Please paste the barcoded label here	TOTAL MARKS

INTERNATIONAL SECONDARY CERTIFICATE EXAMINATION
NOVEMBER 2023

FURTHER STUDIES MATHEMATICS (STANDARD): PAPER I

EXAMINATION NUMBER

Time: 2 hours 200 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 20 pages and an Information Booklet of 4 pages (i–iv). Please check that your question paper is complete.
2. **Answer ALL the questions on the question paper and hand it in at the end of the examination. Remember to write your examination number in the space provided.**
3. Non-programmable and non-graphical calculators may be used, unless otherwise indicated.
4. All necessary calculations must be clearly shown and writing must be legible.
5. Diagrams have not been drawn to scale.
6. Round off your answers to 2 decimal digits, unless otherwise indicated.
7. ONE blank page (page 20) is included at the end of the question paper. If you run out of space for an answer, use this page. Clearly indicate the number of your answer should you use this extra space.

FOR OFFICE USE ONLY: MARKER TO ENTER MARKS

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Total
Mark													
Marker Initial													
Moderated Mark													
Moderator Initial													
Question Total	38	12	10	22	18	14	12	12	12	10	24	16	/200

QUESTION 1

1.1 Solve:

(a) $\ln(2+e^{-x})=2$. Leave your answer in the form $x=\ln(\ldots.)$

(8)

(b) $|2x+3|=3x+4$

(6)

1.2 Give, in standard $ax^4 + bx^3 + cx^2 + dx + e = 0$ form, a quartic equation which has $x = 2 + \sqrt{3}$ and $2 - i$ as roots. The values of *a, b, c, d* and *e* must be rational.

(8)

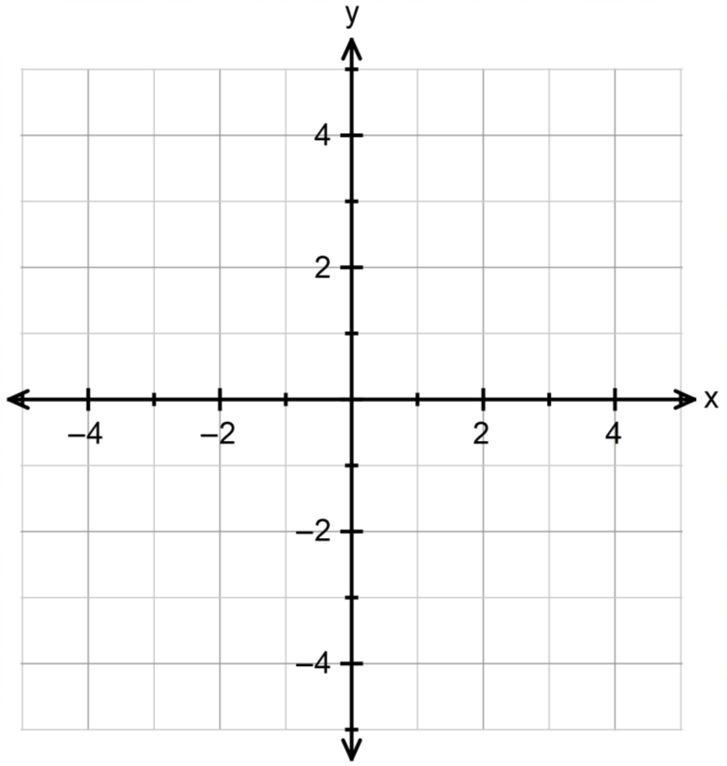
1.3 Determine positive real values of *a* and *b* if:

$(a + bi)(b + i) = (2b + a)i$

(8)

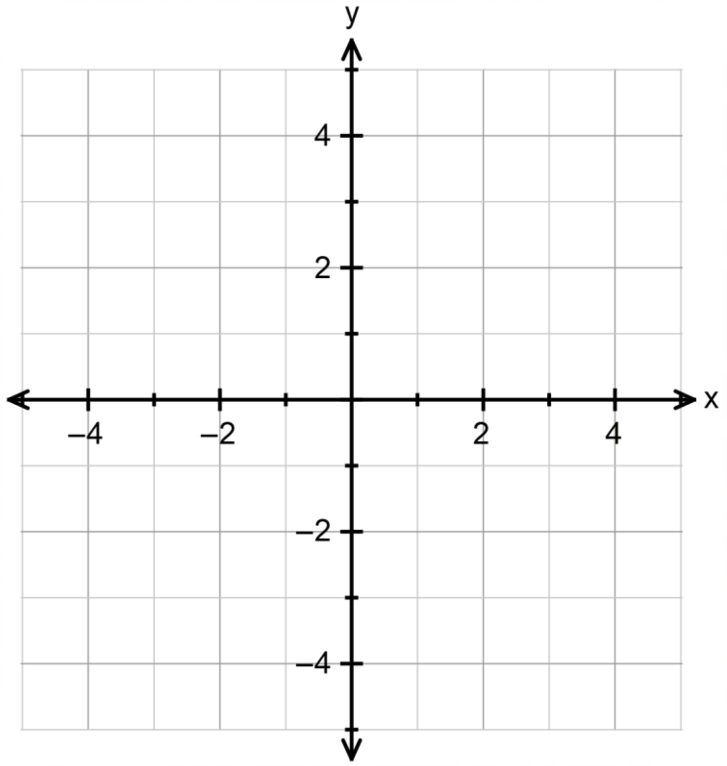
1.4 Sketch the following functions on the axes provided. You should draw and give the equations of any asymptotes as well as showing any intercepts with the axes.

(a) $y = e^{-x} - 1$



(4)

(b) $y = \ln(x+1)$



(4)
[38]

QUESTION 2

Use mathematical induction to prove that:

$$-1+4-9+16-25+.....(-1)^n n^2 = \frac{(-1)^n n(n+1)}{2} \text{ for all } n \in \mathbb{N}$$

[12]

QUESTION 3

Determine $\frac{d}{dx}\sqrt{3x}$ by first principles.

[10]

QUESTION 4

Consider the function $f(x) = \dfrac{x^2 - 5x + 7}{x - 2}$.

(a) Determine, with classification, the equations of any asymptotes.

(6)

