basic education
Department:
Basic Education
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QUALITATIVE ANALYSIS OF LEARNER RESPONSES
AND
EVALUATION OF THE QUESTION PAPERS (PER PAPER)
NATIONAL SENIOR CERTIFICATE 2025
WESTERN CAPE EDUCATION DEPARTMENT

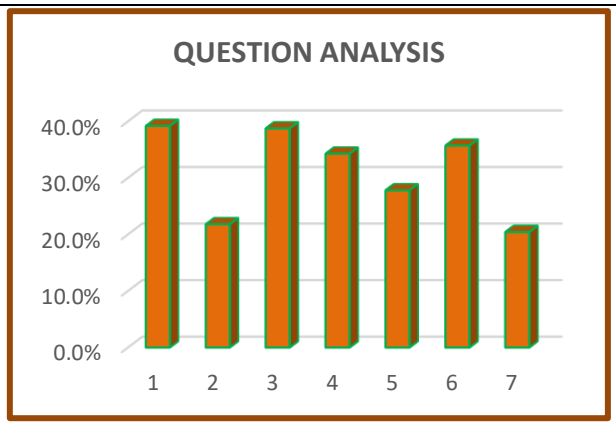
SUBJECT	**ELECTRICAL TECHNOLOGY (POWER SYSTEMS)**		
QUESTION PAPER	**1**	**2**	**3**
DURATION OF PAPER	**3 HOURS**		
INTERNAL MODERATOR	**WEN JOSEPH**		
CHIEF MARKER	**G CONRADIE**		
DATES OF MARKING	**FROM: 29 NOVEMBER 2025**	**TO: 10 DECEMBER 2025**	
HEAD OF EXAMINATION	**MS LM BREDENKAMP**		

REPORT 2: QUALITATIVE ANALYSIS OF LEARNER RESPONSES

SECTION 1: ***(GENERAL OVERVIEW OF LEARNER PERFORMANCE IN THE QUESTION PAPER AS A WHOLE)***

Analysis of the 100 random scripts from the cohort total of 388 shows the following statistical indicators:

QUESTION NUMBER	1	2	3	4	5	6	7	PAPER
TOTAL	15	10	35	35	30	35	40	200
SUM	588	218	1356	1200	834	1250	817	6263
AVERAGE %	39.2%	21.8%	38.7%	34.3%	27.8%	35.7%	20.4%	**31,3%**
AVERAGE MARK	5.9	2.2	13.6	12.0	8.3	12.5	8.2	62.6
RANGE	13	6	34	30	27	34	34	154
RANGE %	86.7%	60.0%	97.1%	85.7%	90.0%	97.1%	85.0%	77.0%
MEDIAN	5	2	11	12	8	10.5	6	52
MEDIAN %	33.3%	20.0%	31.4%	34.3%	26.7%	30.0%	15.0%	**26.0%**
STANDARD DEVIATION	2.8	1.7	9.0	7.8	6.6	8.5	7.6	39.2



CODE DISTRIBUTION		
Code	**Range**	**Number**
7	≥90%	0
7	80% - 89%	1
6	70% - 79%	4
5	60% - 69%	6
4	50% - 59%	8
3	40% - 49%	14
2	30% - 39%	13
1	20% - 29%	17
1	0% - 19%	37
	TOTAL	**100**

Analysis of the 100 learner scripts shows that **overall performance in the 2025 Power Systems question paper was low**, with most learners unable to achieve the expected level of competence across Lower Order, application (Medium Order), and Higher-Order questions.

1. Overall Performance Levels

- **Mean (average) score: approximately 33%**
- **Median score: approximately 27%**
- **Majority of learners (≈ 52%) scored below 30%**
- **Only a very small proportion achieved marks above 60%**

These indicators show that general performance was **well below the expected pass threshold**.

2. Distribution of Performance Across Questions

Performance varied across the seven questions, with consistent patterns:

2.1 Lower-order questions (Q1 and Q2)

- **Q1 (Multiple Choice):** Average performance was weak.
- **Q2 (OHS):** Performance was very low.

These questions typically test basic factual knowledge and comprehension.

Scores in these sections indicate that many learners **lacked foundational content mastery**.

2.2 Application-level questions (Q3–Q6)

Learners struggled with the application of concepts to calculations and diagrams.

Observed patterns:

- Many responses showed incorrect formula selection, incorrect substitution or units.
- Several learners left multi-step questions incomplete.
- Few learners gained method marks consistently across these questions.

