P425/1
PRINCIPAL
MATHEMATICS
Paper 1
Nov./Dec. 2026
3 hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

PRINCIPAL MATHEMATICS

Paper 1

3 hours

INSTRUCTIONS TO CANDIDATES:

This examination paper consists of **two** *sections;* **A** *and* **B**. *It has* **five** *items*.

Section **A** *consists of one* **compulsory** *item.*

Section **B** *has two parts*; **I** *and* **II**, *each with two optional items. Respond to only* **two** *items from Section* **B**, *choosing* **one** *item from* **each** *of the parts*.

Respond to **three** *items* **in all**.

Any additional item(s) responded to will **not** *be scored.*

Begin **each** *item or part of an item on a* **fresh** *page.*

All *necessary working* **must** *be shown clearly.*

Graph paper is provided.

Silent, non-programmable scientific calculators and mathematical tables with a list of formulae may be used.

© 2026 Uganda National Examinations Board

CamScanner

SECTION A

This section is **compulsory**.

Item 1

As part of the expansion of a Transmission Line, Uganda Electricity Transmission Company Limited (UETCL) is testing an automated inspection system that uses drones to monitor transmission towers and conductors. Before the system is commissioned, engineers must verify that the proposed inspection routes, antenna alignment and surveillance radar coverage satisfy the Engineering Design requirements.

Two autonomous drones are launched from separate maintenance stations. The first drone travels along the route joining A(3, 5, 7) and B(4, 7, 8). The second drone travels along the route joining C(1, 2, 3) and D(3, 5, 8). A weather-monitoring sensor is located at S(7, 5, 2).

Engineering Design standards require;

I. the two inspection routes to intersect so that inspection data can be exchanged automatically,

II. the weather-monitoring sensor to lie within a maximum distance of **5.5 units** from the first inspection route to allow direct communication without installing an additional maintenance station.

After the drones exchange inspection data, the communication antenna must be rotated and adjusted to the smallest positive angle satisfying the relationship; $10\sin 2\theta + 5 = 16\sin\theta + 5\cos^2\theta$.
The surveillance radar produces an elliptical coverage region represented by $\frac{x^2}{225} + \frac{y^2}{144} = 1$.

The inspection controller needs to establish the position of the directrices to define the operational limits to be used by engineers during system calibration.

Task:

(a) Assess whether the proposed drone flight routes satisfy the Engineering Design requirements.

(b) Propose the most appropriate antenna orientation required for reliable communication.

(c) Define the operational limits to be used by engineers during system calibration.

(d) Prepare a recommendation to the UETCL, with justifications, indicating whether the tested inspection system should be approved.

CamScanner

SECTION B

Part I

Respond to only **one** *item from this part.*

Item 2

The Government of Uganda is constructing a National Emergency Operations Centre to coordinate disaster response during floods, landslides, disease outbreaks and other national emergencies.

The centre will have an emergency communication system that uses digital radio equipment.

During the final equipment test, one outgoing signal is represented by $Z = -8 + 8\sqrt{3}i$. As part of the encryption process, the communication software applies four identical processing cycles, which together are equivalent to raising the outgoing signal to the **fourth power**.

Before the software is installed, engineers must verify the final signal produced by the processing unit.

Inside the operations centre, a computer continuously estimates indoor air quality using the expression $(1 + 0.02x)^{6}$, where x represents a sensor adjustment factor. Since the computer performs this calculation thousands of times every second, the software developers intend to replace the expression with a simpler approximation containing only terms up to and including the term in x^3.
At the beginning of each emergency, a combination of three essential relief supplies is to be distributed. These include; **Food Rations**, **Medical Kits**, and **Water Filtration Units**.

The system tracks three specific constraints that must be perfectly met to balance weight, cost, and immediate survival needs as follows:

I. A delivery truck should carry exactly **5,600 kg** of these specific supplies.
II. The Government allocates exactly **$13,200** for this load.
III. To meet the Operations Centre's needs, the combined items must provide emergency coverage for exactly **1,200 people**.