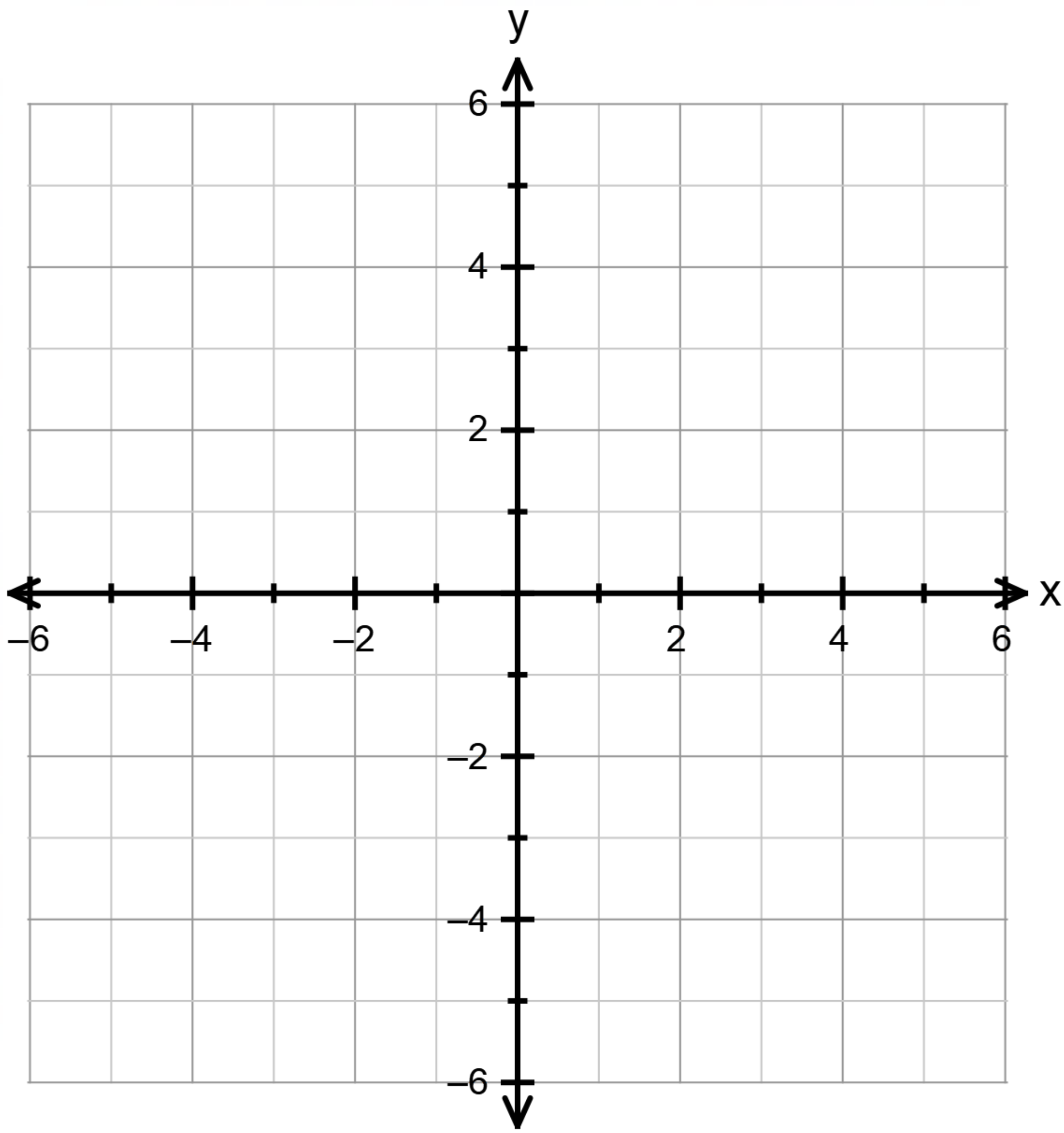
(b) Justify mathematically why the function does not have any *x*-intercepts.

(4)

(c) Determine the coordinates of any stationary points.

(8)

(d) Draw the graph of f on the axes provided showing all points of interest.
You should draw and label any asymptotes.

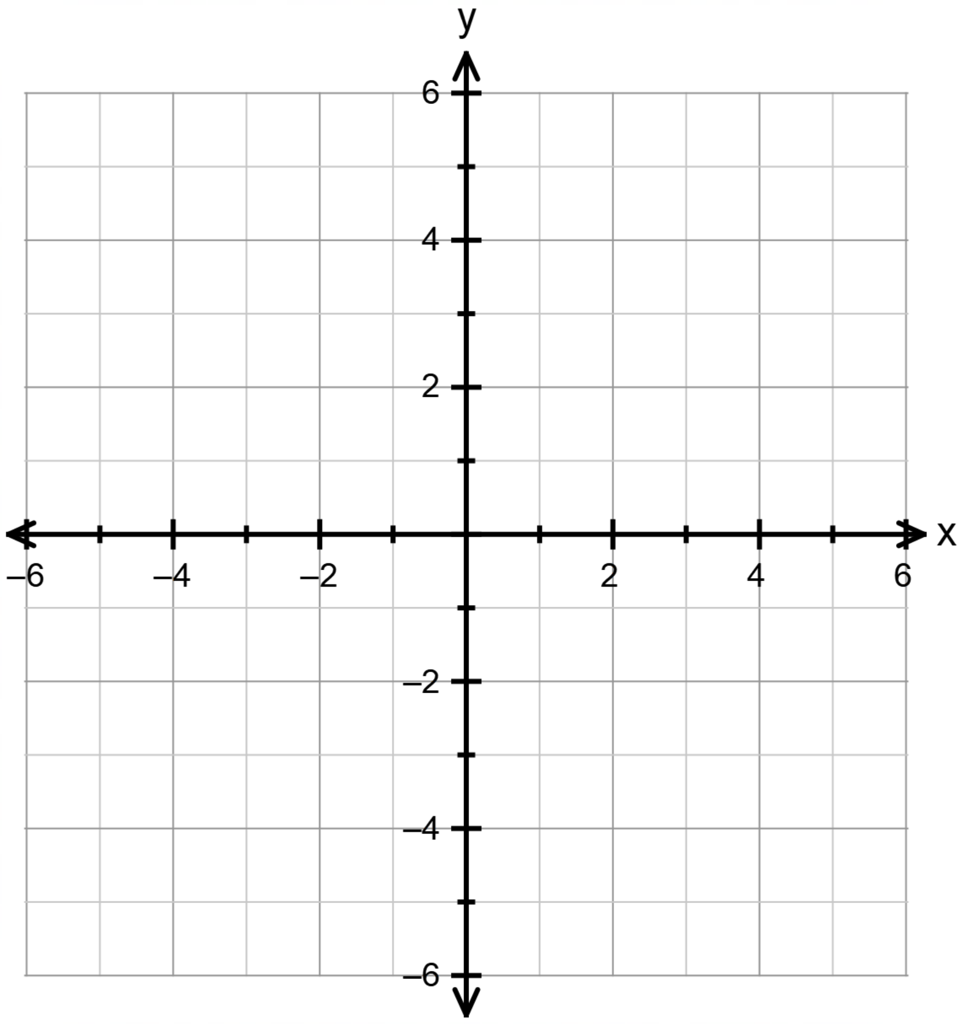


(4)
[22]

QUESTION 5

5.1 On the axes provided draw a **function** g which satisfies the following:

- g is continuous for all values of x except at $x = -3$ and $x = 2$
- $g(-3) = 4$ and $\lim_{x \to -3} g(x)$ exists
- $g(2) = 1$ and $\lim_{x \to 2^-} g(x) = 1$ but there is a jump discontinuity at $x = 2$
- g is also not differentiable at $x = 1$



(10)

5.2 Express the following statements **using mathematical notation**:

(a) The left-hand and right-hand limits of g at $x = a$ are unequal.

(2)

(b) h is not differentiable at p despite being continuous at $x = p$.

(2)

5.3 Answer true or false to each of the following statements:

(a) If a function is differentiable at a point, then it is continuous at that point.

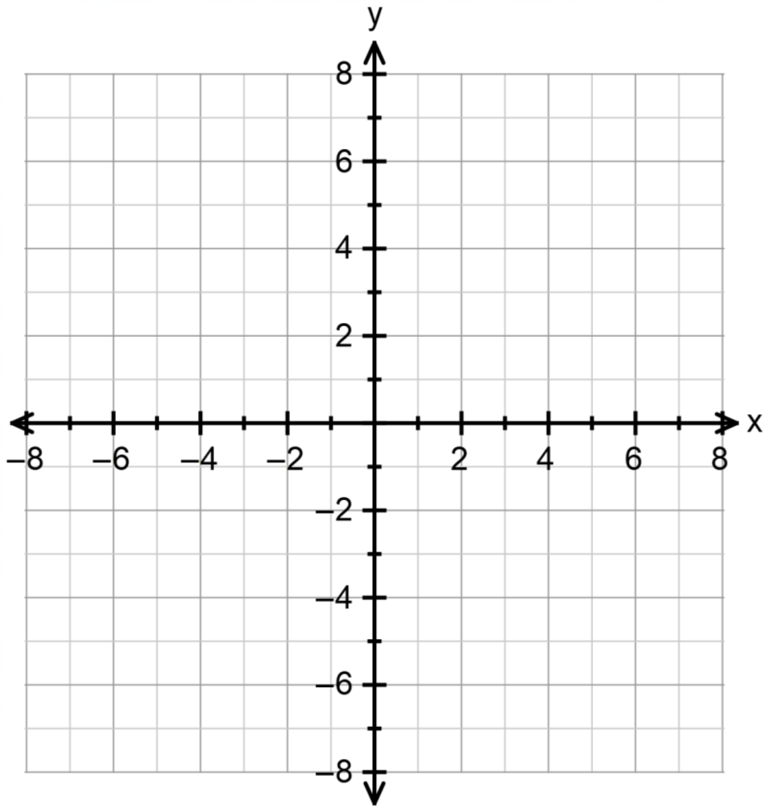
(2)

(b) If a function is not differentiable at a point, then it is not continuous at that point.