Relative performance (approximate):

- **Q3 (RLC Circuits):** Moderate but below expected levels.
- **Q4 (Three-Phase Systems):** Low, with wide variation between learners.
- **Q5 (Transformers):** Among the lowest application-level performances.
- **Q6 (Motors):** Slightly better than Q5, but still weak overall.

Across these questions, many learners achieved **less than one-third of the available marks**.

2.3 Higher-order question (Q7: PLC & VSD)

Performance in Q7 was **consistently the weakest** of all sections.

- Many learners achieved **very low marks (0–6 out of 40)**.
- Ladder logic questions were often not attempted or incorrectly structured.
- PWM interpretation questions showed widespread misunderstanding of duty cycle effects.

This question acted as a **major discriminator**, but for most learners, it resulted in minimal mark accumulation.

3. Patterns of Misunderstanding Across Questions

Common patterns observed across the scripts include:

- Difficulty interpreting diagrams and circuit behaviour.
- Errors in converting between line and phase quantities in three-phase systems.
- Weak understanding of transformer losses and efficiency.
- Incorrect or incomplete calculations of slip, torque, and synchronous speed.
- Fragmented or incorrect PLC ladder logic sequencing.

These patterns occurred at scale across the sample.

4. Attempts vs Non-Attempts

- Most learners attempted all questions, indicating **no major time-management barrier**.
- However, attempts were often incomplete or incorrect, showing **lack of content mastery rather than time constraint issues**.
- Non-attempts were most common in Q7 (both PLC and VSD components).

5. Overall Summary

Based on the 100 scripts:

- Learner performance across the question paper was **generally weak**.
- Foundational knowledge (Q1–Q2) was **below expected levels**.
- Application-level performance (Q3–Q6) showed **major conceptual gaps**.

- Higher-order reasoning (Q7) was **significantly below standard**.
- The majority of learners did not meet the expected Grade 12 competency level in Power Systems.
- Very few learners demonstrated strong conceptual or procedural mastery.

Conclusion (Factual)

The sample of 100 scripts clearly demonstrates **low overall achievement** on the 2025 Power Systems question paper, with consistent weaknesses across foundational, application, and higher-order questions. The distribution of marks and the pattern of errors indicate that most learners were **not adequately prepared** for the cognitive and technical demands of the examination.

SECTION 2: *COMMENT ON CANDIDATES' PERFORMANCE IN INDIVIDUAL QUESTIONS*

(It is expected that a comment will be provided for each question)

QUESTION 1

(a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered?

Learner performance in Question 1 was **generally poor**.
Although Q1 consisted of **lower-order multiple-choice questions**, which typically assess basic recall and understanding, the majority of learners in the sample did not achieve high marks.

Performance patterns indicate that many learners lacked foundational knowledge across several Grade 10–12 content areas. The question did **not function as the "easy access" section** it is designed to be in NSC papers.

(b) Why was the question answered poorly? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions.

1. Weak foundational content knowledge

Many learners selected distractors that reflected confusion with basic definitions, such as:

- Incorrect identification of components
- Misinterpretation of simple AC circuit behaviour
- Confusion between power factor, resistance, and impedance
- Misunderstanding of safety terminology

This suggests insufficient mastery of fundamental concepts taught in earlier grades.

2. Guessing rather than reasoning

Patterns in the data show:

- Large clusters of identical wrong answers
- Repeated selection of the first or last option regardless of question meaning

This suggests that a high proportion of learners were guessing due to lack of knowledge.

3. Misconceptions that appeared repeatedly

Common misconceptions reflected in wrong choices include:

- Confusion between **line** and **phase** quantities
- Incorrect assumptions about the function of **fuses, contactors, and overload relays**
- Misunderstanding AC terms such as **frequency**, **reactance**, and **impedance**
- Incorrect associations between **leading/lagging power factor** and circuit types

These same misconceptions appear later in Q3 and Q4, indicating that poor performance in Q1 is part of a **broader conceptual weakness**.

4. Poor reading and interpretation skills

Some incorrect answers reflected:

- Misreading of question stems
- Failure to identify units
- Confusing symbols (e.g., Ω, H, F, V, A)

These errors suggest inadequate exam technique training.

5. Limited exposure to past exam papers

Learners were unfamiliar with typical NSC-style multiple-choice formats.

