AGA KHAN UNIVERSITY EXAMINATION BOARD

Notes from E-Marking Centre SSC-I Mathematics Annual Examinations 2023

Introduction

This document has been prepared for the teachers and candidates of Secondary School Certificate (SSC) Part I (Class IX) Mathematics. It contains comments on candidates' responses to the 2023 SSC-I Examination indicating the quality of the responses and highlighting their relative strengths and weaknesses.

E-Marking Notes

This includes overall comments on candidates' performance on every question and *some* specific examples of candidates' responses which support the mentioned comments. Please note that the descriptive comments represent an overall perception of the better and weaker responses as gathered from the e-marking session. However, the candidates' responses shared in this document represent some specific example(s) of the mentioned comments.

Teachers and candidates should be aware that examiners may ask questions that address the Student Learning Outcomes (SLOs) in a manner that requires candidates to respond by integrating knowledge, understanding and application skills they have developed during the course of study. Candidates are advised to read and comprehend each question carefully before writing the response to fulfil the demand of the question.

Candidates need to be aware that the marks allocated to the questions are related to the answer space provided on the examination paper as a guide to the length of the required response. A longer response will not in itself lead to higher marks. Candidates need to be familiar with the command words in the SLOs which contain terms commonly used in examination questions. However, candidates should also be aware that not all questions will start with or contain one of the command words. Words such as 'how', 'why' or 'what' may also be used.

General Observations

Candidates performed really well in some concepts, such as, Logarithms, Direct and Inverse Variations, Surds and Rationalisation, Factor and Remainder Theorem. However, candidates who did not score well mostly failed to understand the demands of the questions, often misinterpreting the command words and the stimuli.

Mentioned below are a few concepts that teachers need to focus so that the candidates may perform even better.

- Sets and Venn diagrams
- Simplification of Algebraic Expressions
- Matrices and Determinants
- Practical Geometry and theorems.

Note: Candidates' responses shown in this report have not been corrected for grammar, spelling, format, or information.

DETAILED COMMENTS

Constructed Response Questions (CRQs)

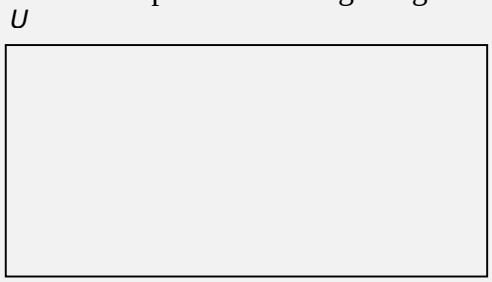
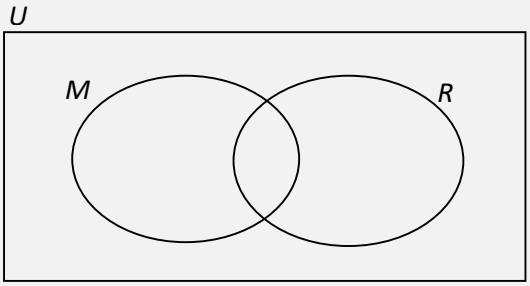
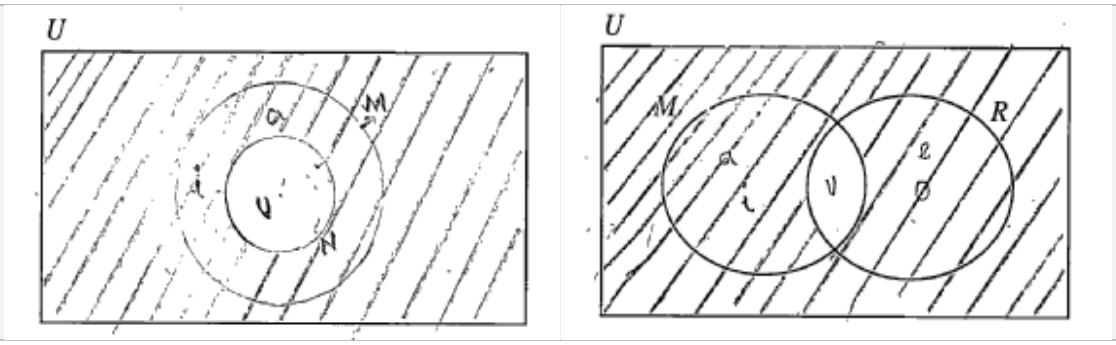
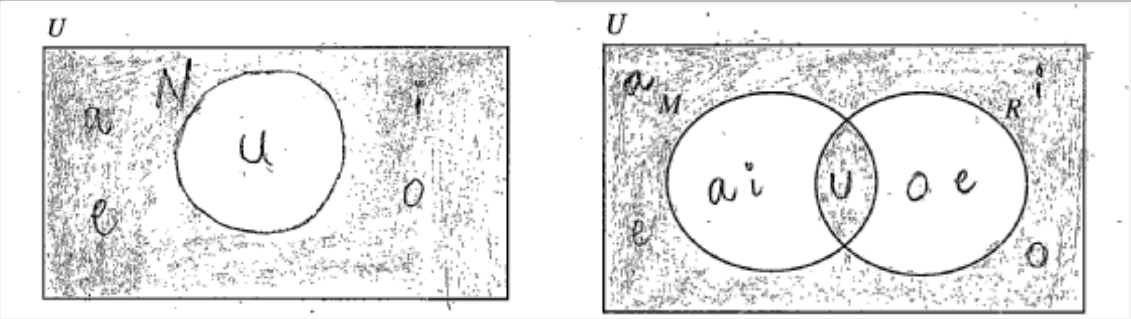
Question No. 1	
Question Text	If $U = \{a, e, i, o, u\}$, $M = \{a, i, u\}$, $N = \{u\}$ and $R = \{e, o, u\}$, then represent i. M and N in the incomplete Venn diagram given below.  ii. N^C on the Venn diagram completed in part (i) by shading. iii. $(M \cap R)^C$ in the Venn diagram given below, by shading. 
SLO No.	1.3.3
SLO Text	Solve problems related to Venn diagrams.
Max Marks	3
Cognitive Level	A*
Checking Hints	i. 1 mark for representing sets M and N on the Venn diagram (Candidate will not be awarded mark if the placement of elements in the Venn diagram is not correct). ii. 1 mark for representing N^c on the same Venn diagram. iii. 1 mark for showing $(M \cap R)^c$ on the Venn diagram.
Overall Performance	This question aimed to assess candidates' ability to represent set operations in Venn diagrams. Fewer of the candidates were able to exhibit a clear understanding of presenting set operations in two cases, i.e., when one set is subset of another set and when two sets are overlapping.
Description of Better Responses	Better responses demonstrated their proficiency by effectively representing the relationship between sets N and M. In part (i), these candidates successfully identified N as a subset of M and appropriately depicted this on the Venn diagram. Subsequently, in parts (ii) and (iii), they accurately portrayed the complement of set N^c on the Venn diagram in part and shaded the specified regions respectively.

Image of Better Response	
Description of Weaker Responses	Weaker responses struggled to illustrate the set operations in Venn diagrams. In part (i), these responses mentioned only set N and shaded N^c for part (ii). Nevertheless, in part (iii), some candidates correctly represented $(M \cap R)'$, but duplicated the elements of set U again and shaded only the set U.
Image of Weaker Response	

Suggestions for Improvement (Highlighted part)

How to Approach SLO	Pedagogy** Used for that SLO	Assessment Strategies
• Understand the expectations of the command words • Look at the cognitive level • Identify the content that is required to answer that question (both in terms of understanding of concepts and any skills that may be required like analysing or evaluating) • Go through the past paper questions on that particular concept • Refer to the resource guide for extra resources	• Story Board • Cause and Effect • Fish and Bone • Concept Mapping • Audio Visual resources • Think, Pair and Share • Questioning Technique (Socratic approach) • Practical Demonstration ** For description of each pedagogy, refer to Annexure A	• Past paper questions • Discussion on E-Marking Notes • AKU-EB Digital Learning Solution powered by Knowledge Platform https://akueb.knowledgeplatform.com/login

Any Additional Suggestion:
To enhance better understanding of the concept, teachers are recommended to use the following strategies. Comparative Analysis: Compare different set operations side by side on Venn diagrams. Emphasise the similarities and differences between intersections, unions, and complements.

Guided Worksheets: Provide guided worksheets where students are asked to perform specific set operations on given Venn diagrams. Gradually increase the complexity of operations.
Error Analysis: Show examples of common mistakes made when representing set operations on Venn diagrams. Discuss why these mistakes occur and how to avoid them.

*K = Knowledge U = Understanding A = Application and other higher-order cognitive skills

Question No. 2	
Question Text	If the value of log 3 = 0. 4771, then find the value of log 81.
SLO No.	3.4.1
SLO Text	Solve problems using the laws of logarithm (without using log and antilog tables).
Max Marks	3
Cognitive Level	A
Checking Hints	1 mark for writing $\log 81 = \log 3^4$ 1 mark for applying law of logarithms to write $4\log 3$ 1 mark for finding the value of log81
Overall Performance	A significant number of candidates performed well in this question by converting 81 into exponential form as 3^4, using third law of logarithm, and substituting the given value of log3 to simplify the expression.
Description of Better Responses	In better responses, candidates correctly converted 81 into exponential form as 3^4 and appropriately applied the power law of logarithm. They then substituted the given value to obtain the value of log81. Additionally, marks were also awarded to responses in which candidates took the Least Common Multiple (LCM) of 81 and applied the multiplication rule to determine log of log81.
Images of Better Responses	**Image (i)**

