THE UGANDA INTER SCHOOL VIRTUAL A LEVEL MATHEMATICS SEMINAR 2026.

Saturday 4^{th} July 2026 (9:00 a.m)

INSTRUCTIONS TO STUDENTS AND TEACHERS:

Dear students and teachers we would like to welcome you to participate in the forthcoming Mathematics seminar for senior six students. This is in preparation for the forthcoming final exams(UNEB) and the Mock Examinations. **This is a free seminar and no one should charge you any fees**.The process to be followed by both the teachers and students is suggested below:

1. Teachers share the Seminar questions with their students and ask for volunteers to discuss any of the questions. Questions should be pinned up and learners write down all the questions in their books.
2. Teachers talk to the school administrators to allow the children participate as presenters in the seminar on Saturday **04th July from 09:00am - 2:00 pm.** Other students will just be participants.
3. The student together with the teachers select atleast two best done presentations and the students to represent the school.The solutions and pictures/videos should be uploaded on padlet and on email kazibastephen42@gmail.com
4. Hold a mock presentation where all your discussants present to the rest of the class.After that release the rest of the class and record your best presenter in a very quiet environment but with good light.Record each part of the question separately .
5. The teacher could now train the student on how to present on zoom as far as sharing a screen and using the whiteboard. Alternatively the students' presentation will be loaded on the computer screen and they explain to us their solution.

SEMINAR DETAILS

S.6 virtual Mathematics seminar 2026.

Time: 04th July 2026, 09:00 AM

Join Zoom Meeting
https://zoom.us/j/3260571655?pwd=epgAW2vNAM7HxKGqS1a4DmMGkVSgmp.1&omn=96791521837
Meeting ID:326 057 1655
Passcode: HeLP

Construct	Topics
Geometry	1. Coordinate geometry 1 and 2 2. Trigonometry 3. Vectors
Algebra	1. Numerical concepts 2. Equations and Inequalities 3. Permutations and combinations 4. Series 5. Complex numbers
Calculus	1. Partial fractions 2. Differentiation 1 and 2 3. Integration 1 and 2 4. Differential equations
Data analysis and probability	1. Descriptive statistics 2. Correlation and scatter diagrams 3. Probability theory 4. Random variables
Numerical methods	1. Trapezium rule 2. Iterative methods 3. Flow charts
Dynamics	1. Resultant and components of forces 2. Friction 3. Connected particles 4. Resultant velocity 5. Relative motion 6. Projectiles

GEOMETRY

1. During the construction of a multi-storey commercial building, engineers use a three- dimensional coordinate system to monitor the alignment of key structural elements before

   concrete is poured. Three reinforced concrete walls are designed to intersect at a common point where a steel joint will be installed to support part of the building framework. The walls are modelled by the planes

   $$x - y + z = -2$$
   $$2x - y + 2z = -9$$

   , and

   $$3x + y - z = -2$$

   A vertical service shaft will pass through the steel joint to provide ventilation and emergency access between the underground level and the ground floor. The point where the shaft reaches the ground floor will be the centre of a circular exclusion zone of radius 5 m, within which heavy construction equipment is not permitted to operate.
   A proposed maintenance access route on the ground floor is represented by the line

   $$2x - y - 9 = 0$$

   The results of the investigation will be used to determine whether the proposed structural layout should be approved for construction.

   Tasks

   (a) Determine the location of the steel joint and the associated exclusion zone for the proposed structure.

   (b) Using your findings, determine whether the proposed maintenance access route satisfies the required safety standards and hence recommend whether the proposed structural layout should be approved for construction.

2. A renewable energy company is testing an automated solar tracking system before installing it at a commercial solar farm. The horizontal displacement, D cm, of the tracking arm from its reference position is modelled by

   $$D = 12\cos\theta + 16\sin\theta$$

   where θ is the angle through which the tracking arm rotates during one operating cycle. The manufacturer recommends that the tracking arm should maintain a horizontal displacement of at least 15 cm for efficient collection of solar energy. The findings of the investigation will be used to determine whether the proposed tracking system should be installed at the solar farm.