(2)
[18]

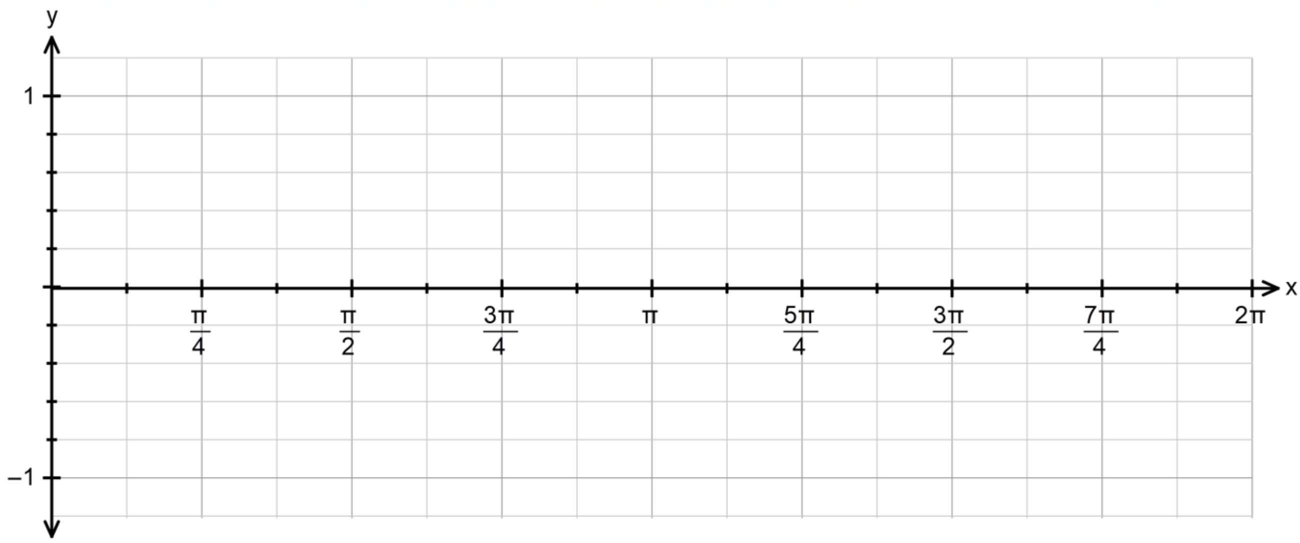
QUESTION 6

6.1 Use the axes below to solve $|x-2|-5 \geq -|x-1|$ by sketching the **graphs of two functions**. You must label the graphs you have drawn with their equations.



(8)

6.2 Draw the graph of $|y| = \sin x$ on the axes provided showing all points of interest.

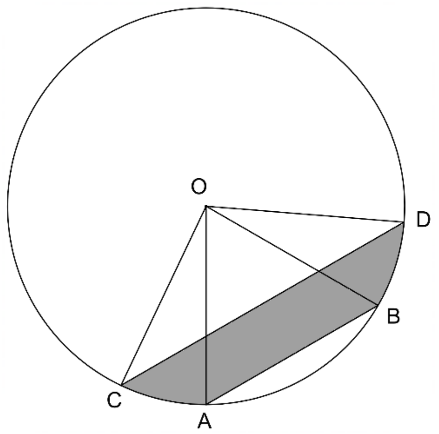


(6)
[14]

QUESTION 7

In the diagram below triangle AOB is equilateral with sides of 1 unit.
O is the centre of the circle and $CD = \sqrt{3}$ units.

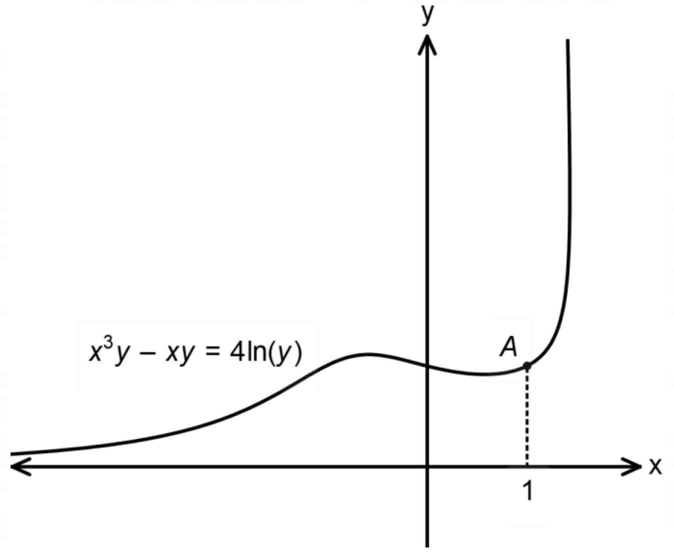
Determine the shaded area.



[12]

QUESTION 8

A portion of the graph of the implicitly defined relationship $x^3y - xy = 4\ln(y)$ is shown below.



(a) Determine the *y*-coordinate of point A showing all working.

(4)

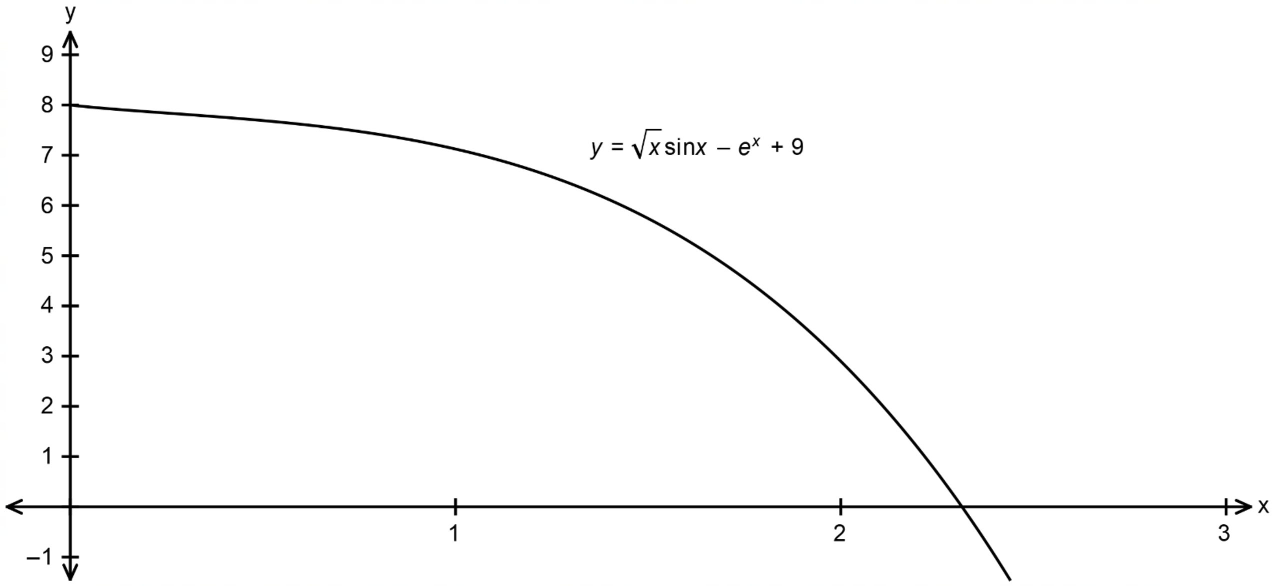
(b) Find the equation of the tangent to the curve at the point A.