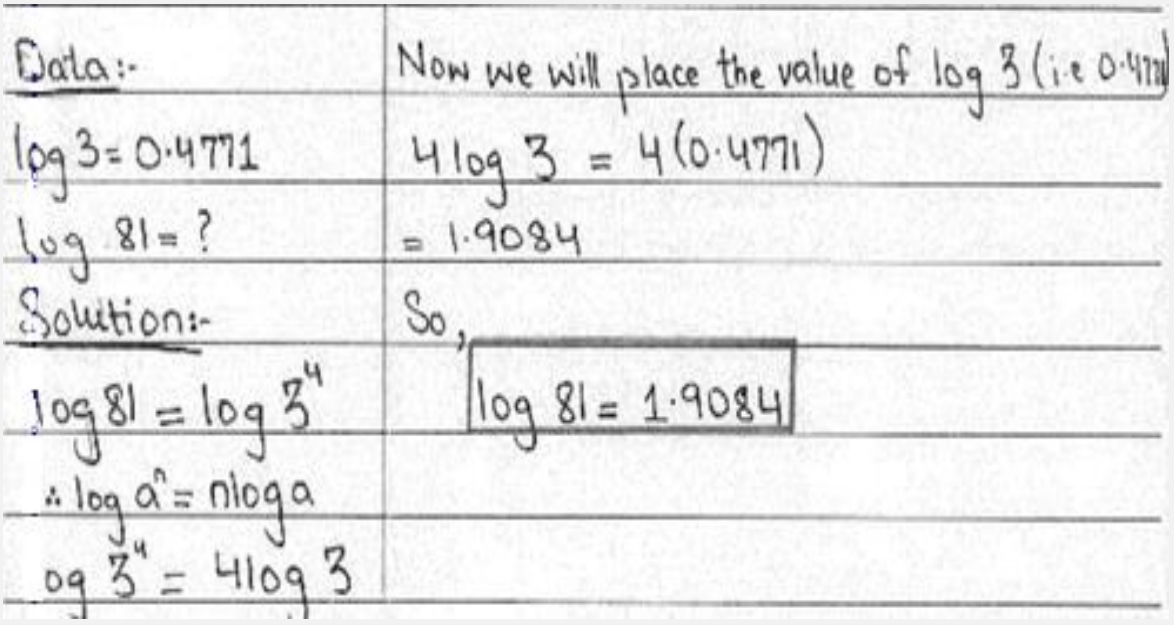
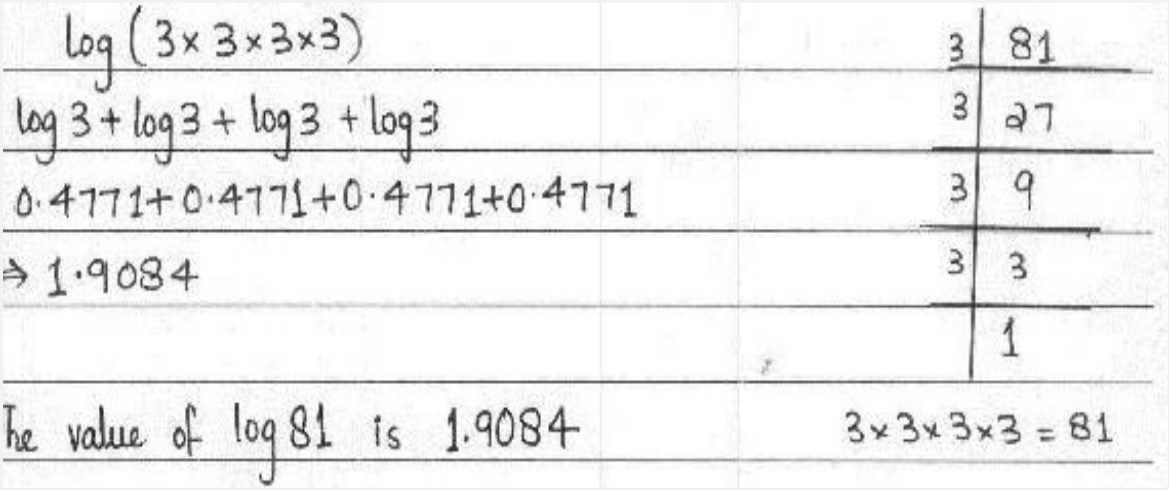
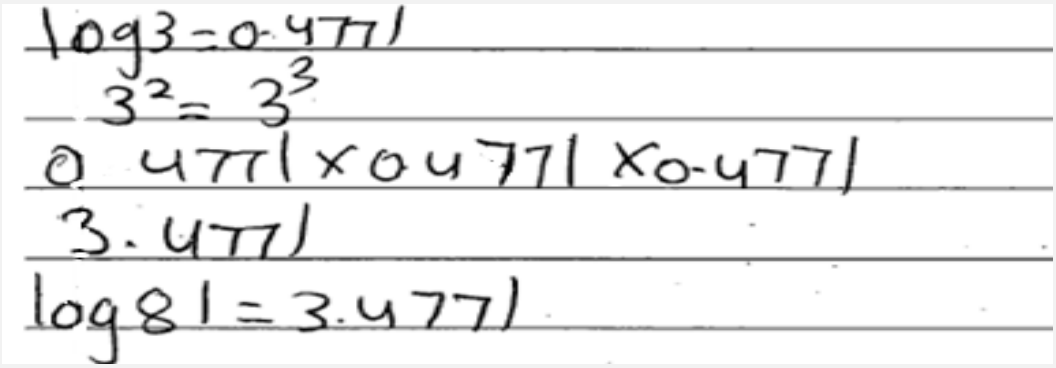
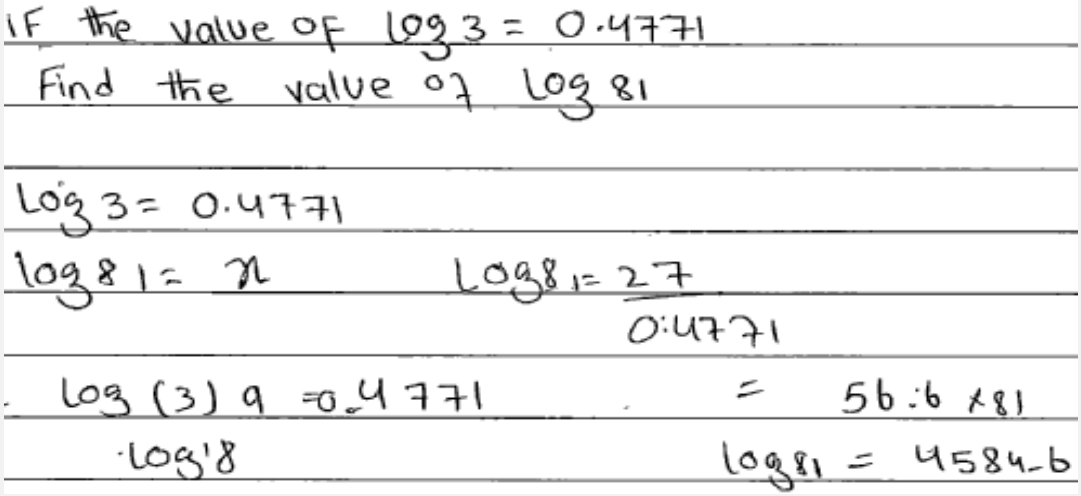


	Image (ii) 
Description of Weaker Responses	Weaker responses from candidates attempting the question indicated the following reasons for their challenges: Incorrect Application of Logarithmic Laws: Candidates misapplied the logarithmic laws, such as the power law and the product law, leading to incorrect results. This happened due to confusion and lack of understanding about when and how to use these laws appropriately. Incorrect Conversion: Candidates incorrectly converted numbers from exponential form to logarithmic form or vice versa. This resulted in inaccurate calculations. Misinterpretation of Given Values: Candidates misinterpret the given logarithmic values or base values, which can lead to incorrect substitutions and calculations.
Images of Weaker Responses	**Image (i)**  **Image (ii)** 

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Any Additional Suggestion:
While teaching the concept of application of the law of logarithm, teachers are advised to use the following strategies.
Clear Explanation of Laws**:** Begin by providing a clear and concise explanation of each logarithmic law, along with examples illustrating their correct application. Emphasis when and why each law is used.
Error Analysis Activities**:** Provide students with incorrect solutions and ask them to identify and explain the errors. Discuss the common misconceptions that might have led to those errors and guide students in correcting the solutions.

Question No. 3a

Candidates were given the choice to attempt any ONE out of the two questions: 3a and 3b.

Question Text	If $m = 2 - \sqrt{3}$ and $n = \frac{1}{2+\sqrt{3}}$, then i. show that $m + n = \frac{2}{2+\sqrt{3}}$. ii. express $m + n$ in the form $a - b\sqrt{c}$ by rationalising the denominator.
SLO No.	4.4.2
SLO Text	Solve problems based on surds.
Max Marks	4
Cognitive Level	A
Checking Hints	i. 1 mark for taking LCM 1 mark for the simplification ii. 1 mark for taking multiplying and dividing by the conjugate surd 1 mark for the simplification

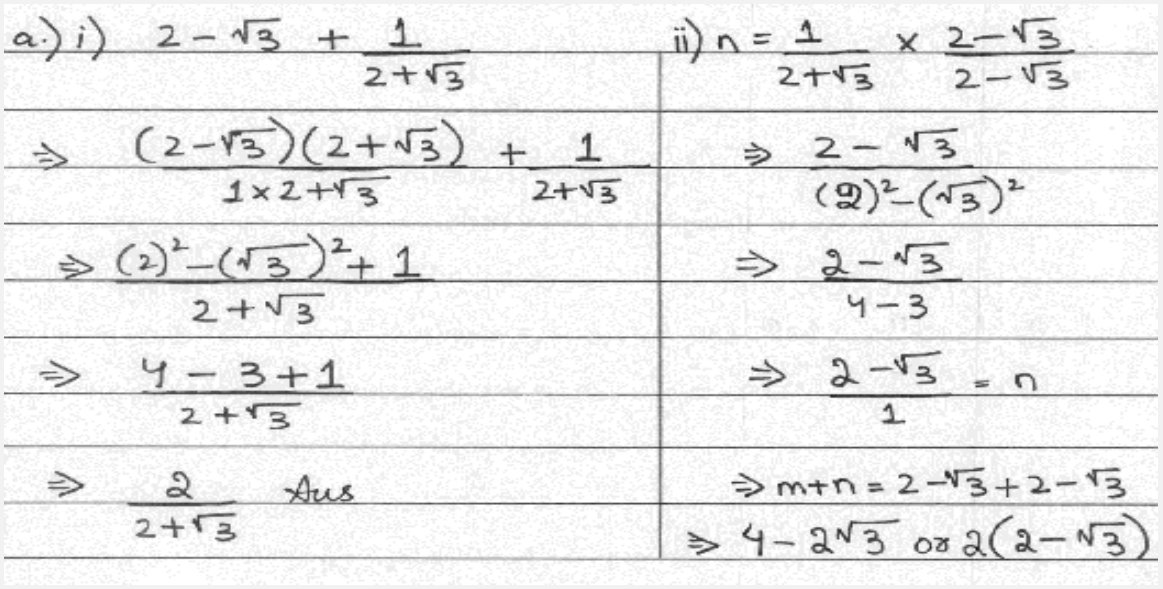
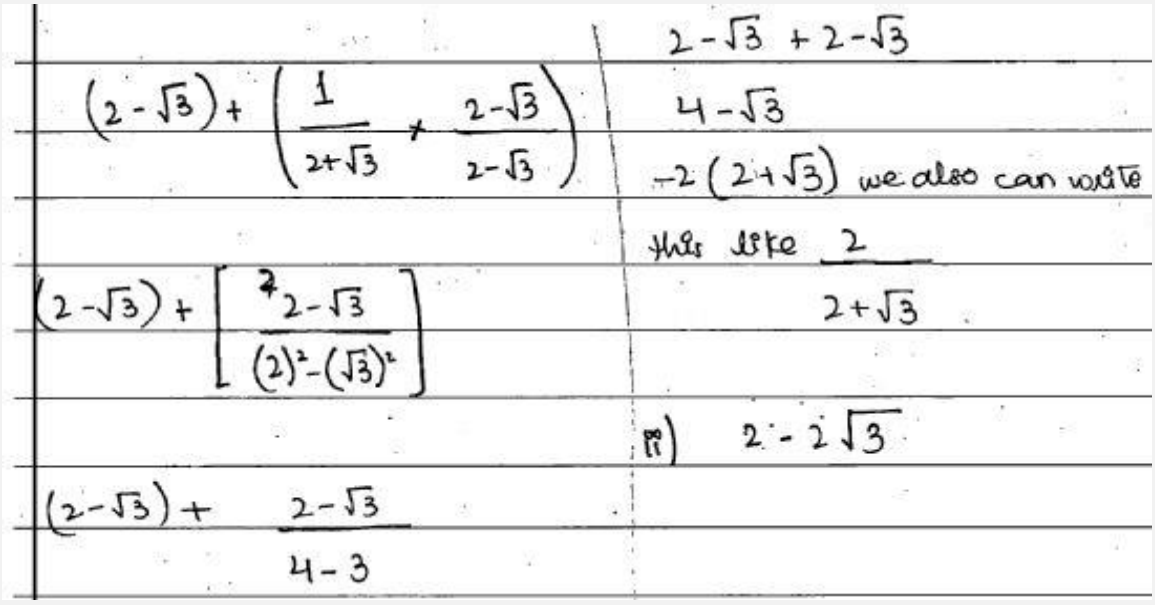
Overall Performance	This question was correctly solved by many candidates showing good command on the concept of surd and rationalisation. This part attempted by majority of the candidates.
Description of Better Responses	In part (i), proficient candidates took LCM of the denominator and correctly simplified the numerator by applying the appropriate formula. Likewise, in part (ii), they reflected their ability to rationalise by using the correct conjugate and subsequently performing the multiplication of surds. Moreover, these candidates simplified (the expression) by applying the correct formula $a^2 - b^2$ demonstrated a deeper understanding.
Image of Better Response	
Description of Weaker Responses	Weaker responses in part (i) showed that some of the candidates initiated rationalising '*n*' correctly; however, they struggled to add 'm' accurately and left part (ii) incomplete. Meanwhile, some candidates divided '*m*' by '*n*' but could not simplify it, resulting in an improper application of the identity in part (ii). Additionally, a few candidates multiplied '*m*' by '*n*' in part (i) and correctly took the conjugate of its denominator, but applied an inappropriate formula. Moreover, candidates with such responses made errors in simplification as well.
Images of Weaker Responses	**Image (i)** 