This was evident from:

- Selecting distractors that experienced learners usually avoid
- Failing to eliminate impossible options
- Not recognising standard definitions used in past papers

(c) Provide suggestions for improvement in relation to Teaching and Learning.

1. Strengthen foundational knowledge in Grades 10–12

Teachers should:

- Frequently revise core definitions and symbols
- Use quick quizzes throughout the term
- Reinforce conceptual understanding before calculations

Foundation gaps must be addressed early.

2. Incorporate regular multiple-choice practice

Teachers should integrate MCQ practice aligned with NSC style, such as:

- Using previous exam papers
- Quick MCQ warm-up activities
- Distractor analysis to teach reasoning

Learners must be taught to **eliminate options** rather than guess blindly.

3. Address common misconceptions explicitly

Teachers should plan lessons that target recurring errors, such as:

- Relationship between line and phase values
- Differences between P, Q, and S
- Basic circuit components and their functions

- Power factor implications in RLC circuits

Misconceptions should be corrected using diagrams and practical examples.

4. Improve exam technique

Learners should be taught:

- How to read technical questions carefully
- How to interpret symbols and units
- Strategies for tackling MCQ questions methodically

5. Integrate practical demonstrations

Use workshop examples to reinforce theoretical definitions.

Learners understand better when they **see, touch, or measure** components.

(d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc.

1. Q1 performance strongly correlates with poor performance in the rest of the paper

The learners who performed poorly in Q1 generally performed poorly across Q2–Q7.

This shows that foundational content gaps persist throughout the exam.

2. Centres with novice or unqualified teachers showed the weakest Q1 performance

This suggests that early-year conceptual teaching was inconsistent or incomplete.

3. Moderation and classroom monitoring should prioritise foundational knowledge

The poor performance in Q1 signals the need for:

- Stronger emphasis on Grades 10 and 11 concepts
- More consistent progression of core content
- Better pacing and early syllabus completion

QUESTION 2

(a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered?

Learner performance in Question 2 was **poor overall**.

Despite being a low-order, theory-based question requiring **basic recall** of safety principles and legal responsibilities, the majority of learners did not achieve satisfactory marks.

The average score for Q2 in the sample was **significantly below expected levels** for this section, which traditionally serves as an accessible part of the paper.

This indicates **limited understanding of fundamental OHS concepts**, which should normally be mastered by all learners by Grade 12.

Learners did not read the questions with comprehension and answered after simply scanning with what the think the answer was about instead of the intention stated.

(b) Why was the question answered poorly? Also provide specific examples, indicate common

errors committed by learners in this question, and any misconceptions.

1. Weak recall of basic OHSA definitions

Many learners failed to:

- Define essential safety terms – Dangerous practices, Critical incident, accident
- Explain basic electrical safety practices – Electrocution precautionary measures.

Answers were often vague, unrelated to the question, or contained no safety terminology.

2. Confusion between OHSA and general workshop rules

Many responses reflected **generic school rule knowledge**, for example:

- "Don't run in the workshop"
- "No eating allowed"

These are *not* OHS principles and show a lack of understanding of **legal safety requirements**.

3. Incorrect or irrelevant examples

Learners frequently provided answers unrelated to electrical safety legislation, such as:

- "Wipe spills to avoid slipping"

While these are safety actions, they are not aligned with what the question required under the Occupational Health and Safety Act.

5. Very short or incomplete responses

Several learners wrote one-word answers such as:

- "Gloves"
- "Helmet"
- "Safety"

These did not meet the requirement for explanation or justification.

6. Lack of specific terminology

Answers lacked key terms such as:

- Hazard
- Risk

This suggests insufficient vocabulary instruction in safety-related topics

(c) Provide suggestions for improvement in relation to Teaching and Learning.

1. Integrate OHS content throughout the year

Safety should be taught:

- At the beginning of each practical session
- During theory lessons
- As part of PAT assessments
- Using real-life examples

Learners build stronger understanding when OHSA is **contextualised**, not memorised.

2. Use scenario-based teaching

Teachers can provide classroom scenarios such as:

- Unsafe tool usage
- Incorrect PPE
- Faulty equipment situations
- Unauthorized operation of machinery

Learners should identify the risk, the hazard, and the correct OHSA control measure.

3. Reinforce vocabulary and short written explanations

Teachers should practice:

- Definitions
- Short structured answers
- Two-mark explanations

This improves clarity and avoids one-word answers.