   Tasks

   (a) Determine the operating positions of the tracking arm during one operating cycle.

(b) Using your findings, recommend whether the proposed solar tracking system should be installed at the commercial solar farm.

3. A government engineering team is constructing a tunnel through a coastal mountain to link two neighbouring cities.Excavation begins simultaneously from opposite sides of the mountain. Using a three-dimensional coordinate system with origin **O**, where 1 unit represents 50 metres,the first excavation starts from $A(-3,-3,9)$ in the direction $2i+2j-k$, while the second starts from $B(-19,-7,-3)$ in the direction $6\mathbf{i}+3\mathbf{j}+2\mathbf{k}$.

   The completed tunnel should not exceed 1.5 km in length. Construction materials are delivered through a nearby harbour where the height, h metres, of the tide t hours after midnight is modelled by

$$h = a + b\sin(30t)^0,$$

   where **a** and **b** are constants.During the construction period , the tide is 9.5 m at 02 : 00 hours and $3.5m$ at 08 : 00 hours.

   Heavy construction barges can enter the harbour only when the water level is at least 5.0 m, while maintenance of the loading jetty can only be carried out when the water level is below 4.0 m. The Ministry of Works and Transport will use the findings of the investigation to determine whether the proposed tunnel project should proceed.

   Task

   (a) Determine whether the proposed tunnel design satisfies the required engineering standards.

   (b) Calculate the operating periods for heavy construction barges and maintenance of the loading jetty. Hence, determine whether the proposed construction schedule satisfies the operational requirements.

4. A government engineering team is designing an underground transport interchange where a highway tunnel, a railway tunnel and a service passage meet beneath a city. During the design stage, the retaining walls are modelled by the planes

$$x + y - z = 1$$
$$2x - 5y + z = -1$$

   and $7x-7y-z=1$. The retaining walls intersect in a common line along which a reinforced service corridor will be constructed. A vertical ventilation shaft will be constructed from a point on the ground surface to the service corridor. The length of the shaft should not exceed 15 m. To protect nearby underground utilities, a circular exclusion zone centred at $(1,0)$ is represented by

$$x^2 + y^2 = 2x + 8.$$

   A proposed maintenance access road is represented by

$$y = x - 2$$

The road should touch the exclusion zone without passing through it. If the proposed road does not satisfy this requirement, a parallel road should be designed.

The Ministry of Works and Transport will use the findings of the investigation to determine whether the proposed underground transport interchange should be approved for construction.

Task

Using your findings, provide the guidance required by the Ministry of Works and Transport on the proposed underground transport interchange.

5. A telecommunications company is expanding its mobile network to improve communication in a newly developed municipality. Three communication towers are located at P$(-1, 4)$,Q$(1, 6)$and R$(5, 4)$. The company intends to construct a circular fibre-optic network passing through the three towers. The network control centre will be located at the centre of the circular network. A proposed maintenance access road is represented by

$$x + y - 8 = 0$$

The access road should not pass through the fibre-optic network. If it does, a new maintenance access road parallel to the proposed road should be designed. The Uganda Communications Commission will use the findings of the investigation to determine whether the proposed network design should be approved.

Tasks

(a) Develop an equation that can be used to model the proposed fibre-optic network.

(b) Determine whether the proposed maintenance access road satisfies the required safety standards.

(c) Recommend, based on calculations, whether the proposed network design should be approved.

6. A manufacturing company has applied to the National Environment Management Authority (NEMA) for approval to expand its production capacity. As part of the approval process, the company is required to establish an Environmental Compliance Committee, monitor the amount of treated waste discharged into a nearby stream and evaluate the expected output of a new production line.

   The Environmental Compliance Committee will be selected from 9 employees, comprising 4 women and 5 men. One of the women is married to one of the men. The Environmental Officer, who is one of the men, is not the husband in the married couple and must serve on every committee. The committee should consist of three members, include at least one woman and one man, and the married couple must not serve on the same committee.