Image (ii)

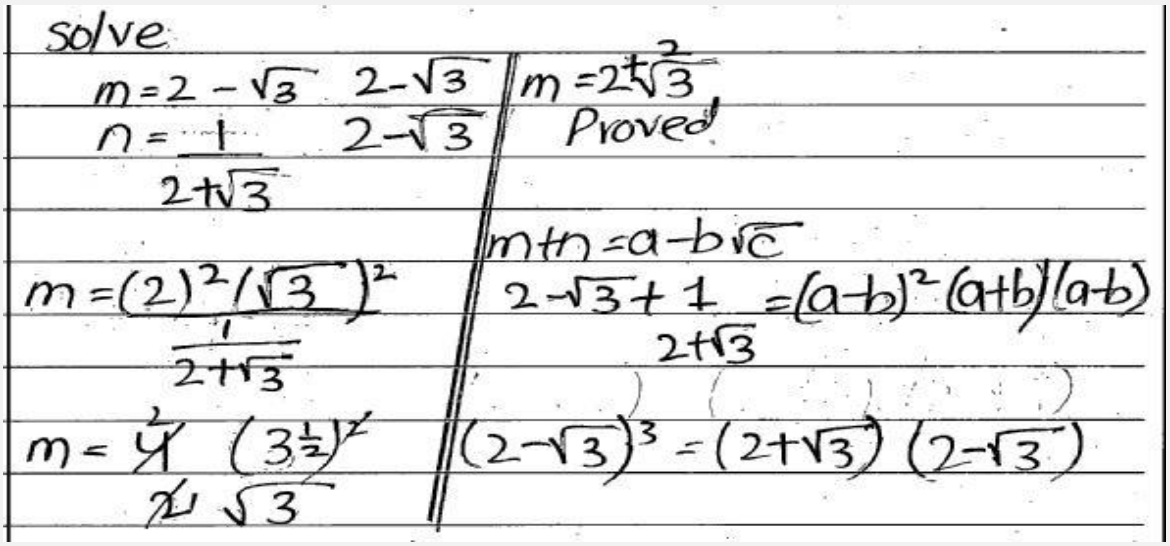
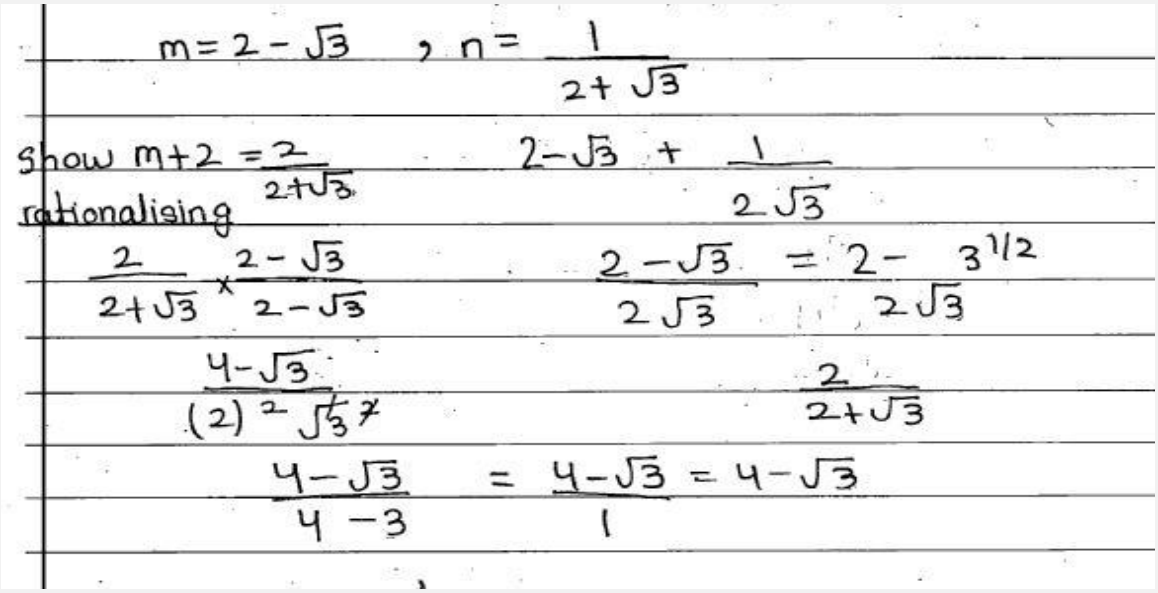


Image (iii)



Suggestions for Improvement (Highlighted part)

How to Approach SLO	Pedagogy Used for that SLO	Assessment Strategies
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of concepts and any skills that may be required like analysing or evaluating) • Go through the past paper questions on that particular concept • Refer to the resource guide for extra resources	• Questioning Technique (Socratic approach) • Practical Demonstration	

Any Additional Suggestion:

Following are some teaching strategies related to misconceptions and common errors which candidates exhibited.

Incorrect Rationalisation: Provide step-by-step demonstrations of rationalisation for various types of expressions. Offer problems that require rationalisation and guide students through the correct process.

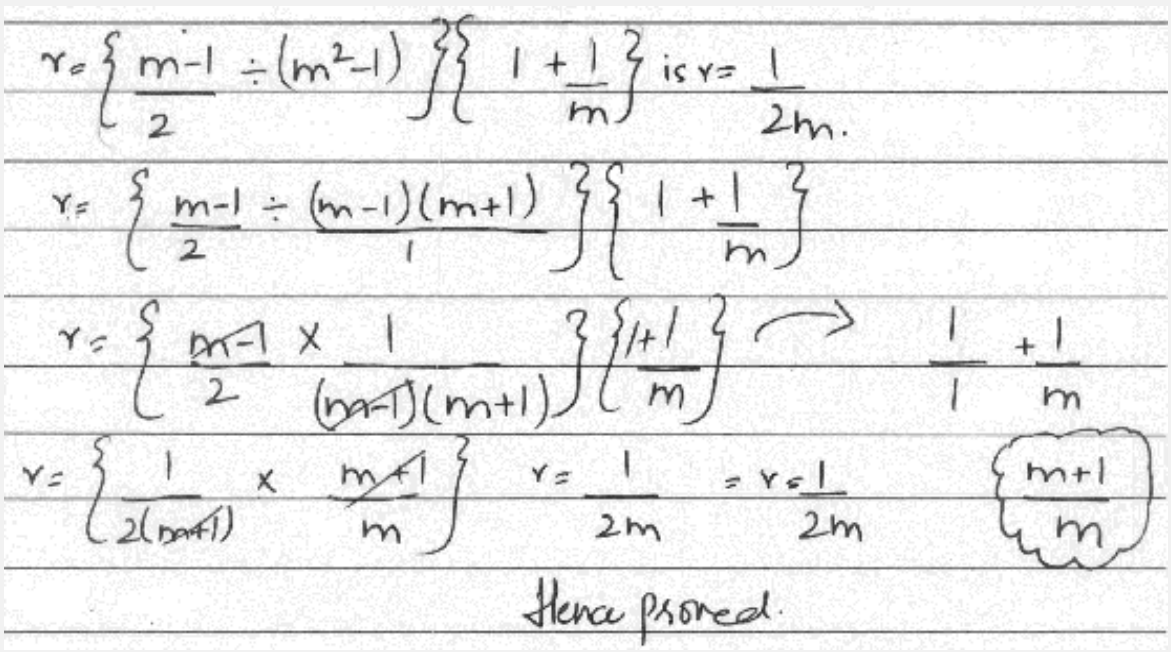
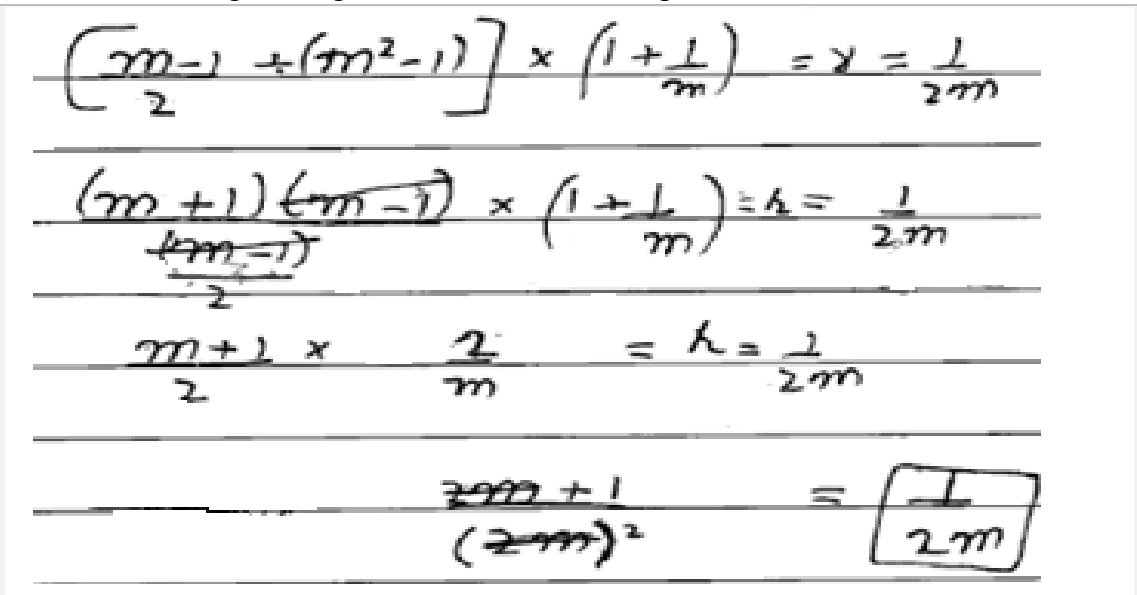
Misapplication of Formulas: Present a variety of problems that require different formulas for surd-related operations. Discuss the scenarios where each formula is applicable and encourage students to identify the correct formula. Break down the simplification process into clear steps. Guide students through problems where simplification is a crucial component and provide practice to reinforce these skills.

Improper Conjugate Usage: Offer guided examples that involve using the conjugate correctly. Include explanations for why the conjugate is used and how it affects the problem-solving process.

Question No. 3b

Candidates were given the choice to attempt any ONE out of the two questions: 3a and 3b.

Question Text	Prove that the simplest form of $r=\left\{\frac{m-1}{2}\div\left(m^2-1\right)\right\}\times\left(1+\frac{1}{m}\right)$ is $r=\frac{1}{2m}$.
SLO No.	4.1.4 and 4.1.5
SLO Text	Solve problems based on the multiplication and division of a rational expression. Find the value of an algebraic expression for a given real number.
Max Marks	4
Cognitive Level	A
Checking Hints	1 mark for factorisation of m^2-1 applying the formula of a^2-b^2. 1 mark for writing $1+\frac{1}{m}$ as $\frac{m+1}{m}$. 1 mark for converting division into multiplication sign 1 mark for the simplification to get $r=\frac{1}{2m}$
Overall Performance	This question assessed the operations on surds, namely subtraction, multiplication and division. Candidates simplified the given expressions using the mentioned operations correctly. Majority of the candidates that selected this question were able to gain full marks.
Description of Better Responses	Better responses diligently performed the operations of division, multiplication, applied the appropriate formula a^2-b^2 and accurately took the LCM, thereby successfully achieving the required expression.