4. Use posters, safety signage, and workshop walkabouts

Visual reinforcement helps learners recall:

- PPE types
- Hazard symbols
- Electrical danger signs
- Emergency procedures

5. Include OHSA questions in class tests and term assessments

Frequent exposure will help learners become comfortable with safety terminology.

(d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc.

1. Centres with poor Q2 performance often had limited practical integration

Where teachers did not run regular practicals or simulations, learners lacked real-world context for OHSA principles.

2. Many teachers may not be reinforcing workshop safety as a formal, examinable topic

Subject advisors should emphasise that OHS content is **not optional**, and appears annually in Power Systems papers.

3. Teacher development should include training on legal safety requirements

Many educators, especially novice or unqualified teachers, may be unfamiliar with:

- The Occupational Health and Safety Act
- Electrical safety regulations

Professional development is needed to ensure teachers can confidently teach OHSA.

4. Learners rely heavily on memorisation instead of understanding

This shows the need for practical demonstrations of:

- Correct PPE usage
- Safe equipment operation

QUESTION 3

(a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered?

Learner performance in Question 3 was **below the expected level** for a Grade 12 Power Systems cohort.

Although some candidates were able to obtain marks in the straightforward calculation items, the majority struggled with:

- Resonance concepts
- Reactance changes
- Phasor diagram interpretation
- Q-factor and bandwidth determination
- Multi-step calculations requiring correct sequencing

Overall, performance was **moderate to weak**, with many learners achieving **only 8–15 out of 35 marks** on average.

(b) Why was the question answered poorly? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions.

1. Incorrect or inconsistent use of formulas

Frequent errors included:

- Selecting incorrect formulas from the formula sheet
- Picking a likely formula instead of one that corresponds to the question

These incorrect formulas led to early errors that affected multiple subsequent answers.

2. Misunderstanding of resonance

Many learners showed conceptual gaps, such as:

- Not having a conceptual understanding about the meaning of resonance
- Not knowing that $X_L = X_C$at resonance
- Not distinguishing between parallel and series RLC circuits

These misconceptions led to incorrect explanations and diagram errors.

3. Difficulty interpreting and drawing phasor diagrams

Common errors observed:

- Incorrect orientation of V_R, V_L, and V_C
- Not drawing phasors as vectors
- Mixing up magnitude and phase angle

Many diagrams lacked structure, resulting in 0 marks for the drawing component.

4. Incorrect calculation of supply voltage

Learners often:

- Added voltages arithmetically instead of using Pythagoras
- Calculated total voltage using $V_T = V_R + V_L + V_C$
- Confused voltage drops with reactance values

This indicates a misunderstanding of **phasor relationships**.

5. Confusion between frequency, reactance, and impedance

Many learners did not understand:

- How reactance changes with frequency
- Why current changes after resonance
- The relationship between Q-factor and bandwidth
- Incorrect identification of frequency axis unit (Hz instead of kHz)

This resulted in incorrect explanations and 0–1 mark responses.

6. Not showing working or skipping steps

Where learners did not show:

- Formulas
- Substitution
- Units
- Intermediate values

they lost method marks unnecessarily.

7. Calculator errors

Common issues:

- Incorrect rounding
- Wrong order of operations
- Using degrees instead of radians
- Inability to use a scientific calculator

Although minor, these errors accumulated across multi-step questions.

(c) Provide suggestions for improvement in relation to Teaching and Learning.

1. Use practical demonstrations to illustrate RLC behaviour

Teachers should use:

- Simulation tools (e.g., PhET, EveryCircuit, Multisim)
- Real RLC circuits with function generators and oscilloscopes

This will help learners visualise:

- Phase relationships
- Resonance
- Voltage magnification
- Current changes

2. Strengthen formula understanding through repeated practice

Learners need structured practice in:

- Calculating X_L, X_C, Z, I, and V
- Using correct phasor formula relationships
- Recognising formulas from question context

Teachers should emphasise **why** formulas work, not only how to apply them.

3. Step-by-step teaching of phasor diagrams

Teachers should:

- Demonstrate phasor drawing
- Reinforce orientation and magnitude
- Use colour coding for R, L, and C components
- Teach angle calculation and interpretation

Phasor understanding should be built gradually.

4. Explicit teaching of resonance concepts

Key points:

- $X_L = X_C$ at resonance
- Impedance is minimum
- Current is maximum
- Phase angle becomes zero

Learners should practice recognising and explaining resonance without formula dependence.