(8)
[12]

QUESTION 9

The function $f(x) = \sqrt{x}\sin x - e^x + 9$ is shown below.

Use the Newton-Raphson method to find the *x*-intercept to 5 decimal places using $x_0 = 2$ as an initial guess.



You should show:

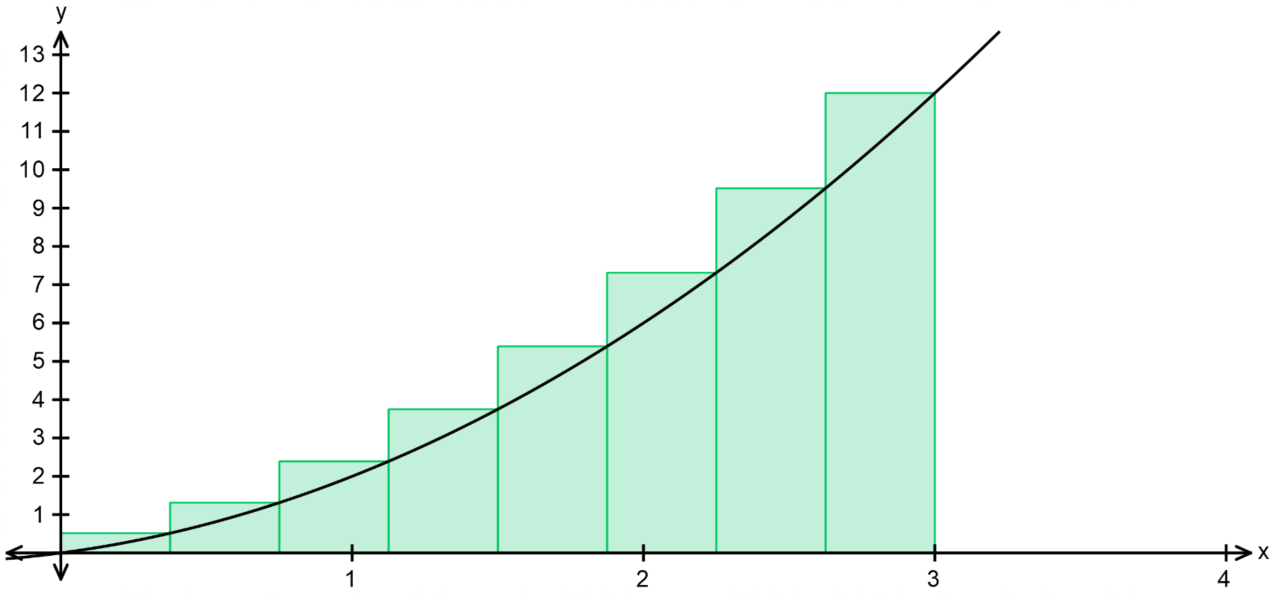
- the iterative formula you use.
- x_1 to 5 decimal places.

You do **not** need to write down all your approximations.

[12]

QUESTION 10

Kofi is attempting to work out the area under the curve $y = x^2 + x$ from $x = 0$ to $x = 3$ by partitioning it into rectangles as shown.



He has correctly worked out that when he uses *n* rectangles the area is given by:

$$A = 13{,}5 + \frac{18}{n} + \frac{27}{6n^2}$$

He uses his formula and ends up with an error of $13\frac{2}{3}\%$. How many rectangles did he use?

[10]

QUESTION 11

Determine the following integrals:

(a) $\int \sin^2 x \, dx$

(6)

(b) $\int x\sqrt{x+1} \, dx$

(8)

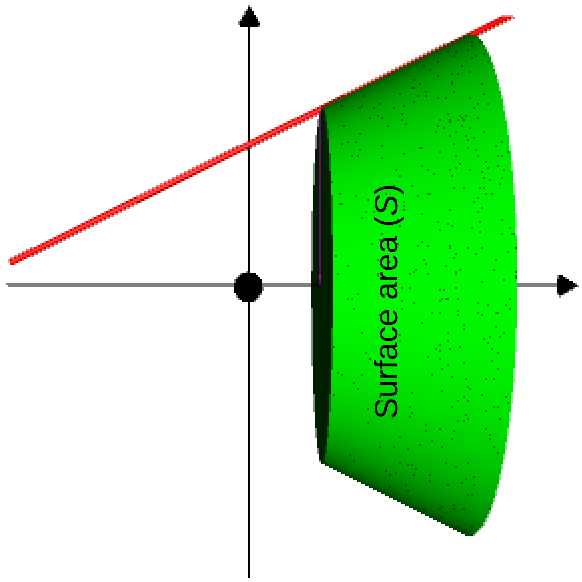
(c) $\int \frac{2x+3}{x^2+6x+9}\,dx$

(10)
[24]

QUESTION 12

Consider the function $y = \frac{x}{2} + 4$.

(a) It is rotated about the x-axis from $x = 2$ to $x = b$ generating a volume of $\frac{436\pi}{3}$ units^3.



By setting up and evaluating an integral, determine the value of b.

(8)

(b) The surface area (S) generated by rotating the graph of y about the x-axis from $x = a$ to $x = b$ is given by the formula:

$$S = 2\pi \int_a^b y \sqrt{1 + \left(\frac{dy}{dx}\right)^2}\, dx$$

Determine the surface area when the function is rotated about the x-axis from $x = 2$ to $x = 6$.

(8)

[16]

Total: 200 marks

ADDITIONAL SPACE (ALL QUESTIONS)

REMEMBER TO CLEARLY INDICATE AT THE QUESTION THAT YOU USED THE ADDITIONAL SPACE TO ENSURE THAT ALL ANSWERS ARE MARKED.

Sequence	Question	Marks	Time (s)	Time (m)	Topic	Cognitive Level
	1.1 (a)	8	288	4:48	Exponents and logarithms	C
	1.1 (b)	6	216	3:36	Absolute Value	R
	1.2	8	288	4:48	Real and Complex roots	R
	1.3	8	288	4:48	Real and Complex roots	C
	1.4 (a)	2	72	1:12	Drawing functions	K
	1.4 (a)	2	72	1:12	Exponents and logarithms	K
	1.4 (b)	2	72	1:12	Drawing functions	K
	1.4 (b)	2	72	1:12	Exponents and logarithms	K
	2	4	144	2:24	Induction	K
	2	8	288	4:48	Induction	R
	3	4	144	2:24	Differentiation	K
	3	6	216	3:36	Differentiation	R
	4 (a)	2	72	1:12	Drawing functions	K
	4 (a)	4	144	2:24	Drawing functions	R
	4 (b)	4	144	2:24	Drawing functions	C
	4 (c)	8	288	4:48	Differentiation	R
	4 (d)	4	144	2:24	Drawing functions	R
	5.1	4	144	2:24	Functions and limits	K
	5.1	6	216	3:36	Functions and limits	R
	5.2 (a)	2	72	1:12	Functions and limits	K
	5.2 (b)	2	72	1:12	Functions and limits	K
	5.3 (a)	2	72	:00	Functions and limits	K
	5.3 (b)	2	72	:00	Functions and limits	K
	6.1	8	288	4:48	Absolute Value	R
	6.2	6	216	3:36	Absolute Value	R
	7	12	432	7:12	Trigonometry	C
	8 (a)	4	144	2:24	Exponents and logarithms	R
	8 (b)	8	288	4:48	Differentiation	C
	9	6	216	3:36	Differentiation	C
	9	6	216	3:36	Application (Max / min; rates of change; Volume and area)	C
	10	10	360	6:00	Integration	P
	11 (a)	6	216	3:36	Integration	R
	11 (b)	8	288	4:48	Integration	C
	11 (c)	10	360	6:00	Integration	C
	12 (a)	8	288	4:48	Application (Max / min; rates of change; Volume and area)	R
	12 (b)	2	72	1:12	Differentiation	P
	12 (b)	6	216	3:36	Application (Max / min; rates of change; Volume and area)	P