Image of Better Response	
Description of Weaker Responses	Weaker responses struggled to perform the operations required. Although factorisation was accurate in many weaker responses, a common mistake was frequently appearing when dividing $(m+1)(m-1)$ by $\frac{(m-1)}{2}$, leaving them with $\frac{(m+1)}{2}$. Moreover, instead of determining the least common multiple (LCM) appropriately, they erroneously added only the numerator, leading to the generation of incorrect expressions.
Image of Weaker Response	

Suggestions for Improvement (Highlighted part)

How to Approach SLO	Pedagogy Used for that SLO	Assessment Strategies
• Understand the expectations of the command words	• Story Board • Cause and Effect • Fish and Bone • Concept Mapping	• Past paper questions • Discussion on E-Marking Notes • AKU-EB Digital Learning Solution powered by Knowledge Platform

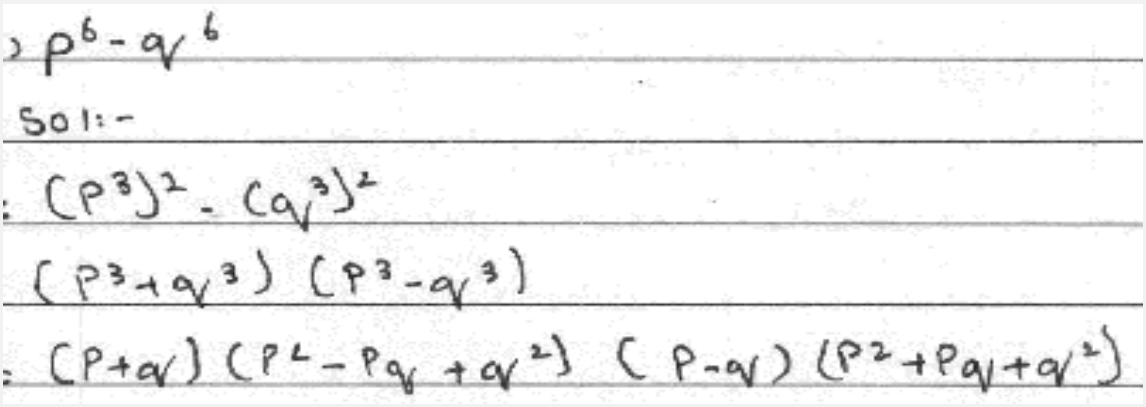
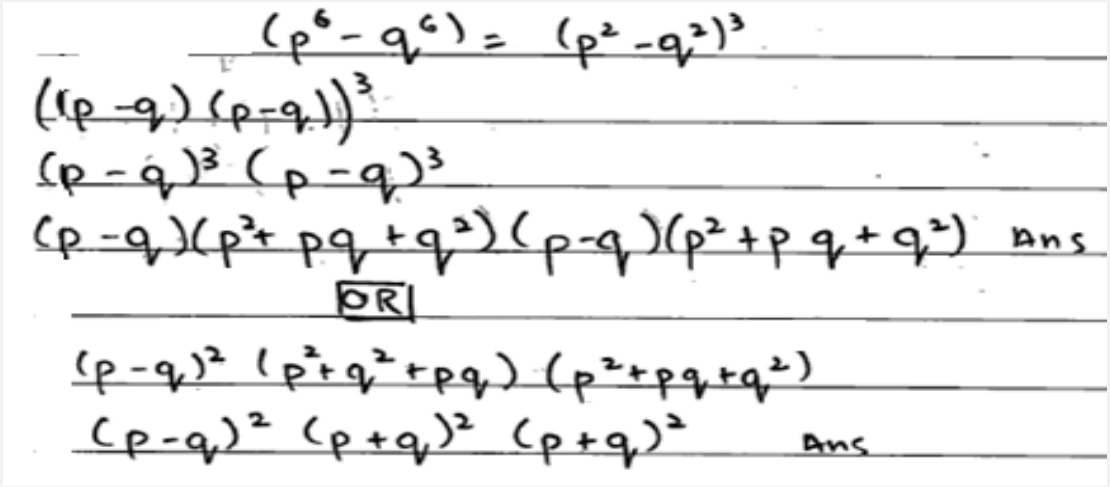
• Look at the cognitive level • Identify the content that is required to answer that question (both in terms of understanding of concepts and any skills that may be required like analysing or evaluating) • Go through the past paper questions on that particular concept • Refer to the resource guide for extra resources	• Audio Visual resources • Think, Pair and Share • Questioning Technique (Socratic approach) • Practical Demonstration	https://akueb.knowledgeplatform.com/login

Any Additional Suggestion:
Following are some teaching strategies related to misconceptions and common errors which candidates exhibited.
Step-by-Step Approach: Break down the process of solving problems involving multiplication and division of rational expressions into clear steps. Guide students through each step, highlighting the importance of factoring and cancelling common factors.
Error Analysis: Provide incorrect solutions and have students identify and correct the mistakes. This helps them develop critical thinking skills and a better understanding of common errors.
Guided Examples: Work through guided examples where students substitute real numbers into algebraic expressions and calculate the results. Highlight the importance of following the correct order of operations.

Question No. 4a

Candidates were given the choice to attempt any ONE out of the two questions: 4a and 4b.

Question Text	Factorise $p^6 - q^6$ completely.
SLO No.	5.2.1(e)
SLO Text	Factorise the expression of the type $a^3 \pm b^3$ (e).
Max Marks	4
Cognitive Level	A
Checking Hints	1 mark for writing $p^6 - q^6$ in the form of $(p^3)^2 - (q^3)^2$ 1 mark for applying formula of $a^2 - b^2$ 1 mark for applying formula of $a^3 - b^3$ 1 mark for applying formula of $a^3 + b^3$
Overall Performance	Candidates who attempted this section demonstrated a comprehensive understanding of the concept of factorisation by accurately applying the relevant formula at each step. Few of the candidates were able to attempt this question successfully.
Description of Better Responses	In this question, candidates were required to use formula or choose one from the formula sheet to apply and factorise. Better responses demonstrated candidates' ability to identify the relevant formulae, as they accurately converted the expression into $a^2 - b^2$ identity and applied cubic identities ($a^3 - b^3$ and $a^3 + b^3$) for factorisation. This led them to simplify the expression to its simplest form.

Image of Better Response	
Description of Weaker Responses	Weaker responses showed that candidates faced difficulty in identifying the most relevant formula. Many candidates applied the whole cube identity to convert the expression into a^2-b^2, but struggled to expand it accurately. Moreover, they mistakenly applied the a^3-b^3 formula to both expended expressions, leading the challenges in factorising the polynomial to the lowest terms.
Image of Weaker Response	

Suggestions for Improvement (Highlighted part)

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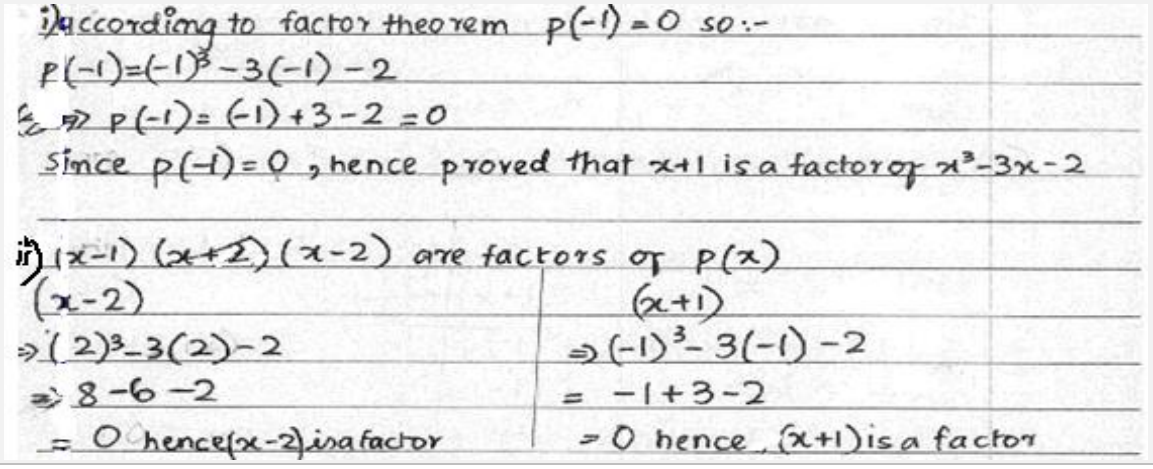
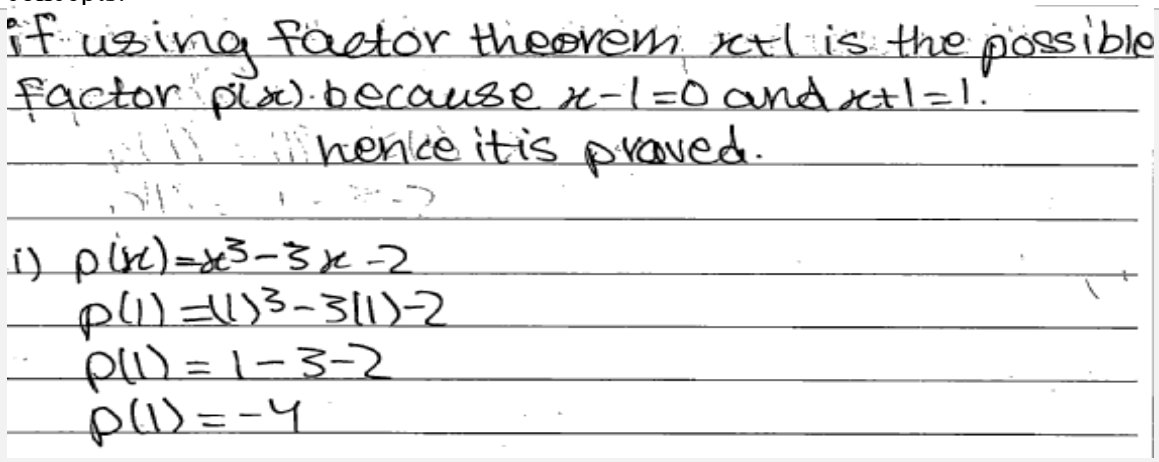
• Go through the past paper questions on that particular concept • Refer to the resource guide for extra resources		

Any Additional Suggestion:
Teachers are suggested to incorporate following strategies while teaching factorisation.
Pattern Recognition: Encourage students to look for patterns in the expanded expressions. Guide them to recognise the pattern in the "sum of cubes" and "difference of cubes" formulas.
Formula Presentation: Introduce the formulas for the "sum of cubes" and "difference of cubes" expressions. Explain the rationale behind each formula and how they relate to the pattern.

Question No. 4b

Candidates were given the choice to attempt any ONE out of the two questions: 4a and 4b.