   The company discharges 160 kg of treated waste into a nearby stream at the beginning of each day. Environmental monitoring indicates that 50% of the waste present in the stream is naturally removed before the next day's discharge.

   A new production line manufactures $10,000$ units during the first production cycle. Production is expected to increase by 20% in each subsequent production cycle.

   According to NEMA and the company's production policy, the amount of waste remaining in the stream at the end of the fifth day should not exceed 310 kg. If the amount of waste in the stream exceeds 300 kg before the fifth day, an additional waste treatment facility must be installed before production continues. The expansion project will be considered financially viable only if production during the sixth production cycle reaches at least 24,500 units.
   The company's management will use the findings of the investigation to determine whether the proposed expansion project should be approved.

   Tasks

   (a) Compute the number of Environmental Compliance Committees that can be formed in accordance with the company's policy.

   (b) Determine:

      i. the amount of waste remaining in the stream at the end of the fifth day;

      ii. whether an additional waste treatment facility will be required before the fifth day.

   (c) Calculate the production during the sixth production cycle. Hence, determine whether the proposed expansion project should be approved.

7. A district sports association is evaluating a new 5 km cross-country training route before introducing it for regional athletics competitions. The route consists of an uphill section, a level section and a downhill section. Athlete A completed the route in 26.4 minutes, while

Section	**Athlete A**	**Athlete B**
Uphill	$8km/h$	$10km/h$
Level	$12km/h$	$15km/h$
Uphill	$15km/h$	$20km/h$

Athlete B completed the same route in 20.8 minutes. The proposed route will be approved if:

- the uphill section does not exceed 1.8 km;
- the downhill section is at least 1.0 km long; and
- the level section is the longest section of the route.

The Association also intends to introduce an eight-week endurance training programme. During the first week, each athlete will complete 2 laps of the route. Thereafter, the number of complete laps will increase by one lap each week.
The programme will be adopted only if each athlete is expected to cover at least 220 km during the eight weeks.
The District Sports Association will use the findings of the investigation to determine whether the proposed route and training programme should be adopted.

Task

(a) Determine whether the proposed cross-country route satisfies the required performance standards.

(b) Determine whether the proposed endurance training programme satisfies the Association's requirements.

8. A pharmaceutical company is evaluating a new herbal medicine before introducing it to health centres across the country. Laboratory studies indicate that the amount of active ingredient released during successive production stages is modelled by

$$(A + Bx)^8$$

where A and B are constants, and x is the concentration factor of one of the active ingredients. Each batch of the medicine contains 1 unit of Extract A and 3 units of Extract B.

The terms of the expansion of $(A + Bx)^8$, arranged in ascending powers of x, represent the quantities of active ingredient released during the production stages. The quantities released during the first and second production stages are 1 g and 24 g, respectively.

Over the past few years, the company has received complaints from health centres because the expiry date is not clearly indicated on the medicine packages. According to the company chemist, the effectiveness, E, of the medicine after ttt months is modelled by

$$2\log_5(t + 2) = \log_5(3t + 16)$$

A new batch of medicine will be manufactured on 1 January 2027. The medicine will only be recommended for use if its effectiveness remains above the required standard determined by the model.

The company also intends to establish three regional distribution centres whose locations satisfy the equation

$$z^3 - 3z^2 - 4z + 12 = 0$$

where z represents the coordinate of a distribution centre on the company site plan. However, information about the quantities of active ingredient released during the intermediate production stages, the expiry date of the new batch of medicine and the locations of the proposed distribution centres is missing.

Tasks

(a) Determine the production stage that released the greatest quantity of the active ingredient.

(b) Recommend, based on calculations, the expiry date that should be indicated on the new batch of medicine.

(c) Generate the coordinates of the proposed regional distribution centres.

CALCULUS

9. Researchers in a microbiology laboratory are conducting experiments on bacterial growth under controlled conditions.

Sarah is investigating the growth of a bacterial culture that initially contains 100 bacteria. Laboratory observations indicate that the rate of increase of the bacterial population is proportional to the number of bacteria present. During one experiment, the proportionality constant was found to be 5 per hour. The laboratory safety guidelines require that the culture be transferred to a secure containment chamber before the population reaches $10,000$ bacteria.