5. Reinforce the link between frequency and reactance

Teachers must explicitly show learners how:

- Increasing frequency increases X_L
- Increasing frequency decreases X_C
- Resonance shifts system behaviour

This concept is central to Grade 12 Power Systems.

6. Encourage step-by-step working

Emphasise:

- Writing definitions
- Showing formulas
- Substituting correctly
- Including units

This secures method marks even if final answers are incorrect.

(d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc.

1. High variability suggests inconsistent teaching across centres

Some learners scored well in Q3, while many scored very low.

This indicates uneven content delivery rather than paper difficulty.

2. Candidates lacked confidence in multi-step reasoning

Learners often stopped mid-calculation or left diagrams incomplete.

This suggests insufficient exposure to complex circuit analysis in class.

3. Teachers may need support in teaching RLC phasor relationships

Errors in phasor interpretation were widespread across centres.

Teacher development should focus on:

- Vector drawing
- Phase angle interpretation
- Practical demonstration of AC quantities

4. Weak resonance knowledge persists across the province

This aligns with national trends and indicates the need for targeted interventions.

QUESTION 4

(a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered?

Learner performance in Question 4 was **generally weak**, with most candidates achieving **well below 50%** of the available marks.

Although Three-Phase Systems is a core Grade 12 content area, many learners demonstrated:

- Difficulty applying formulas
- Confusion between line and phase values
- Weak conceptual understanding of power and power factor
- Incomplete or incorrect interpretation of diagrams

A small number of learners performed reasonably well, but the overall trend was **poor performance** with limited evidence of strong conceptual mastery.

(b) Why was the question answered poorly? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions.

1. Confusion between line values and phase values

This was the **most common error** across all scripts.

Typical incorrect patterns observed:

- Using line voltage in place of phase voltage in Δ systems
- Dividing instead of multiplying by √3 (or vice versa)
- Treating line and phase currents as identical in Y-connected loads
- Applying line formulas to phase diagrams

This indicates a **fundamental misunderstanding** of three-phase relationships.

2. Incorrect application of three-phase power formulas

Many learners incorrectly applied:

- $P = \sqrt{3}V_L I_L \cos\phi$
- $Q = \sqrt{3}V_L I_L \sin\phi$
- $S = \sqrt{3}V_L I_L$

Common errors included:

- Omitting √3 entirely
- Using phase quantities in formulae requiring line quantities
- Incorrect or missing substitution
- Using wrong units (VA vs VAR vs W)

3. Misinterpretation of the wattmeter diagram

A significant number of learners misinterpreted:

- The correct placement of coils

Incorrect assumptions about the wattmeter often resulted in a **complete loss of marks** on the reasoning portion.

4. Difficulty calculating or interpreting power factor

Learners showed limited understanding of:

- The meaning of lagging vs leading
- The relationship between real, apparent, and reactive power
- How PF affects power calculations
- Using $\cos\phi = \frac{P}{S}$

5. Errors with efficiency calculations

Frequent problems included:

- Mixing output power and input power
- Incorrectly handling losses
- Using incorrect formulas for efficiency
- Confusing mechanical and electrical power quantities

Where efficiency appeared in Q4, learners tended to score poorly.

6. Algebraic and calculator errors

Patterns included:

- Incorrect square root operations
- Misplacing decimal points
- Incorrect rounding
- Inability to use correct prefixes

These compounded early mistakes and resulted in incorrect totals.

7. Lack of working steps

Some learners wrote only final answers without:

- Showing formulas
- Substituting values
- Including units

This reduced opportunities to earn method marks.

(c) Provide suggestions for improvement in relation to Teaching and Learning.

1. Reinforce foundational three-phase concepts

Teachers should explicitly teach:

- Differences between line and phase values
- Y vs Δ configurations
- How voltage and current behave in each system
- How to choose the correct formula based on connection type

These basics must be mastered before introducing more complex calculations.

2. Use diagrams to teach line-phase relationships

Teachers should use:

- Colour-coded phasor diagrams
- Annotated Y and Δ circuit diagrams
- Visual demonstrations of $\sqrt{3}$ relationships

Learners respond well to visual explanations of abstract concepts.

3. Incorporate practical measurement activities

Use of:

- Two-wattmeter method demonstrations
- Clamp meters for current measurement
- Simulation software for three-phase power flow

Practical reinforcement improves conceptual understanding significantly.

4. Build fluency with power triangles

Learners need structured practice in:

- Drawing power triangles
- Identifying P, Q, S
- Using trigonometric relationships
- Explaining power factor

This supports deeper understanding of real-world three-phase behaviour.