Question Text	For the polynomial $p(x) = x^3 - 3x - 2$, i. using factor theorem, prove that $x+1$ is a factor of $p(x)$. ii. find the remaining two factors of $p(x)$.
SLO No.	5.3.3 and 5.4.1
SLO Text	Solve problems based on the concept of zeros of a polynomial. Apply factor theorem to factorise a cubic polynomial.
Max Marks	4
Cognitive Level	A
Checking Hints	1 mark for using factor theorem correctly 1 mark for verifying that $x-2$ is a factor or $p(x)$. 1 mark for employing long division or factor theorem. 1 mark for finding each of the factors.
Overall Performance	This question was related to the application of factor theorem to factorise a cubic polynomial. Majority of the candidates solved this question by factor theorem. Only few candidates applied division method after applying factor theorem. This part attempted by majority of the candidates.
Description of Better Responses	Better responses demonstrated correct application of factor theorem to prove the factor $x + 1$, and then applied zeros of the polynomial to find other two factors of the given cubic polynomial.
Image of Better Response	

Description of Weaker Responses	In weaker responses, many candidates inaccurately applied the remainder theorem instead of the factor theorem to deduce the factor $x + 1$. Furthermore, most candidates concluded their work after determining the remainder, which indicated confusion between the two concepts.
Image of Weaker Response	

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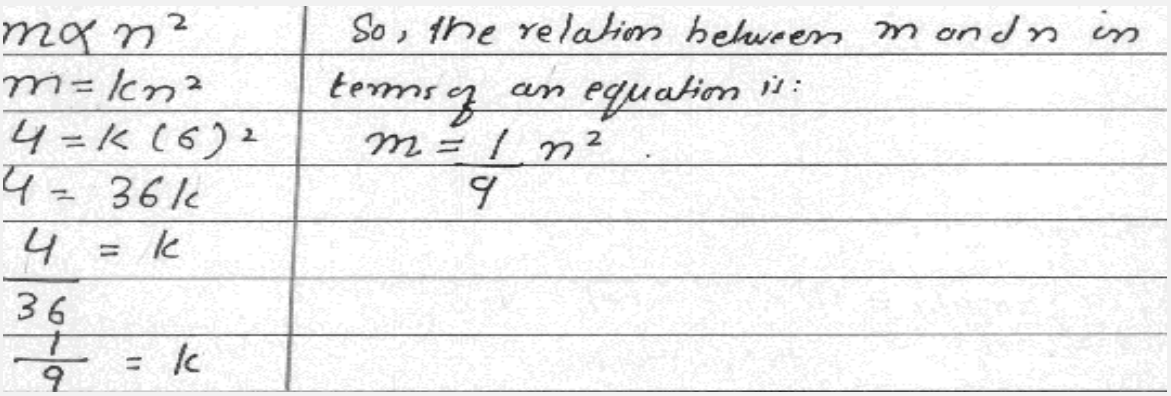
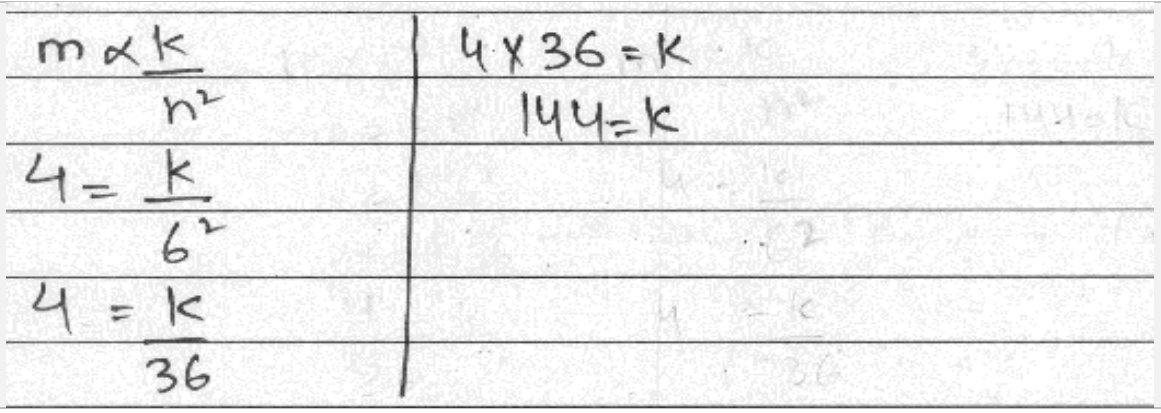
Any Additional Suggestion:
To enhance the conceptual understanding of the topic 'factorisation of a cubic polynomial', teachers can offer a series of problems requiring students to identify factors using the factor theorem. During discussions, students can compare their selected factors with the correct ones, highlighting the reasoning for each choice. Additionally, to address confusion regarding remainders, teachers can present problems that lead to a non-zero remainder during polynomial division. Through these problems, teachers can explain the importance of remainders and their connection to the factor theorem.

Question No. 5	
Question Text	The quantity m varies directly as n^2. If $m = 4$ and $n = 6$, then find the relation between m and n in terms of an equation.
SLO No.	6.3.2
SLO Text	Solve problems related to variations (up to four quantities).
Max Marks	3
Cognitive Level	A
Checking Hints	1 mark for writing relation i.e., $m = kn^2$ 1 mark for substituting the values of m and n to get $4 = k \times (6)^2$ 1 mark for writing relation after finding the value of k, i.e., $m = \frac{1}{9} \times n^2$
Overall Performance	Overall, candidates performed well in this question by forming equation with the help of the given data and finding a particular value corresponding to the given value The overall performance indicates candidates' sound understanding of direct proportions.
Description of Better Responses	Better responses exhibited the candidates' ability to convert a proportional relation into equation form using constant of proportionality. Such candidates were able to find the equation by finding and substituting the value of constant of proportionality. Hence, they successfully determined the unknown value corresponding to the given value, using the equation formed.
Image of Better Response	
Description of Weaker Responses	Following major mistakes were frequently appeared in weaker responses. Confusion with Inverse Proportion: Most candidates used the concepts of inverse proportion and mixed them up with direct proportion. This led to incorrect solutions. Ignoring Constants: Students overlooked the importance of constant factors when setting up the proportionality equation, leading to inaccurate results. Arithmetic Errors: Mistakes in calculations, such as multiplication or division errors, led to incorrect final results even if the proportionality equation was set up correctly.
Image of Weaker Response	

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Any Additional Suggestion:
To address these misconceptions and errors, consider the following teaching strategies:
Clearly Differentiate between Direct and Inverse Proportion: Provide clear explanations and examples that differentiate between direct and inverse proportionality, ensuring students understand the distinction.
Emphasise Constants: Emphasise the significance of constants in proportionality equations and how they affect the relationship between variables.
Careful Reading: Emphasise students to read problems carefully and identify whether direct proportionality is relevant to the situation.

Question No. 6	
Question Text	For the matrices $S = \begin{bmatrix} 2 & -1 \\ s & 4 \end{bmatrix}$ and $T = \begin{bmatrix} 0 & 1 \\ -s & -1 \end{bmatrix}$, find the i. matrix $2(S - T)$. ii. value of s, if $S - T$ is a singular matrix.
SLO No.	7.5.4
SLO Text	Solve problems related to singular and non-singular matrix.
Max Marks	4
Cognitive Level	A
Checking Hints	i. 1 mark for finding the matrix $S - T$ 1 mark for finding $2(S - T)$ ii. 1 mark for the determinant of $S - T$ equal to 0 1 mark for finding the value of s
Overall Performance	The candidates' overall performance in this question was below average. They struggled to meet the question's requirements, which involved matrix operations and using singular

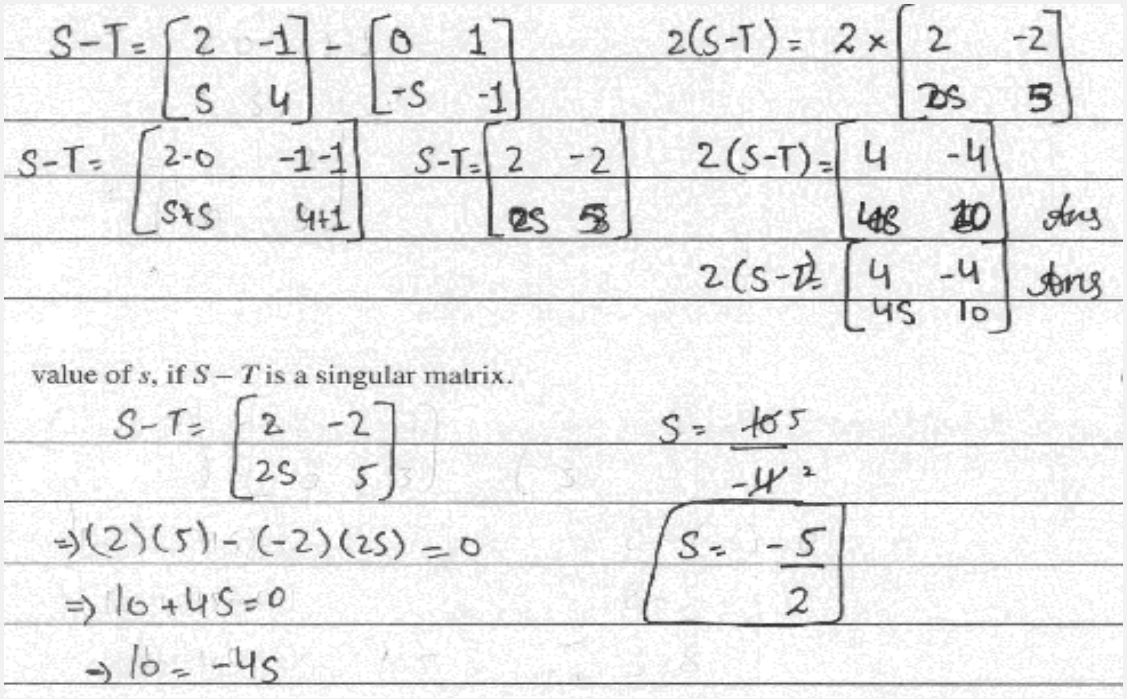
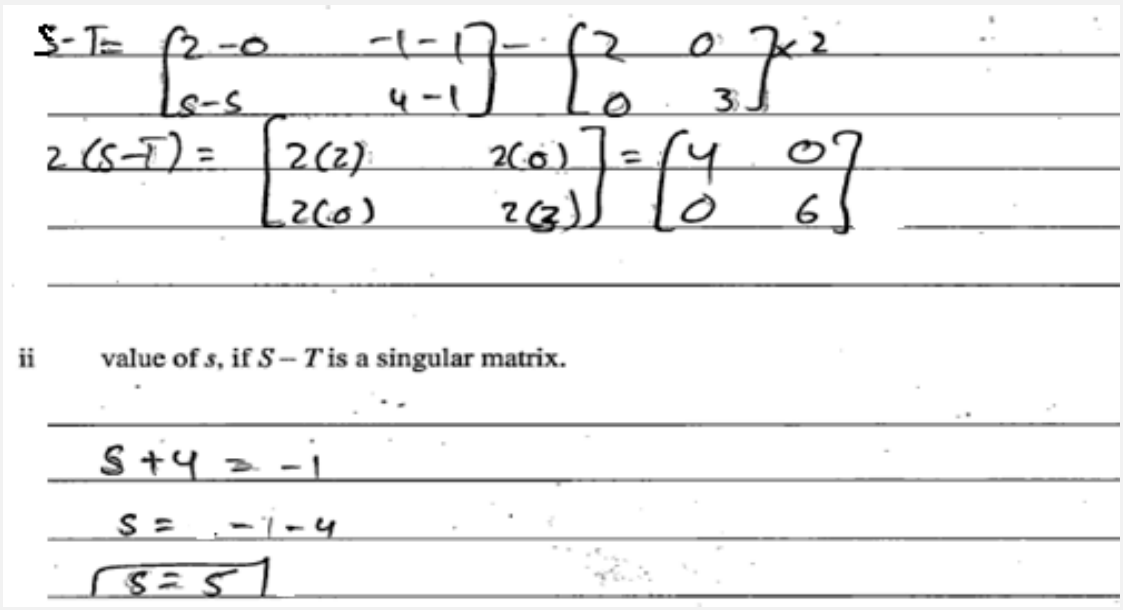
	matrices to solve for unknowns in a given matrix. A prevalent error was observed in matrix operations, including scalar multiplication and subtraction of matrix.
Description of Better Responses	Better responses exhibited the correct subtraction on matrices and proper scaler multiplication by 2. Furthermore, they applied the concept of singular matrices correctly. Such responses also executed the calculations accurately.
Image of Better Response	
Description of Weaker Responses	Candidates with weaker responses demonstrated difficulties in comprehending the concept of singular matrices. Following eerrors were observed in calculations involving determinants and their subsequent manipulation. Misunderstanding Singular Matrices Concept: Candidates with weaker responses demonstrated difficulties in comprehending the concept of singular matrices. Following eerrors were observed in calculations involving determinants and their subsequent manipulation. Inaccurate Determinant Calculations: Candidates exhibited incorrect calculations of determinants in their solutions. This included mistakes in evaluating determinants of matrices and failing to equate them to zero. Operational Errors: Scalar Multiplication and Subtraction: Weaker responses highlighted errors in basic matrix operations such as scalar multiplication and matrix subtraction. These inaccuracies impacted the overall solutions involving singular matrices. Unable to equate with zero: A noticeable trend in weaker responses was the omission of equating determinants to zero, a fundamental step when dealing with singular matrices. This led to incorrect solutions for the given problems.

