Pup gift pack for a profit of \$7, giving an objective function of:

$$Profit (\$) = 5x + 7y$$

Each week Furry Friends has 150 chockie treats, 90 beef chews, and 144 toys available to pack.

(a) Complete the table below.

	_				
	Gift pack	Chockie treats	Beef chews	Toys	
	Pedigree Pooch				
	Pampered Pup				
					(1 mark)
(b)	Five constraints ar	e used to model this	s situation.		
	Complete the list	below.			
	$10x + 2y \le 150$	\rightarrow $y \leq -5x$	z + 75		
	$4x + 2y \le 90$	\longrightarrow $y \leq -2x$	2 + 45		
		→			
					(2 marks)



(c) On the grid below, graph the constraints and shade the feasible region. Label the lines.

(e) Briefly discuss any waste, showing calculations for your optimal solution. (2 marks) (f) The company receives an order for eight Pedigree Pooch gift packs. (i) Determine the new feasible point. (1 mark) (ii) Calculate the optimal solution. (1 mark)

TOPIC 6: SHARE INVESTMENTS (Questions 15 to 19)

(35 marks)

15. Lucia bought a parcel of shares in 2000 and sold them in 2008. The following tables show information about the shares Lucia owned, and about the all-ordinaries index and the consumer price index (CPI):

	shares	Cost per share in 2000	in 2000	Cost per share in 2008	in 2008
Billabong	500	\$8.15	\$4075	\$8.85	
СМІ	1 200	\$1.51	\$1812	\$1.39	
Netcomm	40 000	\$0.05	\$2000	\$0.06	
		_	\$7887	- / .	\$8493
		Index	2000	2008	
	all-ordina	ies index (points)	3257.6	3363.3	
	consumer	price index (points)	126.6	136.6	
(a) Complete	the top ta	ble above.			(1 mark)
(b) Working in the val	to one dec lue of Luc	eimal place, calcul ia's share portfolio	ate the percents for the:	tage change from	n 2000 to 2008
(i) all-or	dinaries ir	idex.			
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					(2 marks)
(ii) CPI.					(2 marks)
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(ii) CPI.					(2 marks)
(ii) CPI.					(2 marks)

Year high	Year low	Stock	Close	Move	Buy	Sell	Vol. (100s)	Sales high	Sales low	Yield
4.75	3.32	ARB Corp	4.20		4.20	4.21	53	4.21	4.20	3.10
6.70	3.53	Auspine	6.10	-0.04	6.10	6.14	32	6.10	6.10	2.79
39.79	23.86	BHP Billiton	38.90	+0.46	38.90	38.91	137083	38.92	38.00	2.00
28.06	20.00	Caltex	24.53	-0.02	24.22	24.35	2488	24.45	23.85	3.90
2.06	1.19	CMI	1.41	+0.01	1.41	1.45	103	1.41	1.41	2.13
4.10	2.70	Dominos	3.26	-0.04	3.25	3.27	529	3.30	3.25	3.34
5.39	3.91	Fairfax	4.52	-0.02	4.52	4.55	33,852	4.55	4.45	4.42
11.94	8.43	IOOF	9.86	-0.15	9.86	9.95	432	10.02	9.83	3.35
44.70	35.75	NAB	39.30	-0.53	39.20	39.30	5307	39.60	38.82	4.35
5.85	3.315	Qantas Air	5.61	-0.06	5.60	5.61	5814	5.64	5.54	4.63

16. Refer to the following table, which lists information about Australian shares published on Saturday 6 September 2008, when answering all parts of this question:

- (a) How many Caltex shares were traded on Friday 5 September 2008?
- (b) If you wanted to buy shares in Qantas Air, what price per share would you have to pay in order to guarantee purchase?

(1 mark)

(c) (i) How much would you pay for 800 CMI shares at the closing price, with 2% brokerage and 10% GST?

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(ii) Find the break-even price for the CMI shares at the closing price.