SPREAD OF TOPICS			
Module	**Topic**	**Required (+-5)**	**Actual**
1A	Functions and limits	20	18
1A	Trigonometry	15	12
1A	Differentiation	35	34
1A	Integration	30	34
1A	Drawing functions	20	18
1A	Application (Max / min; rates of change; volume and area)	20	0
1B	**TOTAL**	**140**	**116**
1B	Real and Complex roots	15	16
1B	Exponents and logarithms	15	16
1B	Absolute Value	20	20
1B	Induction	10	12
	TOTAL	**60**	**64**
	GRAND TOTAL	**200**	**180**

SPREAD OF COGNITIVE LEVELS			
Abbr.	**Category**	**Desired weight**	**Actual weight**
K	Knowing	12-18%	15
R	Performing Routine procedures	37-43%	41
C	Performing Complex procedures	30-36%	35
P	Solving problems	7-13%	9
	TOTAL	**100%**	100

Module	**Topic**	**Mark distribution (±5)**
1A	Functions and limits	20
	Trigonometry	15
	Differentiation	35
	Integration	30
	Drawing functions	20
	Applications (Max / min; Rates of change; Volume and area)	20
	Total	140
1B	Real and Complex roots	15
	Exponents and logarithms	15
	Absolute Value	20
	Induction	10
	Total	60

Category	Knowing	Performing Routine Procedures	Performing Complex Procedures	Solving problems
Weight (%)	**12–18%**	**37–43%**	**30–36%**	**7–13%**

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TOTAL MARKS

INTERNATIONAL SECONDARY CERTIFICATE EXAMINATION
NOVEMBER 2023

FURTHER STUDIES MATHEMATICS (EXTENDED): PAPER II

EXAMINATION NUMBER

Time: 1 hour

100 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 36 pages and an Information Booklet of 4 pages (i–iv). Please check that your question paper is complete.
2. This question paper consists of THREE modules. Choose **ONE** of the **THREE** modules and tick (✓) the one you have chosen.

   MODULE 2: STATISTICS (100 marks) OR ☐
   MODULE 3: FINANCE AND MODELLING (100 marks) OR ☐
   MODULE 4: MATRICES AND GRAPH THEORY (100 marks) ☐
3. **Answer the questions on the question paper and hand it in at the end of the examination. Remember to write your examination number in the space provided.**
4. Non-programmable and non-graphical calculators may be used, unless otherwise indicated.
5. All necessary calculations must be clearly shown and writing must be legible.
6. Diagrams have not been drawn to scale.
7. **Rounding of final answers.**
   MODULE 2: Four decimal places, unless otherwise stated.
   MODULE 3: Two decimal places, unless otherwise stated.
   MODULE 4: Two decimal places, unless otherwise stated.
8. FIVE blank pages (pages 32–36) are included at the end of the question paper. If you run out of space for an answer, use these pages. Clearly indicate the number of your answer should you use this extra space.

FOR MARKER'S USE ONLY

Module 2	Q1	Q2	Q3	Q4	Q5	Q6	**Total**
Marks	**14**	**26**	**19**	**17**	**14**	**10**	**100**

Module 3	Q1	Q2	Q3	Q4	Q5	Q6	**Total**
Marks	**19**	**10**	**19**	**16**	**23**	**13**	**100**

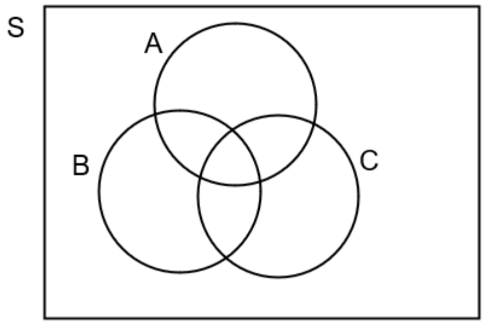
Module 4	Q1	Q2	Q3	Q4	Q5	Q6	**Total**
Marks	**17**	**10**	**17**	**13**	**31**	**12**	**100**

MODULE 2 STATISTICS

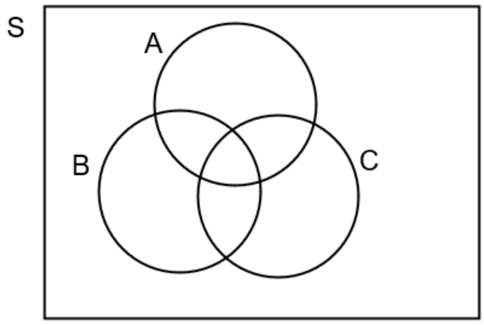
QUESTION 1

1.1 The Venn diagrams given below shows the sets A, B and C. In each case shade the given probability.

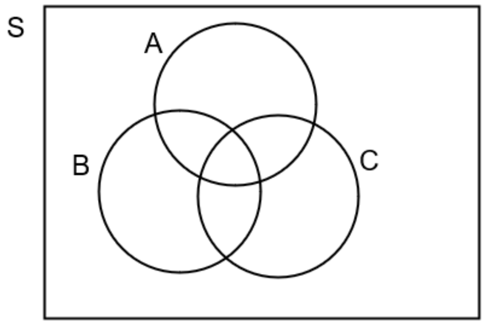
(a) $P(A' \cap B)$ (2)



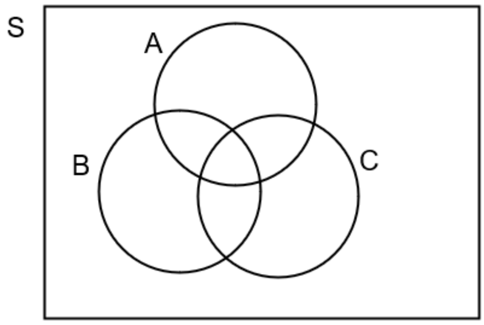
(b) $P(B \cup C)$ (1)



(c) $P(A \cap B \cap C)$ (1)



(d) $P(A' \cup C)$ (2)



1.2 Rebecca asked a group of females and males whether they preferred taking part in low-impact sports or high-cardio sports in their free time. The following two-way table shows part of the results of the survey.

	low-impact sports	**high-cardio sports**	**Total**
Female	63		
Male			72
Total			180

(a) Write down the probability of a randomly selected person being female and taking part in low-impact sports.

(2)

(b) Hence, given that in this sample the events gender and preference for a particular sport type are independent, find the total number of people who take part in low-impact sport.

(6)
[14]

QUESTION 2

The Sunday evening queuing times, in minutes, at Jordan's corner store is modelled by a normal distribution with a mean of 10 minutes and a standard deviation of 4 minutes.

(a) Calculate the probability that Zac, a randomly chosen customer, will have to queue between 12 and 15 minutes.

(8)

(b) In a long queue, find the minimum time, correct to the nearest minute, for which at most 8% of the customers are delayed in the queue.

(6)

(c) Given that a customer, Rahul, has to queue for more than 12 minutes, find the probability that he has to queue for more than 15 minutes.

(6)

(d) Six new customers are chosen at random. Find the probability that two of them had to queue between 12 and 15 minutes.

(6)
[26]

QUESTION 3

3.1 Greg, a geologist, is investigating the mean number of fossils found in 220 standard size rock samples collected from a certain area.

His data are summarised in the table below.

Number of fossils	0	1	2	3	4	5	6
Number of rocks	11	45	56	61	17	23	7

(a) Calculate a 96% confidence interval for the mean number of all fossils found per rock in that area, if the standard deviation is known to be 1,45.

(7)

(b) Naomi, another geologist, claims that there are an average of 3 fossils found per rock in that area. Using the confidence interval above, justify whether Naomi's claim is correct.