David is preparing nutrient solution for bacterial cultures using a cylindrical container with a fixed surface area. He intends to determine the dimensions of the container that will hold the greatest volume of nutrient solution.

Grace is calibrating a spherical culture flask. The intended radius is 10 cm, but the manufactured flask has a radius of 9.8 cm. According to the laboratory quality standards, the percentage error in the volume should not exceed 8%.

Task

(a) Determine whether Sarah's bacterial culture should be transferred before the next scheduled inspection after 1 hour.

(b) Determine the dimensions of the cylindrical container that will hold the greatest volume of nutrient solution.

(c) Establish whether Grace's spherical flask satisfies the laboratory quality standards

10. A newly established beverage manufacturing company is evaluating the performance of a new production line before committing additional investment. Market analysts have developed a mathematical model relating the rate of change of the company's accumulated profit to the time, ttt, in months after production begins. The rate of change of the accumulated profit is modelled by

$$\frac{dP}{dt} = \frac{5-t}{t^2+5t+6},$$

where **P** represents the accumulated profit in millions of shillings and $t \geq 0$. At the beginning of operations $t = 0$, the company's accumulated profit was UGX 8 million.

The Board of Directors requires the accumulated profit after the first 4 months and the total increase in accumulated profit during the same period to evaluate the performance of the new production line. The company will approve the proposed expansion only if the accumulated profit after the first 4 months has increased by at least 80% of its initial value and the total increase in accumulated profit during the same period is at least UGX 7 million.
Task

Using appropriate calculations, determine whether the performance of the new production line satisfies the company's investment policy.

11. A district local government is constructing an irrigation canal to supply water to a newly established farming scheme. The canal will have a rectangular cross-section of width xxx metres and depth yyy metres. To minimise construction costs, concrete lining will be provided only on the base and the two vertical sides. The total length of concrete lining available for the cross-section is 120 m.

According to the contractor, the rate at which the canal is excavated after ttt hours is modelled by

$$\frac{dL}{dt} = 15 - 0.2t, \qquad 0 \leq t \leq 20,$$

where L is the length of canal excavated, in metres.

During excavation, the canal passes through a small mound whose cross-section is modelled by

$$y = 18 - \frac{x^2}{8},$$

where x is the horizontal distance, in metres, from the centre of the mound and yyy is its height above the surrounding ground. The mound extends uniformly for 2 m perpendicular to the cross-section. The excavated soil will be used to fill a nearby depression of volume $450m^3$.

The district engineer requires the dimensions of the canal that will carry the greatest amount of water and wishes to establish whether the excavated soil will completely fill the depression before construction begins.

Task

(a) i. Determine the dimensions of the canal that will provide the greatest cross-sectional area.

ii. Compute the number of hours required to excavate 150 m of the canal.

(b) i. Sketch the cross-section of the mound.

ii. Determine whether the excavated soil will completely fill the depression.

NUMERICAL ANALYSIS

12. DHL Express Uganda intends to construct a new service centre and introduce a computerized quotation system before expanding its operations.

The proposed service centre occupies a rectangular plot measuring 16.25 m by 12.50 m, both measured correctly to two decimal places. The estimated cost of fencing wire is UGX 2,000 per metre, rounded to the nearest Uganda shilling, with a maximum possible percentage error of 2.5%.
According to the Project Engineer, the estimated fencing cost lies within the approved budget interval

$$111,910.5 \leq C \leq 118,100.5,$$

where (C) is the total fencing cost in Uganda shillings.

To test the computerized quotation system, shipment records show that parcels weighing 2 kg, 5 kg, 8 kg, 12 kg and 16 kg were charged UGX 32,000, UGX 48,500, UGX 69,000, UGX 105,500 and UGX 156,000, respectively.

During system testing, a customer requested a quotation for an 18 kg parcel, while another customer produced a receipt showing a payment of UGX 82,000, but the corresponding parcel mass could not be retrieved because of a temporary system failure.