(d) You have the opportunity to invest in either BHP Billiton or Caltex.

Using the information from the table on page 30, discuss two main points that would help you in making your decision.

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(2 marks)

17. Refer to the following diagram, which shows the share price, the 10-day moving average, and the 30-day moving average for Rags Industries, a clothing business that imports its stock from Asia:



(c) Is it reasonable to use price-earnings ratios to compare these two companies?

(1 mark)

- 18. The paid-up capital of a particular company is \$5 million, made up of 2 million 1-dollar 6% preference shares and 6 million 50-cent ordinary shares. Last year the company declared a profit of \$980000. It retained \$494000 for taxation and future requirements.
 - (a) Show that the dividend cheque for an investor holding 1500 preference shares and 1100 ordinary shares would be \$156.00. Work to the nearest cent when calculating the dividend per ordinary share.



- 19. George invested in 1000 shares at \$3.54 per share. They cost him \$3559.95. He tracked the daily closing price and, noticing after 10 months that the share price had risen to \$4.98, thought he would sell the shares.
 - (a) If brokerage, including GST, was a flat \$19.95, what would George's capital gain be?

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(b)	Geo	orge	's 1	nar	gina	al t	taxa	atio	n r	ate	wa	ıs 3	s0%).		\langle		<							(3 1	na]
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TOPIC 7: STATISTICS AND WORKING WITH DATA (Questions 20 to 23)

(35 marks)

- 20. A Kangaroo Island farm supplies eggs for supermarkets in South Australia. It was decided to conduct tests to investigate the weight of a large sample of the farm's eggs. The weights were found to be normally distributed. The mean weight was 60 grams and the standard deviation was 8 grams.
 - (a) Complete a normal distribution model based on the information given above.



- 21. A business is concerned about the effects of stress levels on the productivity of its 500 employees. Management decides to conduct a survey to determine the willingness of the employees to take part in a 'well-being' program. There are 315 male employees and 185 female employees. The mean age of the employees is 30 years.
 - (a) One day management randomly selects twenty people to survey from those having lunch in the staff room.

Discuss any potential bias in the method used.

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(b) Discuss the sample size and how reliable the sample mean will be in representing the population mean.

\rightarrow	
	(2 marks)
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(c) Management revises the sample size to fifty.

Determine how many women you would expect to be in the sample.

(1 mark)

22. The management of a large company decides to encourage all employees to participate in a 30-minute walk every day. The weight loss, in kilograms, of a sample of ten male employees and ten female employees who participate in the program is recorded after 1 month, as shown below:

Women	2.9	3.2	2.3	3.1	1.5	4.4	5.7	1.6	2.9	2.7
Men	3.2	2.5	4.8	2.7	4.1	1.3	8.8	2.5	4.5	1.1

(a) (i) Complete the following back-to-back stem-and-leaf plot with the data for the men. Include a key.



(b) Write the missing values in the following table (to one decimal place).

	Weight le	oss (kg)
	Women	Men
Minimum	1.5	
First quartile		2.5
Median	2.9	
Third quartile	3.2	
Maximum		8.8
Mean	3.03	3.6
Standard deviation		2.2

(c) A box plot for the women is shown on the axis below. Using the same axis, draw and label a box plot for the men in the space provided. Men Women 8 0 2 4 6 10 (2 marks) (d) Interpret some measures of centre and spread from part (b) and/or part (c) in order to compare the men's weight loss with the women's weight loss over the month.

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23. Agricultural scientists investigated the effect of a new chemical on vegetables of a particular type that were infected by a fungus.

The table below represents the data collected by the agricultural scientists. It shows percentages of infected vegetables (P) at certain concentrations of the new chemical (C).