(2)

3.2 Two independent random variables $X \sim N\left(\mu_x ;50^2\right)$ and $Y \sim N\left(\mu_y ;20^2\right)$.

- A random sample of 40 observations of X produced a sample mean of 1 752.
- A random sample of 50 observations of Y produced a sample mean of 1 598.

Test, at the 5% significance level, whether the mean of X is greater than the mean of Y by more than 140.

(10)
[19]

QUESTION 4

Muhammad enters a chess tournament where he plays 3 games each day. Each game played is independent of the previous game played. Let M be the number of games Muhammad wins on any given day of the tournament. The probability distribution for M is given below.

m	0	1	2	3
$P(M=m)$	0,1	0,2	p	0,25

(a) Determine the value of p.

(1)

(b) A day is selected at random. Write down the probability that Muhammad wins every game he plays on that day.

(1)

(c) The tournament is played over 3 days. Find the probability that Muhammad wins every game only on the third day.

(4)

Kirsten enters the same chess tournament. Let K be the number of games Kirsten wins on any given day of the tournament. Each game played is independent of the previous game played. The probability distribution for Kirsten is:

k	0	1	2	3
$P(K = k)$	0,05	0,15	0,45	0,35

(d) Find the standard deviation for the number of games Kirsten will win on any given day.

(5)

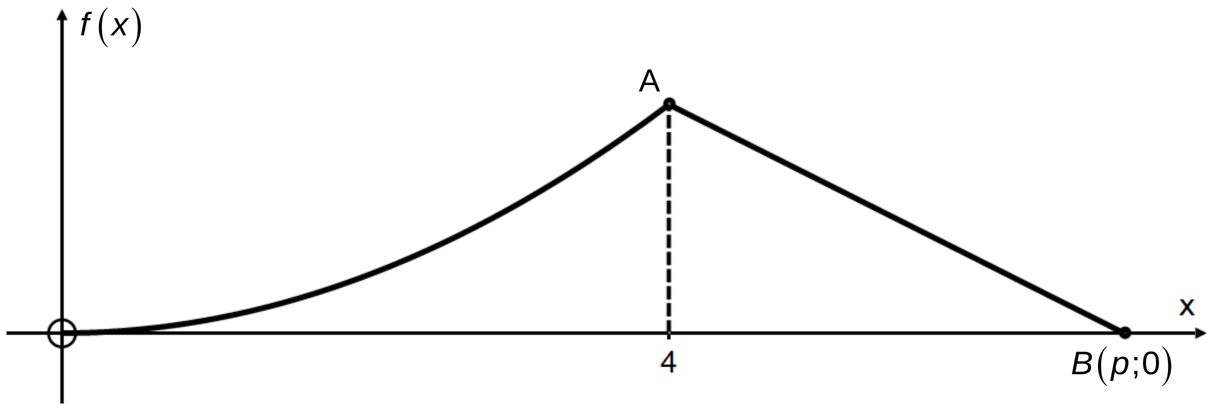
On the final day of the tournament, both Muhammad and Kirsten play their three respective games and their results are independent of each other.

(e) Find the probability that they win more than 4 games combined.

(6)
[17]

QUESTION 5

The figure below shows the graph of the probability density function, $f(x)$, of a continuous random variable X.



The graph of $f(x)$ consists of a:

- curved segment OA with equation $f(x) = kx^2 \quad 0 \le x \le 4$, where k is a positive constant.
- straight line from A to $B(p;0)$, for $4 < x < p$.
- For all other values of x, $f(x) = 0$.

(a) Explain why the mode of X is at $x = 4$.

(1)

It is further given that the mode of X is equal to the median of X.

(b) Show that $k = \frac{3}{128}$.

(7)

(c) Hence, find the value of p.

(6)
[14]

QUESTION 6

The eight digits below are written on 8 separate cards.

2, 2, 4, 4, 6, 6, 8, 8

These cards are placed next to each other at random, forming an 8-digit number.

(a) Determine how many of the 8-digit numbers exceed 60 000 000.

(4)

Four cards are picked at random and placed next to each other to form a 4-digit number.

(b) How many 4-digit numbers can be formed that exceeds 6 000?

(6)
[10]

Total for Module 2: 100 marks

MODULE 3 FINANCE AND MODELLING

QUESTION 1

A loan of R750 000 is taken now. Interest is charged at 7,5% per annum compounded monthly for the first 6 years and then 10% per annum compounded quarterly thereafter. The timespan of the loan is 10 years. The total loan amount will be repaid as follows:

Rx after 3 years

R550 000 after 7 years

R2x after 10 years.

(a) Using a timeline, or otherwise, calculate x.

(12)

(b) Determine the outstanding balance after 6 years.

(7)
[19]

QUESTION 2

I invest R30 000 per quarter, starting immediately. Furthermore, I deposit an additional R100 000 at the end of every 6 months. The account yields interest at a rate of 8% per annum compounded quarterly. How much money has been accumulated after 15 years?

[10]

QUESTION 3

A loan of R1 500 000 is repaid by equal monthly payments, starting after one year and finishing after 10 years. The compound interest accumulated in the first month is R15 000.

(a) Calculate the monthly payment.

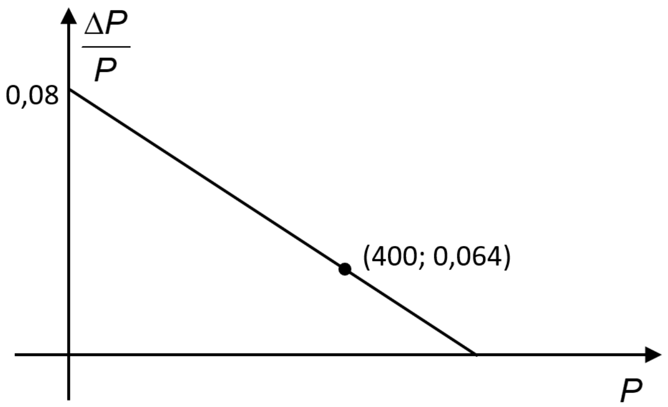
(9)

(b) Calculate the interest paid in the 7th year.

(10)
[19]

QUESTION 4

For a particular population some data are gathered and the line of best fit for $\frac{\Delta P}{P}$ against P is a straight line. This line is shown below with y-intercept (0; 0,08) and a point (400; 0,064).



(a) From the information given:

(1) Write down the intrinsic growth rate.

(2)

(2) Calculate the carrying capacity.

(3)

(3) Determine the population when the growth rate, $\frac{\Delta P}{P}$, is equal to 0,032.

(4)

(b) Write a recursive equation for this model.

(3)

(c) Assuming an initial population of 200, use your equation in question (b) above, to determine an estimate for the number of cycles/iterations it will take for the rate of change of population with time, to start decreasing.

(4)
[16]

QUESTION 5

In a certain forest area, the grey wolf was introduced to balance the rising numbers of white-tailed deer. Initially there are 500 deer and 20 wolves. The female deer, accounting for 60% of the prey population, give birth to 1 foal per year, with a survival rate of 80%. There are equal numbers of male and female wolves and an estimate of 50% of the female population of the wolves have one litter of 3 cubs per year. On average, each wolf will kill 10 deer per year. It is predicted that the number of wolves will settle to an equilibrium population of the same as the starting population and the deer will stabilise at 95.

Calculate the following:

(a) The per annum intrinsic growth rate of the deer.

(5)

(b) The rate of successful attacks of wolves on the deer.

(3)

(c) The value of *f*, the efficiency coefficient of utilising the prey meat.

(4)

(d) The approximate lifespan of the wolf, in years.

(5)

(e) The carrying capacity of the environment.

(6)
[23]

QUESTION 6

The sequence associated with the formula $T_n = aT_{n-1} - T_{n-2} + b$ begins:

3; 5; 9; 15; ……

(a) Calculate a and b.

(7)

(b) Write down the next two terms of the sequence.