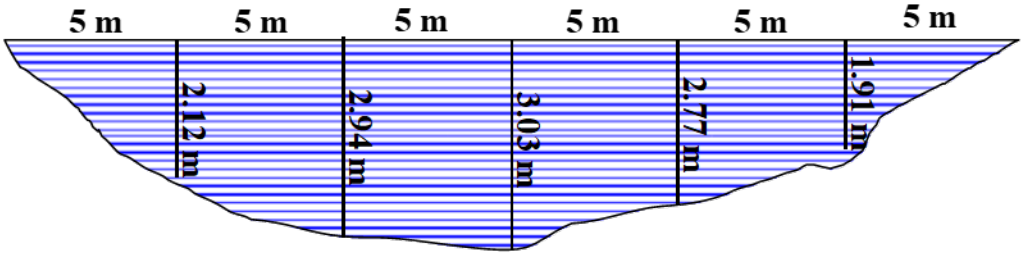
After verification, the shipping charge for the 18 kg parcel was confirmed to be UGX 183,500, while the parcel corresponding to the UGX 82,000 payment was found to have a mass of 9.2 kg. The computerized quotation system will be considered satisfactory if the percentage error in estimating the shipping charge does not exceed 5% and the estimated parcel mass differs from the verified mass by not more than 0.5 kg.

The Operations Manager requires evidence that the estimated fencing cost falls within the approved budget and that the computerized quotation system satisfies the required operational standards before approving the proposed projects.
Task

(a) Provide the proof required by the Operations Manager regarding the proposed service centre.

(b) Investigate whether the computerized quotation system satisfies the required operational standards

13. The Ministry of Fisheries and Aquatic Resources intends to establish a commercial fish farming project in a natural water body. Before approving the project, surveyors measured the depths of the water body at equal intervals across the proposed site, as shown in the figure, to estimate its cross-sectional area.



According to the Engineering Department, the proposed site is suitable for the project because the estimated cross-sectional area of the water body is at least $63.85m^2$, the minimum area required for commercial fish farming.

To accommodate workers at the project site, the Ministry has acquired a rectangular piece of land measuring 123.65 m in length, measured correct to two decimal places, and 96.774 m in width, measured correct to three decimal places. Each accommodation tent, including the required clearance around it, occupies a rectangular space measuring 4.50 m by 6.85 m, both measured correct to two decimal places.

According to the Site Engineer, the campsite can accommodate the required 390 to 410 tents.
The Permanent Secretary requires evidence that both the proposed fish farming site and the campsite satisfy the project requirements before granting approval for implementation.
Task

(a) Provide the evidence required by the Permanent Secretary regarding the suitability of the proposed fish farming site.

(b) Investigate whether the proposed campsite satisfies the Ministry's accommodation requirements.

DATA AND PROBABILITY

14. A fruit processing company received a consignment of apples from different farmers for juice production. Before processing, the Quality Control Department collected a random sample of the apple weights, in grams, and summarised the results in the table below.

Weights(grams)	**Number of apples**
$120 \leq w < 140$	6
$140 \leq w < 150$	16
$150 \leq w < 160$	30
$160 \leq w < 170$	36
$170 \leq w < 180$	29
$180 \leq w < 200$	2
$200 \leq w < 220$	1

According to the company's quality assurance policy, only consignments with an estimated mean weight of at least 160 g are accepted for processing. The lightest 25% of the apples are classified as Economy Grade, the heaviest 25% as Premium Grade, while the remaining apples are classified as Standard Grade. Management requires the grading limits and the number of apples in each grade to be established before processing begins.

The packaged apples are transported daily to the processing plant. Historical records show that the probabilities of sunny, rainy and stormy weather during transportation are $\frac{1}{2}$, $\frac{1}{3}$ and $\frac{1}{6}$,, respectively. The corresponding probabilities that a delivery truck arrives on time under these weather conditions are $\frac{4}{5}$, $\frac{2}{5}$ and $\frac{1}{10}$, respectively.
Last week, one delivery truck arrived late. According to the company's transport policy, additional refrigerated trucks will only be purchased if the probability that the delay occurred during stormy weather exceeds 40%.