Percentage infected (P)	6.6	6.53	6.41	6.36	6.31	6.25	6.20	6.18	6.15	6.88	6.02
(a) Determin chemical coefficier	ie and o and th nt and t	describ e perce the coe	e the reentage of fficient	elations of infec of det	ship bet cted ve ermina	tween t getable tion to	he con s. Use two de	centrati Pearso ecimal	ion of t n's com places.	the new relation	marł
(b) There is apparentl Identify	an outh ly infect this out	lier in t ted by ther.	the data anothe	a. This ir disea	set of se.	data oc	curred	on a p	lant th	at was	
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(c) (i) Rem resul	love the	e outlie e conte	r, calcu xt of th	ulate th	e coeff lem.	icient c	of deter	minatio	on, and	interp	et th
(c) (i) Rem resul	ove the	e outlie e conte	r, calcu xt of th	ulate th ne prob	e coeff lem.		of deter	minatio	on, and		ret th
(c) (i) Rem resul	hove the	e outlie e conte	r, calcu xt of th	ulate th ne prob	e coeff lem.				on, and		mar
(c) (i) Rem result	e the equects the	e outlie e conte	r, calcu xt of the of the variable	least ses.	e coeff lem.	regress	ion lin	e (line	on, and	interproved to the second seco	mar ²
(c) (i) Rem resultion (c)	e the ecuects the	e outlie e conte	r, calcu xt of the of the variable	least ses.	e coeff lem.	regress	ion lin	e (line	on, and	interproved a second se	marl

(iii) Using the equation of the least squares regression line, predict the percentage of vegetables infected by the fungus when 5.5 milligrams per litre of the new chemical is used.

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(iv) A prediction was made of the amount of chemical needed for only 5.7% of the vegetables to be infected by the fungus. The equation of the least squares regression line was used to determine the amount of chemical needed to achieve this level of infection. The amount of chemical was found to be approximately 15.5 milligrams per litre.

Discuss the reliability of this prediction,

	(2 marks)

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2011 SAMPLE MATHEMATICAL APPLICATIONS PAPER

The purpose of this sample paper is to show the structure of a Mathematical Applications examination (using the Semester 1 topics) and the style of questions that may be used. The following extract is from the subject outline for Mathematical Applications:

EXTERNAL ASSESSMENT

Assessment Type 3: Examination (30%)

For a 10-credit subject, students undertake one external examination at the end of the semester of study.

For a 20-credit subject, students undertake two external examinations, one at the end of each semester.

The external examinations are undertaken under supervision. The total time spent by students on external examinations is 90 minutes for a 10-credit subject, or 90 minutes at the end of each semester for a 20-credit subject.

The examinations are based on the subtopics, key questions, and key ideas outlined in the topics studied in the semester. The considerations for developing teaching and learning strategies are provided as a guide only, although applications described under this heading may provide useful contexts for examination questions. The examination questions are evenly balanced across the topics in each semester. Each examination is set by the SACE Board and conducted under supervision in schools on a common day and time to be nominated by the Board.

The examination at the end of the first semester contains questions on each of the following topics:

- Topic 2: Investment and Loans
- Topic 4: Matrices
- Topic 5: Optimisation
- Topic 6: Share Investments
- Topic 7: Statistics and Working with Data.

The examination at the end of the second semester contains questions on each of the following topics:

- Topic 1: Applied Geometry
- Topic 2: Investment and Loans
- Topic 3: Mathematics and Small Business
- Topic 6: Share Investments
- Topic 7: Statistics and Working with Data.

Students answer questions from only the two topics studied during the semester.

Examinations consist of a range of questions, some focusing on knowledge, routine skills, and applications, and others focusing on analysis and interpretation. Students are required to provide explanations and arguments, and use notation, terminology, and representation correctly throughout the examination.

Students must have access to approved electronic technology during the external examination. However, students need to be discerning in their use of electronic technology to solve questions in examinations

For this assessment type, students provide evidence of their learning in relation to the following assessment design criteria:

- · mathematical knowledge and skills and their application
- mathematical modelling and problem-solving
- communication of mathematical information.

Source: Mathematical Applications 2011 Subject Outline Stage 2, pp. 43-4, on SACE website, www.sace.sa.edu.au