(3)

(c) Determine an equivalent first order difference equation for the equation given.

(3)
[13]

Total for Module 3: 100 marks

MODULE 4 MATRICES AND GRAPH THEORY

QUESTION 1

1.1 Matrix:

$$\begin{pmatrix} 6 & 2 & 2 \\ 4 & 2 & 2 \\ 9 & 2 & 2 \end{pmatrix}$$

Why is the determinant zero?

(2)

1.2 $A = \begin{pmatrix} 1 & 3 & 0 \\ -1 & 2 & -p \\ -2 & 4 & 0 \end{pmatrix}$

(a) Write A^T, the transpose of matrix A.

(3)

(b) Show that det (A) = det (A^T).

(6)

(c) Given $p = 7$, evaluate AA^T.

(4)

(d) Given that B is a square matrix, will BB^T always be symmetrical and square?

(2)
[17]

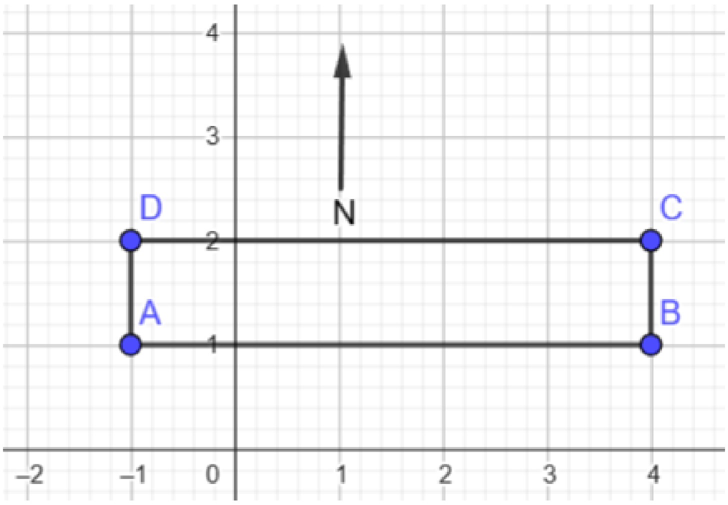
QUESTION 2

Solve x; y; z simultaneously, using row-reduction.

$$x + 3y - 2z = -7$$
$$4x + y + z = 5$$
$$2x - 5y + 7z = 19$$

[10]

QUESTION 3



A house with a footprint defined by matrix $M = \begin{pmatrix} -1 & 4 & 4 & -1 \\ 1 & 1 & 2 & 2 \end{pmatrix}$

is given with the front of the house (DC) currently facing north.

3.1 An architect stretches the footprint of the house by a scale factor of 2, parallel to the y-axis and with the x-axis invariant. What is the new footprint?

(4)

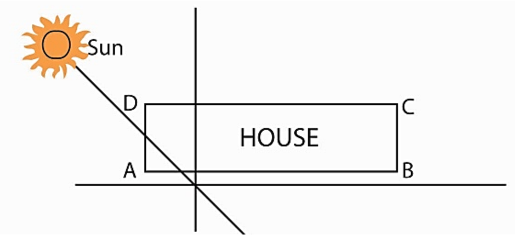
3.2 What consequence does the stretch have for the area of the house?

(1)

3.3 What matrix must be used to move the stretched house in question 3.1 so that the back wall (AB) once again lies on the line y = 1? Give the matrix for the new footprint.

(3)

3.4 The owners of the house want to rotate the original footprint, matrix M, of the house so that line DC faces the sun. The sun rises and sets on the line $y = \frac{-3x}{2}$. Create a matrix transformation to rotate the house so that it lies perpendicular to the line of the sun. Present the new matrix for the footprint.



(9)

[17]

QUESTION 4

4.1 Given the adjacency matrix.

	A	B	C	D	E
A	–	1	–	1	–
B	1	–	1	–	1
C	–	1	–	–	–
D	1	–	–	–	–
E	–	1	–	–	–

(a) Complete the complement adjacency matrix in the matrix below.

	A	B	C	D	E
A					
B					
C					
D					
E					

(5)

(b) Draw the graph that represents the complement of the adjacency matrix.

(3)

(c) Explain why a Eulerian path is not possible in the graph of question (b) above.

(2)

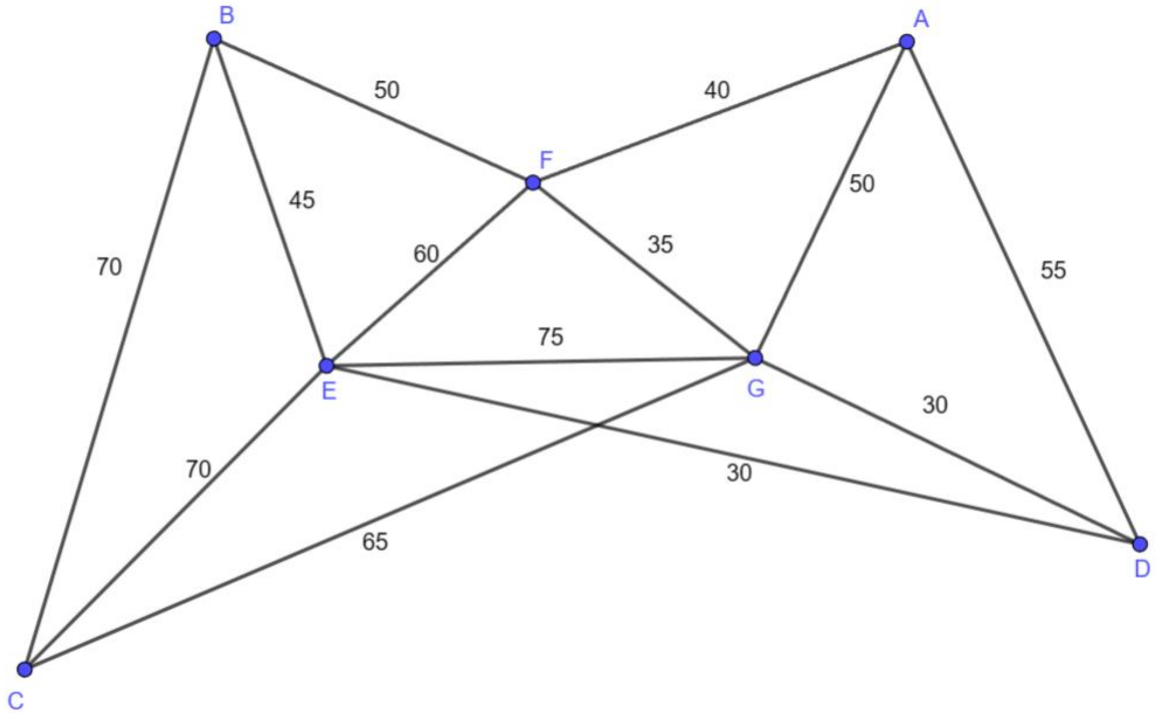
4.2 Explain why a graph with 6 vertices, each of degree: 1, 2, 2, 3, 4, 4 cannot be a tree.

(3)
[13]

QUESTION 5

5.1 In the Kruger Park there are only 2 electricity generator stations in a specific campsite. One at E and one at G. New tented sites are being set up at A; B; C; D and F. The number on each edge is the distance between the new tented sites in metres. All the tented sites must be connected by cables either directly or indirectly. The cable EG must be included for safety.