Management requires evidence that the consignment satisfies the company's quality assurance policy and that the proposed investment in additional refrigerated trucks is justified before making a final decision.

Task

(a) Provide the evidence required by Management regarding the quality of the apple consignment.

(b) Investigate whether the purchase of additional refrigerated trucks is justified.

15. The National Environment Monitoring Agency is investigating whether maximum daytime temperature can be used to predict the concentration of a particular air pollutant in a major city. During the investigation, environmental officers recorded the maximum daytime temperatures and the corresponding pollutant concentrations over several days, as shown in the table below.

Maximum temperature	10	12	14	16	18	20	22	24
Amount of pollutants	513	475	525	530	516	520	507	521

According to the Environmental Monitoring Department, the proposed temperature-based pollution monitoring system will only be adopted if the relationship between maximum daytime temperature and pollutant concentration is sufficiently strong to support reliable prediction.

Previous environmental studies indicate that maximum daytime temperature is normally distributed with a mean of 22^0C and a standard deviation of 3^0C.

The Agency reviews its heat advisory whenever the probability that the maximum daytime temperature exceeds 225^0C is greater than 30%. In addition, unusual weather patterns are investigated whenever the probability that the total maximum temperatures recorded over five randomly selected days is less than 100^0C exceeds 10%.

Task
Assist the Environmental Monitoring Department to:

(a) determine whether the proposed temperature-based pollution monitoring system is suitable for adoption.

(b) establish whether the Agency should:

- review its heat advisory; and
- investigate unusual weather patterns.

DYNAMICS

16. A golf training academy is evaluating a new practice range before introducing it for professional training. One particular shot is struck from a raised platform A, which is 4.9 m above the level of the field. The golf ball leaves the club with a speed of $49m/s$ at an angle of elevation α and lands for the first time at point B, which is 98 m horizontally from A. The motion of the golf ball is modelled as that of a particle moving freely under gravity, neglecting air resistance.
According to the academy's training programme, the launch technique is considered suitable if:

- the golf ball remains in flight for not more than 2.1 s;
- the maximum height of the golf ball does not exceed 30 m above the field; and

- the golf ball lands within the designated target area at B.

At the instant the golf ball is struck, a maintenance vehicle starts moving towards point B along a straight service road. The vehicle is initially 24 m from B and travels at a constant speed of $12m/s$. According to the academy's safety policy, practice will continue only if the maintenance vehicle reaches point B before the golf ball lands.

Task
Assist the Sports Performance Analyst to:

(a) determine whether the proposed launch technique satisfies the academy's training requirements.

(b) establish whether practice should continue in accordance with the academy's safety policy.

17. A highway rescue company is evaluating a new recovery truck before deploying it on major highways. During a trial, a truck of mass 2800 kg is used to tow a broken-down car of mass 1200 kg, initially at rest on a horizontal road. The truck and the car are connected by a light, inextensible tow cable inclined at an angle θ to the horizontal, where

$$\cos\theta = 0.85$$

The coefficient of friction between the car tyres and the road is 0.03, and the tension in the tow cable is 500 N.

After the towing operation begins, both vehicles move together at a constant speed of $12m/s$. During this stage, the resistance to the motion of the truck is 600 N, while that of the car is 270 N.

The driver then accelerates uniformly until the speed reaches $27m/s$ after travelling 2.50 km. The maximum driving force available during acceleration is 1.5 kN, while the engine can deliver a maximum useful power of 35 kW during towing.

According to the company's operational standards:

- the vertical load on the towing hook shall not exceed 400 N;
- the tow cable shall not be subjected to a tension exceeding 600 N;
- the maximum available driving force shall be sufficient to achieve the required acceleration; and
- the required engine power shall not exceed 35 kW during towing.

The company will base its decision on the outcome of the mathematical analysis before approving deployment of the recovery truck.

Task

Determine whether the recovery truck satisfies the required operational and safety standards before deployment.

END