Item Specifications

Supply Item	Weight per Unit	Cost per Unit	People Helped per Unit
Food Ration	10 kg	$20	2 people
Medical Kit	5 kg	$60	4 people
Water Filtration Unit	20 kg	$40	3 people

The Project Steering Committee must confirm the proposed allocation for each unit before the emergency response plan is approved.

CamScanner

Task:

(a) Determine the final signal produced by the communication software after the four processing cycles.

(b) Generate the simpler approximation the software developer will replace the indoor air quality expression with. Comment on whether the approximation is suitable for implementation.

(c) Recommend the exact number of each of the essential relief supplies that should be distributed in case of an emergency.

Item 3

Uganda Electricity Distribution Company Limited (UEDCL) is extending electricity to a rapidly growing rural trading centre. The project involves the purchase of a new distribution transformer, installation of monitoring unit and financing of the project through a government infrastructure loan.

The monitoring unit analyses alternating-current signals during calibration, and the electrical engineer obtains the relationship $(3 + 4i)Z_1 = -7 + 24i$.

The phase angle of the alternating-current signal must lie between 40^o and 60^o, to ensure accurate synchronisation with the national grid.

The monitoring unit is also programmed so that every permissible operating point $Z = x + iy$ satisfies the region; $|Z - Z_1| = |Z_1|$.

The Engineers need to identify the permissible operating region before the monitoring software is commissioned.

The Government has advanced a loan of **Shs46,800,000** to a contractor to finance the transformer and the contractor has verbally agreed to repay the loan in **20 weekly instalments**.

Each week's repayment is **Shs120,000 greater** than the previous week's repayment because electricity sales are expected to increase steadily after commissioning.

Before signing the loan agreement, the contractor needs to determine the first and final weekly instalments for proper planning.

The transformer will be supported by two identical steel anchor cables whose design is governed by the relationship; $x^2 - 28x + \mathbf{k} = 0$.

Laboratory tests indicate that one design parameter exceeds the other by **8 units**.

The Engineers require both design parameters as well as the value of, **k**, to be determined before fabrication begins.

CamScanner

Task:

(a) Assess whether there is accurate synchronisation of the monitoring signal with the national grid.

(b) Identify the permissible operating region of the monitoring unit.

(c) Provide the;

(i) information needed by the contractor for proper planning of the loan repayment.

(ii) design parameters and the value of, **k**, required by the Engineers before fabrication begins.

Part II

Respond to only **one** *item from this part.*

Item 4

A tank is to be designed by rotating a curved steel profile about its vertical centreline. Engineers require the tank to widen smoothly from its base until it attains its greatest internal radius to maximise storage, and then narrow again towards the top to improve structural stability and reduce construction costs.

Hydraulic tests indicate that the radius, y metres, of the internal profile of the tank varies with the vertical height, x metres, according to;

$$\frac{dy}{dx} = \frac{6x - 2x^2}{y}$$

The profile starts from the tank base where $x = 0$ and $y = 2$ m.

A fabrication workshop will construct the tank until the profile naturally returns to its initial radius of 2 m, after which the steel plates are welded to a cylindrical inspection neck.

The Fabrication Design Manual specifies that the design will be approved only if;

I. the profile expands to a unique maximum radius before narrowing,

II. the maximum radius does **not** exceed 5.0 m, to avoid excessive stress on the cylindrical inspection neck,

III. the storage volume generated by the profile before the inspection neck begins is at least 250 m^3.

Task:

(a) Establish the height at which fabrication of the curved section should stop.

(b) Determine whether the proposed profile will satisfy the maximum radius requirement of the Fabrication Design Manual.

(c) Assess whether the proposed tank will provide the required storage capacity.

CamScanner

Item 5

The Ministry of Water and Environment plans to divert part of River Awoja into a newly constructed reservoir to reduce downstream flooding while supplying irrigation water to neighbouring communities.