Image of Weaker Response	

Suggestions for Improvement (Highlighted part)

How to Approach SLO	Pedagogy Used for that SLO	Assessment Strategies
• Understand the expectations of the command words • Look at the cognitive level • Identify the content that is required to answer that question (both in terms of understanding of concepts and any skills that may be required like analysing or evaluating) • Go through the past paper questions on that particular concept Refer to the resource guide for extra resources	• Story Board • Cause and Effect • Fish and Bone • Concept Mapping • Audio Visual resources • Think, Pair and Share • Questioning Technique (Socratic approach) • Practical Demonstration	• Past paper questions • Discussion on E-Marking Notes • AKU-EB Digital Learning Solution powered by Knowledge Platform https://akueb.knowledgeplatform.com/login

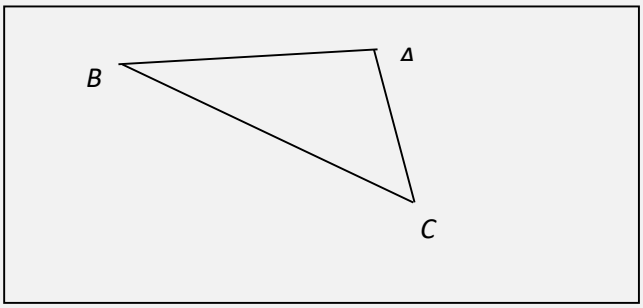
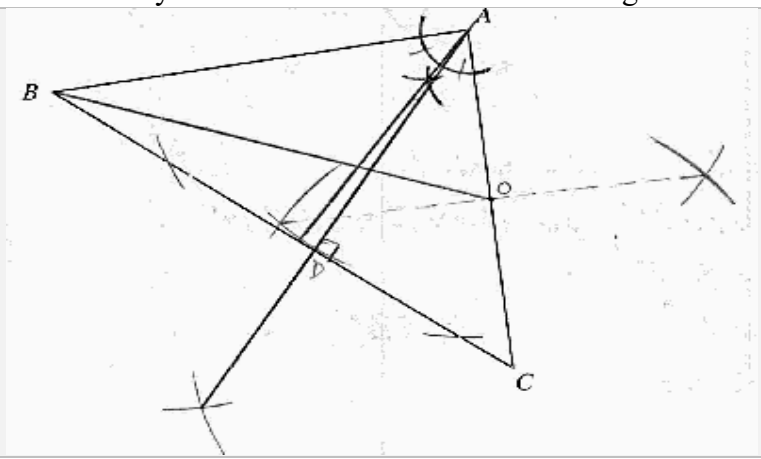
Any Additional Suggestion:

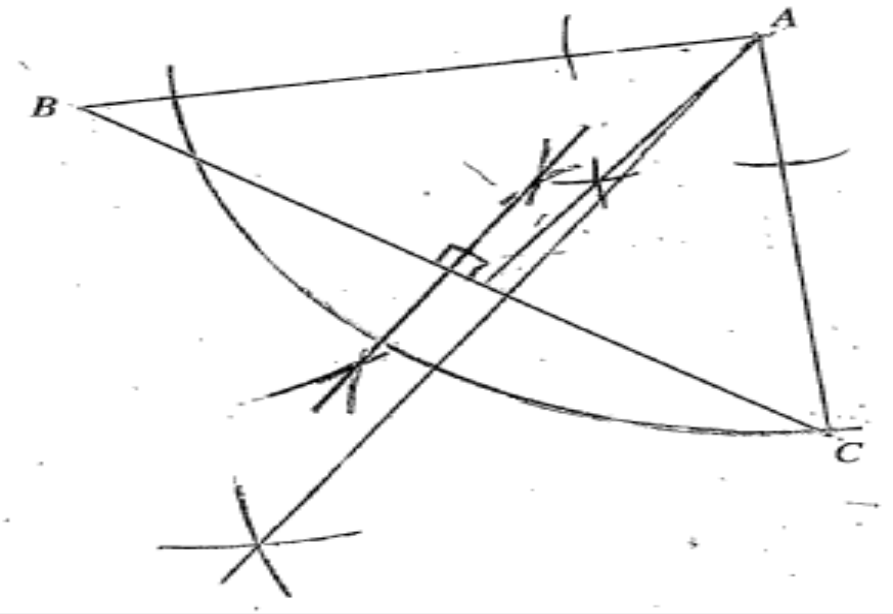
Following strategies can be applied to effectively teach singular matrix.

Problem-Based Learning: Provide problems that require students to determine whether a matrix is singular or non-singular based on its determinant value. Discuss solutions as a class.

Variation in Matrices: Show how changing specific elements of a matrix can impact its determinant and whether it becomes singular.

Application in Linear Systems: Connect singular matrices to systems of linear equations. Show how the determinant can provide insights into the solvability of a system.

Question No. 7	
Question Text	For the given triangle *ABC*, draw the i. angle bisector of angle *A*. ii. median passing through vertex *B*. iii. altitude from vertex *A* to its opposite side. 
SLO No.	8.1.2
SLO Text	Draw for a given triangle a) angle bisector b) perpendicular bisector c) median, d) altitudes
Max Marks	3
Cognitive Level	A
Checking Hints	1 mark for drawing angle bisector of angle *A* 1 mark for drawing median passing through *B* 1 mark for drawing altitude from *A* to *BC*
Overall Performance	This question was related to practical geometry. The candidates' performance on this question was below expectations. In this question, it was expected to draw an angle bisector, a median and a perpendicular bisector using compass. Furthermore, to draw all the necessary arcs and mention the measurements. The common mistakes that were observed in this question include candidates' inability to differentiate between median and altitude and their shallow knowledge of drawing steps. In addition, there were cases in which candidates did not focus on accuracy.
Description of Better Responses	In better responses, many candidates successfully performed the construction of an angle bisector, a median, and a perpendicular bisector using a compass. They accurately included all necessary arcs and measurements in their diagrams.
Image of Better Response	

Description of Weaker Responses	Weaker responses reflected candidates' inability to differentiate between perpendicular bisector, median, altitude and angle bisector. Also is evident from the given image of response that shows candidate's confusion between perpendicular bisector and altitude. Moreover, the candidate struggled to draw a median clearly.
Image of Weaker Response	

Suggestions for Improvement (Highlighted part)

How to Approach SLO	Pedagogy Used for that SLO	Assessment Strategies
• Understand the expectations of the command words • Look at the cognitive level • Identify the content that is required to answer that question (both in terms of understanding of concepts and any skills that may be required like analysing or evaluating) • Go through the past paper questions on that particular concept • Refer to the resource guide for extra resources	• Story Board • Cause and Effect • Fish and Bone • Concept Mapping • Audio Visual resources • Think, Pair and Share • Questioning Technique (Socratic approach) • Practical Demonstration	• Past paper questions • Discussion on E-Marking Notes • AKU-EB Digital Learning Solution powered by Knowledge Platform https://akueb.knowledgeplatform.com/login

Any Additional Suggestion:
Teachers are advised to use following teaching activities.
Real-Life Applications: Relate each construction to real-world scenarios. For example, discuss how medians can represent roads connecting the vertices of a triangle town layout, or how altitudes can relate to the height of a flagpole on a triangular flag. Connecting abstract concepts to practical situations enhances understanding.

Field Trips: If possible, take a field trip to a place where students can observe triangular structures, such as bridges or buildings. Discuss how the principles of triangle constructions might have been used in the design and construction of these structures i.e., structural stability, truss system and measurement and layout etc.

Question No. 8a

Candidates were given the choice to attempt any TWO out of the three questions: 8a, 8b, and 8c.