5. Step-by-step problem-solving templates

Teachers should train learners to:

- Identify the system type (Y or Δ)
- Convert between line and phase values

- Select the correct formula
- Substitute correctly
- Show clear working

This improves both accuracy and marking outcomes.

(d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc.

1. Centres with stronger Q4 performance often had experienced teachers

This suggests that novice and unqualified teachers may lack confidence in teaching three-phase content.

2. Learners were unfamiliar with wattmeter behaviour

This indicates insufficient practical exposure or demonstration in workshops.

3. Confusion between power factor correction and general PF concepts was widespread

Teacher development should include training on:

- Inductive vs capacitive loads
- Leading vs lagging PF
- Common real-world examples

4. Errors in Q4 often reappeared in Q5 and Q6

This shows foundational weaknesses in AC theory that extend across multiple Grade 12 topics.

QUESTION 5

(a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered?

Learner performance in Question 5 was **weak**, with the majority of candidates scoring well below half of the available marks.

Although transformers are a central component of the Grade 12 Power Systems curriculum—and typically an accessible application question—learners in the sample struggled significantly with:

- Turns ratio calculations
- Current and voltage relationships
- Transformer losses
- Efficiency calculations
- Conceptual explanations (e.g., purpose of laminations, flux behaviour)

Overall, performance suggests **inadequate conceptual understanding and limited practice** with transformer-based problems.

(b) Why was the question answered poorly? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions.

1. Incorrect use of turns ratio formulas

Many learners confused the relationships between:

- Voltage ratio

- Turns ratio
- Current ratio

Typical incorrect answers included:

- Using $\frac{V_p}{V_s} = \frac{I_p}{I_s}$ instead of $\frac{V_p}{V_s} = \frac{N_p}{N_s} = \frac{I_s}{I_p}$
- Swapping primary and secondary quantities
- Mixing units (e.g., treating V and t as interchangeable)

This resulted in early errors that carried through the rest of the question.

2. Poor understanding of transformer concepts

- Mutual inductance
- Reason for using an iron core
- Cooling methods

Frequent errors observed:

- Incorrectly interpreting a percentage loss vs a value in watts

3. Incorrect efficiency calculations

Efficiency was a major stumbling block.

Common issues included:

- Using the wrong formula (e.g., $\eta = \frac{P_{\text{loss}}}{P_{\text{in}}} \times 100$)
- Not distinguishing input and output power
- Forgetting to subtract losses
- Using VA instead of W for efficiency calculations
- Omitting percentage symbol

Learners showed general unfamiliarity with efficiency contexts.

4. Incorrect conceptual explanations

Open-ended transformer questions showed weak responses.

Examples of typical incorrect explanations:

- "Laminations cool the transformer."
- "Laminations increase current flow."
- "Flux always stays the same in both coils because the coils are equal."

These reflect gaps in understanding magnetic flux linkage, eddy current reduction, and core structure.

5. Not showing working or writing incomplete answers

A number of learners wrote only:

- A final answer without steps
- Incorrect units
- Partial calculations without clear logic

This cost them method marks available for substitution and formula writing.

6. Calculator and arithmetic errors

Learners often made:

- Incorrect ratios
- Decimal errors
- Incorrect square root or multiplication steps

While individually small, these errors accumulated across multi-step problems.

(c) Provide suggestions for improvement in relation to Teaching and Learning.

1. Reinforce transformer fundamentals with hands-on demonstrations

Learners benefit from seeing:

- Primary and secondary coils
- Open vs short circuit tests
- Effect of changing load
- Visualisation of flux paths

Workshop demonstrations improve conceptual understanding dramatically.

2. Teach and practice the three transformer ratios repeatedly

Learners should master:

1. $\frac{V_p}{V_s} = \frac{N_p}{N_s}$
2. $\frac{I_s}{I_p} = \frac{V_p}{V_s}$
3. The relationship between power, voltage, and current

Teachers should emphasise consistent formula selection.

3. Use structured examples for efficiency

Provide learners with:

- Clear steps for calculating input and output power
- Tables showing values before applying the formula
- Practice with typical loss values

This reduces confusion and builds confidence.

4. Teach losses conceptually, not as memorised lists

Practicals and simulations can demonstrate:

- Eddy currents using magnets and aluminium plates
- Hysteresis using B-H curves
- Heat generation in resistive materials

These improve the quality of explanations.