Two engineering firms have submitted alternative gate-control system designs.
The Ministry can only finance one design.
Before awarding the contract, Ministry engineers require mathematical evidence showing which design;

I. initially responds more rapidly to changes in gate opening,

II. supplies more water during the first eight hours,

III. exceeds the reservoir's safe storage limit of 32 million litres.

The discharge rates (m^3/min) are;

Design A

$$y_A = \frac{12t+8}{t^2+7t+10}$$

Design B

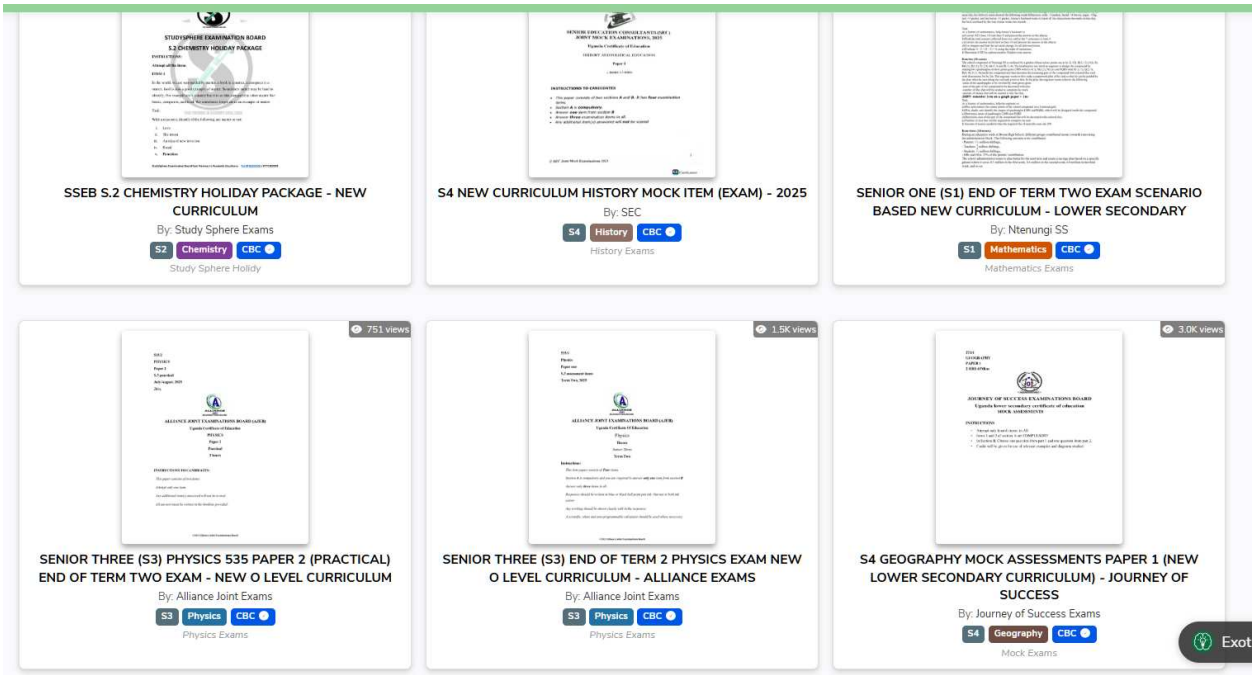
$$y_B = 4e^{-0.2t} + 1,$$

where $0 \leq t \leq 8$, for both designs.

Task:
Propose the design which should be adopted by the Ministry Engineers.

CamScanner

This document was downloaded from https://exoticnotes.com



Do you need more papers for secondary?

Click
https://exoticnotes.com/papers/secondary

If you need papers for O level (S.1 – S.4)

Click
https://exoticnotes.com/papers/secondary/o-level

If you need papers for A level (S.5 – S.6)

Click
https://exoticnotes.com/papers/secondary/a-level