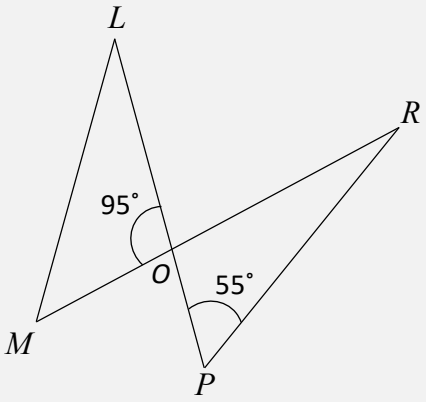
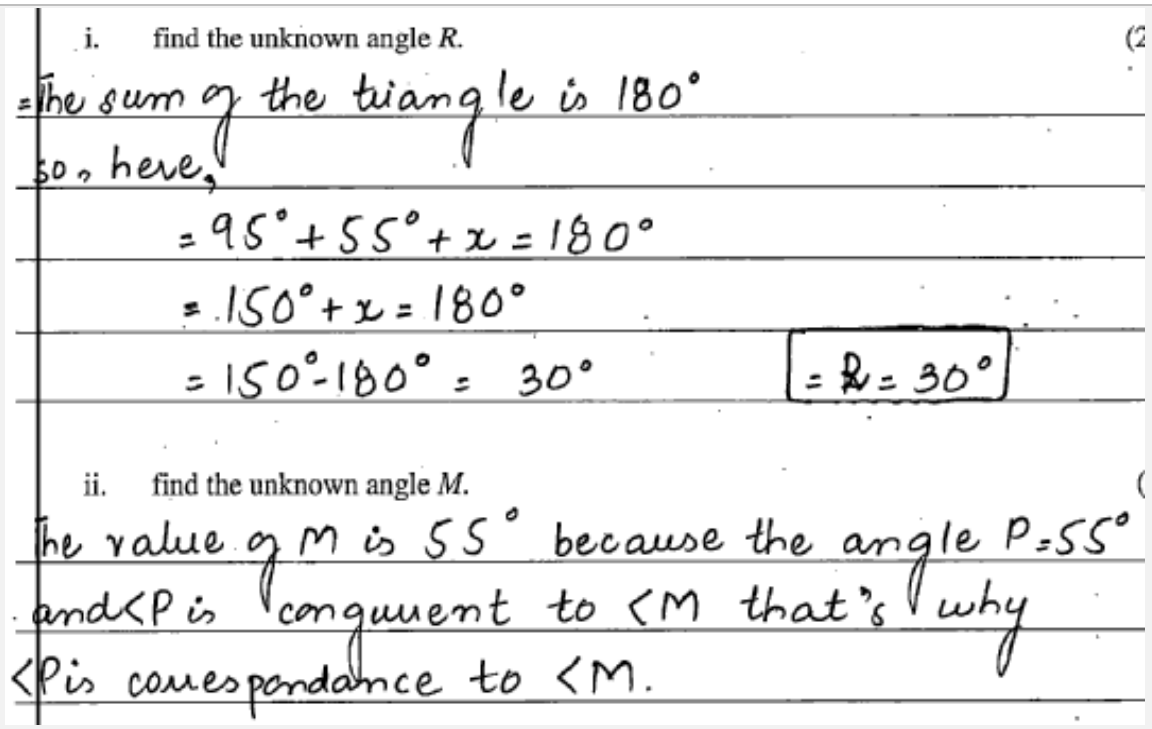
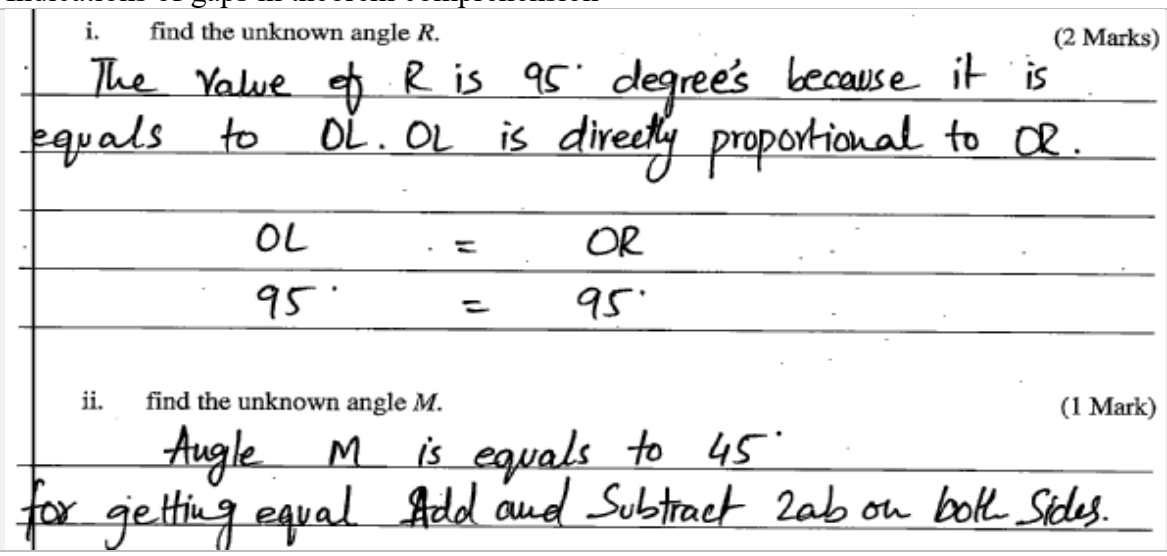
Question Text	In the given diagram, $OM = OP$ and $OL = OR$  **NOT TO SCALE** In the correspondence $\Delta MOL \leftrightarrow \Delta POR$, i. find the unknown angle R. ii. find the unknown angle M
SLO No.	9.1.1a
SLO Text	Apply the following theorems to solve related problems. (a) if two angles of a triangle are congruent, then the sides opposite to them are also congruent.
Max Marks	3
Cognitive Level	A
Checking Hints	i. 1 mark to finding angle POR 1 mark for finding angle R ii. 1 mark for finding angle M
Overall Performance	Relatively, fewer number of candidates attempted question 8a indicating high level of complexity in the concept. The overall performance of candidates in this question revealed areas of improvement concerning their comprehension related to application of corresponding angles and effective utilisation of Triangle Angle Sum Theorem
Description of Better Responses	In this question, candidates were expected to apply their understanding of the theorem 'if two angles of a triangle are congruent, then the sides opposite to them are also congruent'. Better responses demonstrated the clear understanding of geometric principles. They correctly applied the properties of corresponding angles and angle sum in a triangle to determine the unknown angles POR, R and M.

Image of Better Response	 i. find the unknown angle *R*. (2 =The sum of the triangle is 180° so, here, =95°+55°+x=180° =150°+x=180° =150°-180° = 30° = R = 30° ii. find the unknown angle *M*. The value of M is 55° because the angle P=55° and<P is conguent to <M that's why <P is corresponsance to <M.
Description of Weaker Responses	Ineffective Application of Corresponding Angles and Triangle Angle Sum Theorem: Difficulty in applying corresponding angles Struggles with utilizing the triangle angle sum theorem Impact on the determination of angles *POR*, *R*, and *M* Challenge in Theorem Selection and Confusion with Side Lengths: Struggles in choosing the appropriate theorem Frequent misuse of *OL* = *OR* Incorrect assumption of *OR* = 95 Unsound Assumptions and Inaccurate Angle Determinations: Attempted solutions based on assumptions Inaccurate determination of angle *M* Indications of gaps in theorem comprehension
Image of Weaker Response	 i. find the unknown angle *R*. (2 Marks) The Value of R is 95° degree's because it is equals to OL. OL is directly proportional to OR. OL = OR 95° = 95° ii. find the unknown angle *M*. (1 Mark) Angle M is equals to 45° for getting equal Add and Subtract 2ab on both Sides.

Suggestions for Improvement (Highlighted part)

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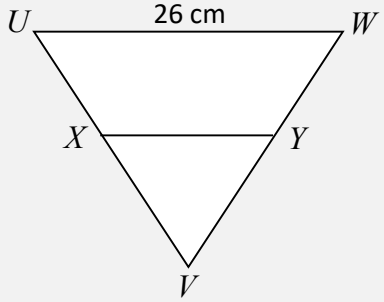
Any Additional Suggestion:
Real-Life Applications: Connect triangle congruence theorems to real-world situations. For example, relate the theorems to architecture, engineering, or design. Demonstrating how these theorems are applied in practical scenarios can enhance students' motivation and understanding i.e., tents, flagpoles and playground swings etc.
Reflective Problem Solving: Assign problems that require students to reflect on the theorem to apply and the angles to find. Encourage them to explain their choices and methods. This reflective practice promotes deeper understanding and critical thinking

Question No. 8b

Candidates were given the choice to attempt any TWO out of the three questions: 8a, 8b, and 8c.

Question Text	In the given figure, X and Y are the midpoints of UV and WV respectively.  If $UW = 26$ cm and $XY = (x + 5)$ cm, then i. find the value of x. ii. recalling the statement of a relevant theorem, complete the given sentence. XY and UW are lines_____ to each other.
SLO No.	10.1.1c

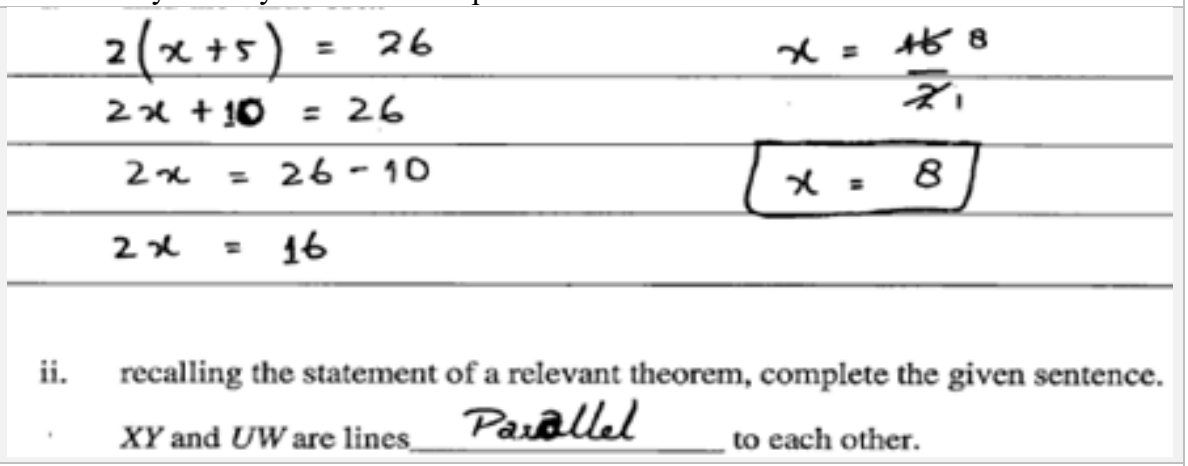
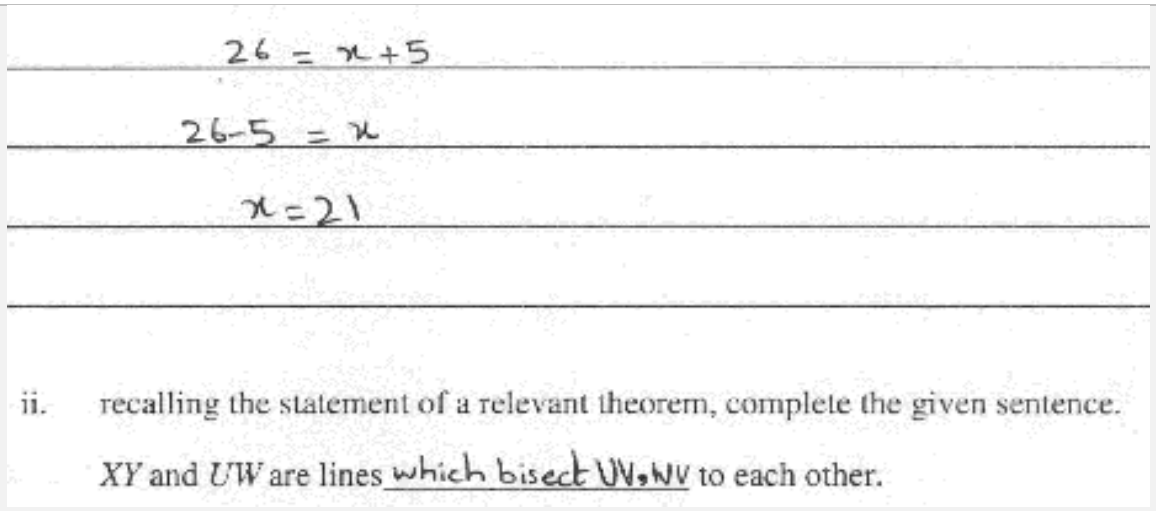
SLO Text	Apply the following theorems to solve related problems. c) The line segment, joining the midpoints of two sides of a triangle, is parallel to the third side and is equal to one half of its length.
Max Marks	3
Cognitive Level	A
Checking Hints	i. 1 mark for writing $x+5=\frac{1}{2}(26)$ 1 mark for finding the value of x ii. 1 mark for writing "XY and UW are parallel"
Overall Performance	In this question, candidates were expected to apply their understanding of the theorem 'the line segment joining the midpoint of two sides of triangle is parallel to the third side and equal to its half-length'. Only fewer candidates were able to solve this question.
Description of Better Responses	In part(i), better responses reflected sufficient understanding of the theorem's application. Such responses began the question by equating $2XY$ to UW, i.e., $2(x + 5) = 26$ or $x+5=\frac{1}{2}(26)$ and simplified the equation to find the correct value of x. In part(ii), better responses accurately recognised the parallel lines, utilising the relevant theorem to successfully identify this relationship.
Image of Better Response	
Description of Weaker Responses	Weaker responses exhibited inaccuracies in equating XY and UW, including instances where candidates considered UW as half of XY. Such responses began with incorrect assumption as $x + 5 = 26$, leading to an inappropriate value of x. Furthermore, the candidates were unable to identify the parallel lines which reflects candidates' lack of understanding of the theorem.

Image of Weaker Response	

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Any Additional Suggestion:

Teachers are advised to use following teaching activities.