5. Provide scaffolds for multi-step transformer calculations

A recommended approach:

1. Identify known values
2. Determine whether step-up or step-down
3. Select the correct formula

4. Substitute and calculate
5. Apply losses
6. Calculate efficiency

This helps learners produce structured, logical responses.

(d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc.

1. Transformer misconceptions were widespread across centres

This suggests systemic issues in teaching this content area rather than isolated learner weaknesses.

2. Learners showed limited exposure to past NSC transformer questions

Repeated errors mirror unfamiliarity with NSC-style problem-solving.

3. Teachers may require additional training in transformer losses & efficiency

Many novice or unqualified teachers struggle with:

- Iron vs copper loss differentiation
- How losses impact efficiency
- How to teach transformer theory conceptually

Subject advisors should prioritise this in professional development workshops.

4. Weak understanding in Q5 correlates with poor performance in Q3 and Q4

This shows a deeper misunderstanding of AC principles that cuts across the Grade 12 syllabus.

QUESTION 6

(a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered?

Learner performance in Question 6 was **generally poor to moderate**, with most learners achieving **low marks**. While some candidates showed basic understanding of synchronous speed and slip calculations, the overall performance was **below expected Grade 12 levels**.

Key weaknesses appeared in:

- Slip and synchronous speed calculations
- Torque–speed curve interpretation
- Starter circuit understanding
- Conceptual explanations related to motor behaviour

Few learners achieved high marks on this question.

(b) Why was the question answered poorly? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions.

1. Poor understanding of the torque–speed curve

Many learners:

- Misinterpreted the curve
- Incorrectly identified maximum torque
- Could not describe the shape of the curve or operating region
- Failed to explain speed behaviour under changing load

This indicates insufficient exposure to **graph interpretation** and real motor characteristics.

2. Confusion about starter circuits (DOL, Star–Delta)

Learners frequently:

- Confused the purpose of Star–Delta vs DOL
- Incorrectly described the function of contactors and OL relays
- Mistook the sequence of coil operation

This suggests weak practical integration and limited exposure to real starter panels.

3. Incomplete calculations / no working shown

Learners often:

- Wrote final answers only
- Omitted units
- Did not substitute values clearly

This reduced their ability to earn method marks.

4. Weakness in AC theory carried over from earlier questions

Poor performance in Q3 and Q4 correlated with similar misunderstandings in:

- Frequency relationships
- Phasor interpretation
- Power and speed relationships

This shows systemic conceptual gaps rather than isolated errors.

(c) Provide suggestions for improvement in relation to Teaching and Learning.

1. Teach motor speed and slip using practical demonstrations

Learners benefit from observing:

- No-load vs loaded motor speed
- Slip changes on real motors
- Starting current using clamp meters
- Star–Delta starting sequences

Real-world demonstration reduces abstract confusion.

2. Reinforce the procedures for motor speed calculations

Teachers should emphasise:

1. Identify frequency
2. Identify number of poles
3. Calculate synchronous speed

4. Calculate slip
5. Apply slip to determine rotor speed

Structured steps reduce algebraic mistakes.

3. Strengthen understanding of motor starter circuits

Teaching should include:

- Practical exposure to DOL and Star–Delta panels
- Explanation of the role of contactors, timers, and overloads
- Sequence diagrams for starting and running conditions

Videos or simulations can be used where physical panels are unavailable.

4. Develop graph interpretation skills

Learners need practice reading:

- Torque–speed curves
- Current–speed graphs
- Load vs speed relationships

Teachers should use guided exercises to explain key features of these graphs.

5. Emphasise conceptual explanations over memorisation

Lessons should focus on:

- Why starting current is high
- Why slip increases with load
- Why torque decreases as speed approaches synchronous speed

Conceptual mastery leads to more accurate exam responses.

6. Increase practice with contextual questions

Use more NSC-style questions that require:

- Linking slip, speed, and torque
- Describing behaviour during load changes
- Explaining starter circuit operation

(d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc.

1. Learners lack familiarity with real motor starter equipment

This limits understanding of function and sequence.

Centres should be encouraged to integrate workshop demonstrations more frequently.

2. Conceptual errors were consistent across centres

This suggests that **novice and unqualified teachers** may be uncertain about teaching induction motor theory.

3. Weak performance in Q6 is strongly correlated with poor performance in Q7

Both require reasoning about industrial electrical systems.