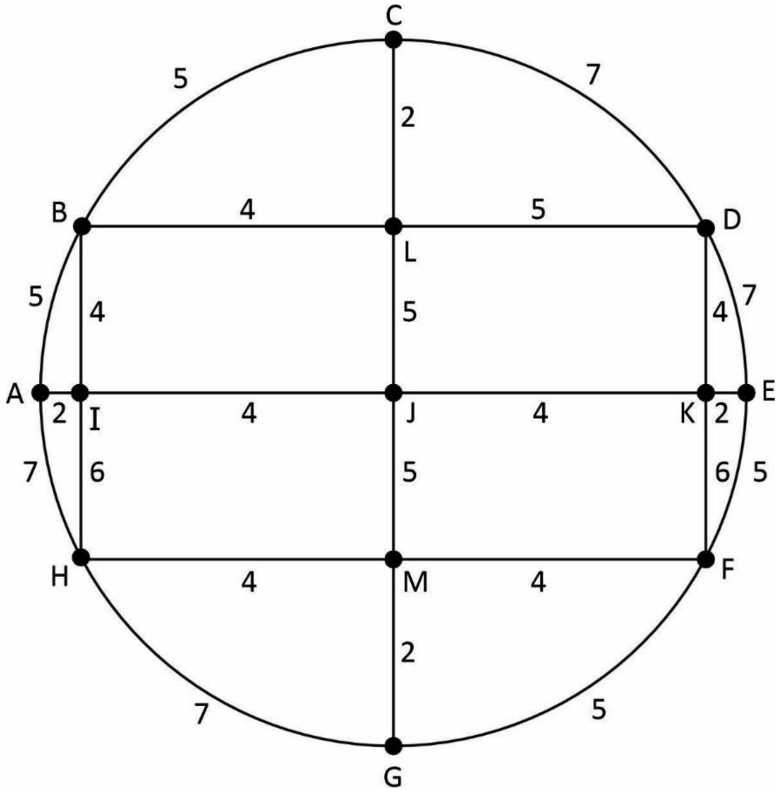
Use Kruskal's algorithm to find the minimum length of cable that must be used. Clearly state the order in which you choose the edges, as well as the length of the minimum spanning tree.



(10)

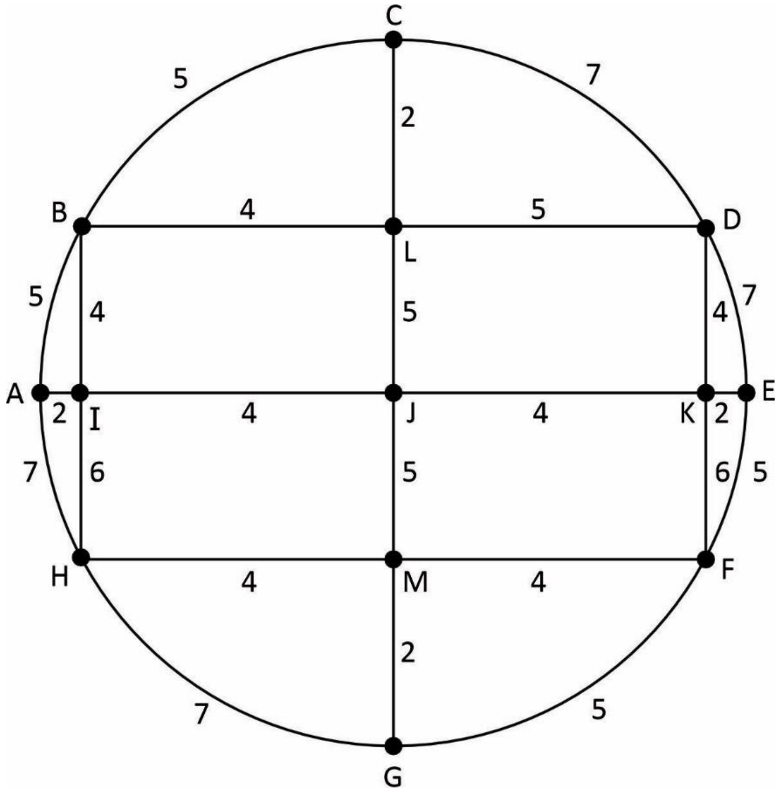
5.2 (a) A tourist visits a circular museum. Being pressed for time and also not all that interested in this museum, she wants to find the shortest path to view every corridor. The edges represent the corridors.

The entrance and exit are at point A. Find the shortest path starting and ending at A.



(9)

(b) The tourist finds herself at G, the information centre is at I. The tourist needs the bathroom urgently, but doesn't know where it is. She first travels to I, to find out that the ladies bathroom is at D. Use Dijkstra's algorithm to find the shortest path to the ladies' bathroom (D), via the information desk (I), for the tourist at G. Show clear evidence of your working, including the termination of non-viable routes. Be sure to state your final route, as well as its length.



(12)
[31]

QUESTION 6

A *nilpotent* matrix, N, is such that $N.N = 0$

An *idempotent* matrix, A, is such that $A = A^2 = A^3 = ... = A^P$

6.1 If B = $\begin{pmatrix} ab & b^2 \\ -a^2 & -ab \end{pmatrix}$, show that B is nilpotent.

(4)

6.2 (a) Given A = $\begin{bmatrix} 2 & -2 & -4 \\ -1 & 3 & 4 \\ 1 & -2 & -3 \end{bmatrix}$

Detemine the minimum value of P, if A is idempotent.

(3)

(b) Prove that $(I - A)^2 = I - A$, if A is idempotent.

(5)

[12]

Total for Module 4: 100 marks

ADDITIONAL SPACE (ALL QUESTIONS)

REMEMBER TO CLEARLY INDICATE AT THE QUESTION THAT YOU USED THE ADDITIONAL SPACE TO ENSURE THAT ALL ANSWERS ARE MARKED.

MODULE 2 STATISTICS

Question	Knowledge	Routine	Complex	Problem Solving	description
1.1	6				Probability
1.2 (a)	2				Probability
1.2 (b)			6		Probability
2(a) + (b)		14			Statistics
(c)			6		Probability
(d)				6	Probability
3.1 (a) + (b)		9			Statistics
3.2			10		Statistics
4 (a)	1				Probability
4 (b)	1				Probability
4 (c)		4			Probability
4 (d)		5			Statistics
4 (e)			6		Probability
5 (a)	1				Statistics
5 (b)		7			Statistics
5 (c)			6		Statistics
6(a)		4			Statistics
6(b)				6	Statistics
Totals	**11**	**43**	**34**	**12**	

MODULE 3 FINANCE AND MODELLING

Question	Level	Mark
1 (a)	2	12
(b)	3	7
2	2	10
3(a)	3	9
3(b)	3	10
4 (a) (1)	1	2
(2)	1	3
(3)	2	4
(b)	1	3
(c)	3	4
5 (a)	1	5
(b)	1	3
(c)	2	4
(d)	4	5
(e)	4	6
6 (a)	2	7
(b)	1	3
(c)	4	3

Level 1	Level 2	Level 3	Level 4
19	37	30	14

Finance	Modelling
48	52

MODULE 4 MATRICES AND GRAPH THEORY

Taxonomical Differentiation		
Category	**Recommended (%)**	**Actual (%)**
Knowing (K)	12–18	15.00
Routine procedures (R)	37–43	40.00
Complex procedures (C)	30–36	34.00
Solving Problems (P)	7–13	11.00
		100.00

Allocation of Topics and Marks		
Topic	**Recommended (±5%)**	**Actual (%)**
Matrices	50	56.00
Graph theory	50	44.00
TOTAL	**100**	

Question	Marks	Topic	Cognitive Level
1.1	2	Matrices	K
1.2 a	3	Matrices	K
1.2 b	6	Matrices	R
1.2 c	4	Matrices	C
1.2 d	2	Matrices	K
2	10	Matrices	R
3.1	4	Matrices	R
3.2	1	Matrices	K
3.3	3	Matrices	R
3.4	9	Matrices	C
4.1 a	5	Graph theory	K
4.1 b	3	Graph theory	R
4.1 c	2	Graph theory	K
4.2	3	Graph theory	P
5.1	10	Graph theory	R
5.2 a	9	Graph theory	C
5.2 b	3	Graph theory	P
	9	Graph theory	C
6.1	4	Matrices	R
6.2 a	3	Matrices	C
6.2 b	5	Matrices	P
	100		