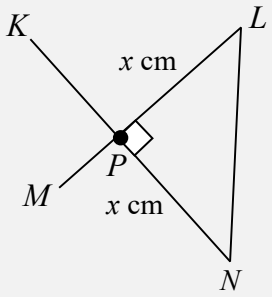
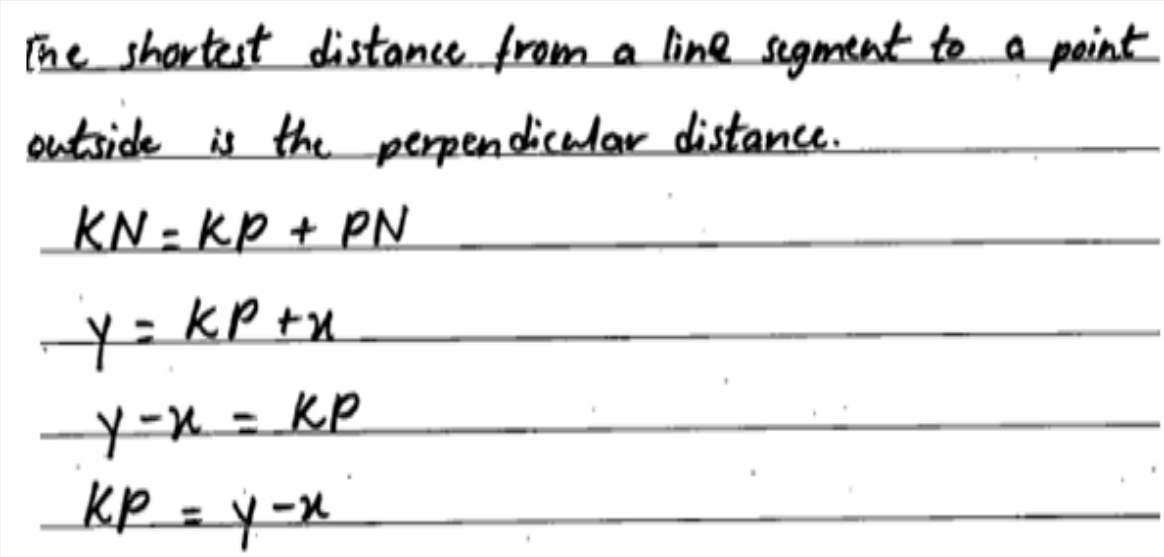
Visual Introduction**:** Begin by visually demonstrating the concept using a clear and well-labeled triangle diagram on the board or through a digital presentation. Highlight the midpoints of two sides and the parallel line segment connecting them. Ensure that students can clearly see the relationship between the mid-segments and the third side.

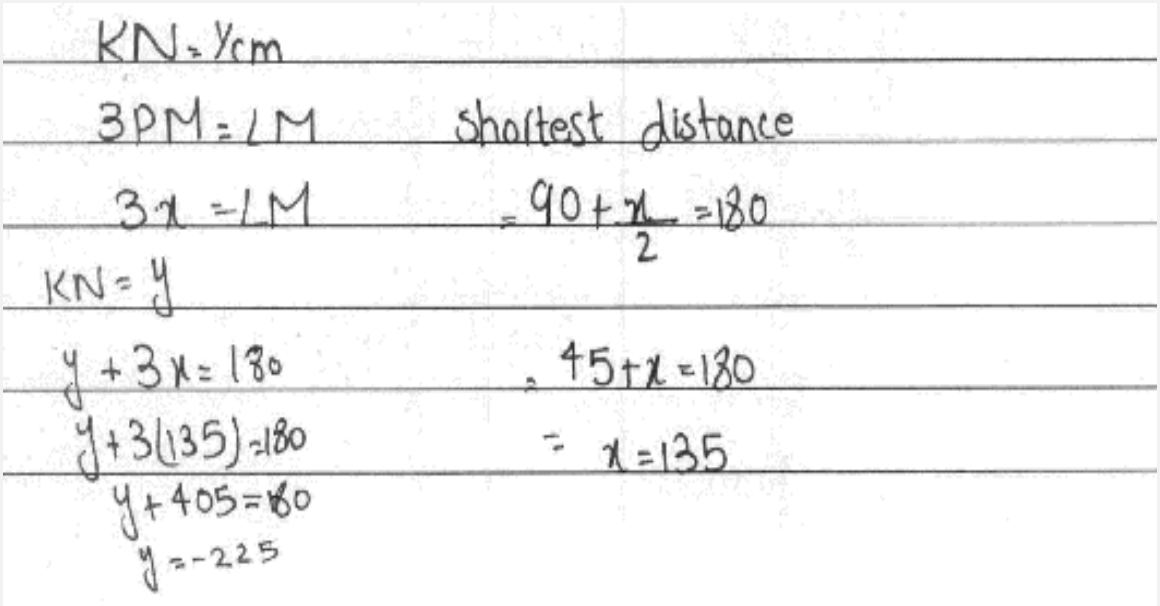
Hands-on Activity: Provide physical triangles made of cardboard or paper cutouts. Instruct students to physically cut and manipulate the triangles to observe the mid-segment and its properties. This tactile experience can enhance their understanding.

Real-world Applications: Discuss real-world scenarios where mid-segments might appear, such as bridges, trusses, or architectural structures. This helps students see the practical relevance of the concept.

Question No. 8c

Candidates were given the choice to attempt any TWO out of the three questions: 8a, 8b, and 8c.

Question Text	In the given diagram, $PL = PN = x$ cm and KN is perpendicular to ML.  **NOT TO SCALE** If $KN = y$ cm, then find an expression for the shortest distance from K to ML. (Note: The expression shall be in terms of x, and y.)
SLO No.	12.1.1d
SLO Text	Apply the following theorems to solve related problems. d) perpendicular is the shortest distance from a point to the line.
Max Marks	3
Cognitive Level	A
Checking Hints	1 mark for the correct understanding of the shortest distance, i.e., KP 1 mark for writing $KP + x = y$ 1 mark for finding KP
Overall Performance	Majority of the candidates successfully attempted this part. They were able to correctly apply their understanding of the theorem 'the points lying on the perpendicular bisector of a line segment are equidistant from its arms'.
Description of Better Responses	Better responses reflected the ability of recalling the related theorem and apply in solving the problem. In such responses, candidates identified the equal sides in the light of theorem statement and expressed the shortest distance in terms of x and y.
Image of Better Response	 The shortest distance from a line segment to a point outside is the perpendicular distance. $KN = KP + PN$ $y = KP + x$ $y - x = KP$ $KP = y - x$

Description of Weaker Responses	Weaker responses did not meet the demand of the questions primarily due to following key factors: Challenges with Theorem Recall and Length Relationships: Struggles in recalling the relevant theorem for the problem and comprehending length relationships in the given context. Errors in Equation Setup and Inaccurate Calculation of x: Setting up the equation by equating the calculated angle to 180°, but encountering mistakes in the calculation of x. Confusion with Comparison of Lengths and Replacement of Variables: Attempting to compare $3PM$ to LM and substituting x with PM, leading to challenges in accurately showing the relationship between angles and lengths. Struggles in Demonstrating Angle Calculation with Precision: Encountering difficulties in accurately presenting the calculation of angles, particularly the calculation of 3(135) as 180° within the context of the problem.
Image of Weaker Response	

Suggestions for Improvement (Highlighted part)

How to Approach SLO	Pedagogy Used for that SLO	Assessment Strategies
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• Go through the past paper questions on that particular concept • Refer to the resource guide for extra resources		

Any Additional Suggestion:

Teachers are advised to use following teaching activities.

Step-by-Step Problem Solving: Break down the problem-solving process into step-by-step instructions. Model how to apply the theorem correctly, emphasising the logic and reasoning behind each step. Encourage students to follow along and ask questions as you work through examples.

Interactive Worksheets: Provide interactive worksheets that guide students through the problem-solving process. Include prompts and hints that encourage them to think critically about the theorem's application and length relationships.

Real-Life Scenarios: Present real-life scenarios where the theorem and angle calculations are relevant. For example, relate the concept to architectural designs or surveying tasks. Discuss how accurately applying the theorem impacts practical situations.

Annexure A: Pedagogies Used for Teaching the SLOs

Pedagogy: Storyboard
Description: A visual pedagogy that uses a series of illustrated panels to present a narrative, encouraging creativity and critical thinking. It helps learners organise ideas, sequence events, and comprehend complex concepts through storytelling.
Example: In a Literature class, students are tasked with creating storyboards to visually retell a novel. They draw key scenes, write captions, and present their stories to the class, enhancing their reading comprehension and fostering their imagination.

Pedagogy: Cause and Effect
Description: This pedagogy explores the relationships between actions and consequences. By analysing cause-and-effect relationships, learners develop a deeper understanding of how events are interconnected and how one action can lead to various outcomes.
Example: In a History class, students study the causes and effects of the Industrial Revolution. They research and discuss how technological advancements in manufacturing led to significant societal changes, such as urbanisation and labour reform movements.

Pedagogy: Fish and Bone
Description: A method that breaks down complex topics into main ideas (the fish) and supporting details (the bones). This visual approach enhances comprehension by highlighting essential concepts and their relevant explanations.
Example: During a Biology class on human anatomy, the teacher uses the fish and bone technique to teach about the human skeletal system. Teacher presents the main components of the human skeleton (fish) and elaborates on each bone's structure and function (bones).

Pedagogy: Concept Mapping
Description: An effective way to visually represent relationships between ideas. Learners create diagrams connecting key concepts, aiding in understanding the overall structure of a subject and fostering retention.
Example: In a Psychology assignment, students use concept mapping to explore the various theories of personality. They interlink different theories, such as Freud's psychoanalysis, Jung's analytical psychology, and Bandura's social-cognitive theory, to see how they relate to each other.

Pedagogy: Audio Visual Resources
Description: Incorporating multimedia elements like videos, images, and audio into lessons. This approach caters to different learning styles, making educational content more engaging and memorable.
Example: In a General Science class, the teacher uses a documentary-style video to teach about the solar system. The video includes stunning visual animations of the planets, interviews with astronomers, and background music, enhancing students' interest and understanding of space.

Pedagogy: Think, Pair, and Share
Description: A collaborative learning technique where students ponder a question or problem individually, then discuss their thoughts in pairs or small groups before sharing with the entire class. It fosters active participation, communication skills, and diverse perspectives.
Example: In a Literature in English class, the teacher poses a thought-provoking question about a novel's moral dilemma. Students first reflect individually, then pair up to exchange their opinions, and finally participate in a lively class discussion to explore different viewpoints.

Pedagogy: Questioning Technique (Socratic Approach)
Description: Based on Socratic dialogue, this method stimulates critical thinking by posing thought-provoking questions. It encourages learners to explore ideas, justify their reasoning, and discover knowledge through a process of inquiry.
Example: In an Ethics class, the instructor uses the Socratic approach to lead a discussion on the meaning of justice. By asking a series of probing questions, the students engage in a deeper exploration of ethical principles and societal values.

Pedagogy: Practical Demonstration
Description: A hands-on approach where learners observe real-life applications of theories or skills. Practical demonstrations enhance comprehension, skill acquisition, and problem-solving abilities by bridging theoretical concepts with real-world scenarios.
Example: In a Food and Nutrition class, the instructor demonstrates the proper technique for filleting a fish. Students observe and then practice the skill themselves, learning the practical application of knife skills and culinary precision.

(**Note:** The examples provided in this annexure serve as illustrations of various pedagogies. It is important to understand that these pedagogies are versatile and can be applied across subjects in numerous ways. Feel free to adapt and explore these techniques creatively to enhance learning outcomes in your specific context.)

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Additionally, we express our gratitude to the esteemed team of reviewers for their constructive feedback on overall performance, better and weaker responses, and validating teaching pedagogies along with suggestions for improvement.

These contributors include:

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- Dr Shehzad Jeeva, CEO, AKU-EB