This indicates a broader issue with **higher-order practical reasoning**.

4. Teacher development should prioritise motor theory and starter circuits

Training should cover:

- Induction motor fundamentals
- Slip and torque principles
- Real starter wiring
- Safety and troubleshooting

QUESTION 7

(a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered?

Learner performance in Question 7 was **very poor overall**.

This question carries **40 marks**, with both conceptual and higher-order components, yet most candidates scored **well below 10–15 marks**.

Key observations:

- Many learners left sections of Q7 blank.
- Ladder logic construction was frequently incorrect or incomplete.
- VSD PWM interpretation showed widespread misconceptions.
- Very few candidates demonstrated the reasoning skills required for synthesis-level tasks.

This was **the weakest-performing question** in the paper for the 2025 cohort.

(b) Why was the question answered poorly? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions.

1. Inability to construct ladder logic diagrams

Frequent issues included:

- Incorrect placement of NO/NC contacts
- Wrong sequencing or missing steps
- forgetting to include latching/seal-in circuits where required
- Incorrect or missing output coil connections
- Using symbols inconsistent with standard PLC notation
- Reversing input and output functions

This indicates **limited exposure to PLC programming** and very weak practical integration.

2. Confusion between inputs, outputs, sensors, and actuators

Common errors:

- Misinterpreting start/stop pushbuttons

These errors show fundamental misunderstandings of a PLC's basic structure.

3. Minimal understanding of sequence control

Learners struggled with:

- Multi-step operation sequences
- Conditional logic (AND/OR)
- Timer activation and delay functions
- Interlocking and safety logic

Most responses resembled random arrangements of contacts rather than structured logic.

4. Weak conceptual understanding of VSD PWM control

Widespread incorrect answers included:

- Stating that longer ON-time *increases* frequency
- Believing duty cycle controls voltage only, not speed
- Assuming PWM works the same as mechanical speed control
- Thinking shorter ON-time produces higher torque

These misconceptions led to very low marks.

5. Very limited exposure to industrial control systems

Patterns seen in learner responses suggest:

- Little to no hands-on PLC practice
- Insufficient simulation exposure
- Limited workshop demonstrations
- Weak integration of practical and theory lessons

Learners appeared unfamiliar with real-world automation concepts.

6. Lack of structured working and explanation

Many responses were:

- Very short
- Missing explanations
- Missing diagrams
- Missing line numbers or rungs
- Missing labels

This greatly reduced opportunities for partial credit.

(c) Provide suggestions for improvement in relation to Teaching and Learning.

1. Increase practical PLC instruction

Teachers should use:

- Real PLCs where available
- Simulation software (e.g., EasySoft)
- Trainer boards for input/output demonstration
- Step-by-step programming exercises

Practical engagement builds confidence and conceptual accuracy.

2. Teach ladder logic using a scaffolded approach

Suggested sequence:

1. Basic logic gates
2. Simple start/stop circuits
3. Latching circuits
4. Interlocking
5. Timers and counters
6. Full system sequences

This progressive method ensures learners understand each component before integrating them.

3. Provide templates and structured examples

Teachers should give learners:

- Blank ladder templates
- Symbol banks
- Example sequences with commentary
- Multi-step rung-building exercises

This improves layout, symbol use, and logical structuring.

4. Reinforce the relationship between frequency, duty cycle, and speed

Teachers should explicitly explain:

- VSD controls speed by varying frequency
- PWM duty cycle influences output frequency
- Longer ON-time reduces output frequency
- Motor speed is proportional to frequency

Demonstrations using oscilloscope or simulation tools greatly improve understanding.

(d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc.

1. Q7 performance was the lowest across all centres

This indicates a **systemic teaching challenge** rather than isolated gaps.

2. Centres with experienced teachers performed better

Learners who had teachers confident in PLC and VSD content performed noticeably higher.

This highlights the need for targeted teacher development in industrial automation.

3. Many teachers did not integrate PLC or VSD content into workshop practice

This resulted in learners having theoretical exposure only, with minimal real-world reinforcement.

4. VSD concepts remain one of the most challenging areas province-wide

Learners consistently show:

- Weak understanding of frequency control
- Confusion about PWM
- Little exposure to industrial drives

Teacher support in this area is essential.

5. Q7 exposed higher-order thinking deficits

Learners demonstrated difficulty with:

- Sequencing
- Interpretation
- Synthesis
- Logic construction
- Problem solving

These are skills developed over time and require consistent practice.