P425/1
PRINCIPAL MATHEMATICS
PAPER 1
APRIL 2026
3 HOURS

KABALE DIOCESAN MOCK EXAMINATION

UGANDA ADVANCED CERTIFICATE OF EDUCATION

PRINCIPAL MATHEMATICS

TIME: 3 HOURS

INSTRUCTIONS TO CANDIDATES

- *This paper consists of two sections: Section A and section B*
- *Section A has one compulsory items*
- *Section B has part I and part II*
- *Answer only one item from each part of section B*
- *In total, answer three items only*
- *Begin each item on a fresh page*
- *Any additional item(s) answered will not be marked.*
- *All working must be shown clearly*
- *Silent non-programmable scientific calculators and mathematical tables with a list of formulae may be used.*

SECTION A (COMPULSORY

ITEM 1

In Kampala capital city, an emergency response system uses drones to deliver medical supplies between hospitals. The drones move along fixed straight paths to avoid collisions with themselves and permanent buildings.

The first drone depot is located between points A(2, -1, 4) and B(10, 3, 8). The second drone depot is located between points C(6, -3, 2) and D(10, -1, 4).

Also due to weak network signal in the city, a telecom company also plans to put up a mast between three busy divisions X, Y and Z whose map co ordinates are (1,1), (2,0) and (3,1) in kilometers respectively. The mast must be positioned equidistant for all the three divisions.

The dish is mounted on the mast so that the signal to any of the towns is maximum.

The signals transmitted by the dish are modulled by the equation, $S(\theta)=12\sin\theta-5\cos\theta+18$, where θ is the angle of the dish's indination and $S(\theta)$ is the signal strength in the direction θ and better network signals must be between 28 and 35 units inclusive.

Task

(a) Show that the two drone's paths are parallel and determine the shortest distance between them.
(b) Establish the point where the mast will be located
(c) Determine the maximum signal strength and the angle at which it occurs in order to advise the telecom company.

SECTION B

PART I (Answer only one item from this section)

ITEM 2

Joseph is a clinical officer graduate who has struggled with getting employment. Recently Joseph landed a job for a 15 years contract. The hospital administrator offered Joseph two salary options.

OPTION 1: A starting salary of Shs. 600,000 per month with a fixed monthly increment of Shs. 50,000:

OPTION 2: A starting salary of Shs. 1,200,000 with an annual increment of 8% of the previous year's monthly.

For an investment for his retirement in future, Joseph plans to save Shs. 2,000,000 at the beginning of every year with centenary bank that offers 10% compound interest per year and wishes to wait until the savings accumulates to more than 50 millions shillings.

The hospital administrators also tasked Joseph to form an emergency committee of 6 members from a group of 8 men and 7 women to work on emergencies.

Task

As a mathematics student,

(a) Advise Joseph on which scheme is better for the fifteen years.
(b) Determine the least number of years, Joseph will have to wait for in order to withdraw his savings.
(c) How many possible committees can Joseph make with;
    (i) No restrictions
    (ii) Atleast three men and one woman on the committee

✓ **ITEM 3**

A certain secondary school in Kigezi region is expanding. It needs to build classrooms, library and laboratory. The contractor presented cost estimates as below:

2 Classrooms, 1 library and 1 laboratory cost Shs.180 millions. 1 classroom, 2 libraries and 3 laboratories cost Shs.360 millions 3 classrooms, 1 library and 2 laboratories cost Shs.300 millions.

The school has Shs.380 millions from the government and community contributions. They need at least 4 class rooms, 1 library and 2 laboratories but the school management is confused since the contractor has not provided them with the cost of each and they don't know if they can afford everything.

One parent of the same school donated 5 identical mathematics textbooks, 4 identical physics text books and 3 identical chemistry text books which are to be arranged in book shelves.

In the same school, agriculture department has a diary project and they collect milk from it every day. The daily milk collection volume V(d) is modulled by the equation $V(d)=150-100d+30d^2-3d^3$ where d is the day of the month. They need atleast 200 litres daily to supply the processor.

Task

(a) Establish if the school can afford the infrastructure required with Shs.380 millions
(b) Determine the number of ways of arranging the books in a book shelf if:
    (i) Mathematics books have to be kept together
    (ii) The first and last books on the shelf must be mathematics books.
(c) Establish how many days of the month, the agriculture department meets the milk requirement.

PART TWO (Answer 1 item from this part)

ITEM 4

An engineer won a contract for designing a water storage tank for a village in a certain district. The cross-sectional area, A (m^2) of the tank at height h, meters is modulled by $A(h) = \frac{50h^3}{h^2-4}$. The engineer will be paid if volume of the tank from height h=3m to height h=5m is atleast $500m^3$.

The company that highered the engineer is also considering transporting fuel using large spherical storage tanks mounted on ships.

Each tank is designed with radius, r meters.

Due to temperature changes during transport, metal expands and contracts slightly.

Engineers monitor how small changes in radius affect volume of the tank to avoid structural leakage. At a certain stage of the journey, a tank has a radius of 2.5m but due to thermal expansion, the radius increases by 2%. The tank is considered safe if volume variation does not exceed 3% and corresponding surface area variation is less than 2%.

Task

(a) Establish if the engineer will be paid.
(b) Advise the company on safety of the spherical tanks.

ITEM 5

A rural community in kabale district is to construct a cylindrical water reservoir to serve house holds. The reservoir must have a volume of $1000m^3$. The construction cost depends on surface area. The top and bottom costs Shs.50,000= per m^2 while the curved surface costs Shs.30,000 per m^2. The community wants to minimize the total construction cost and will only begin the project if the minimum cost is less than Shs.20,000,000.

An agriculture researcher in the same community is comparing two maize varieties. Variety A yields are modulled by the equation, $y_1 = -x^2+8x$ tonnes per hectare and variety B is modulled by $y_2 = 2x+5$ tonnes per hectare where x represents fertilizer amount in hundreds of kilogram per hectare.

The region enclosed by the yields is rotated through 360^0 about the horizontal axis to form a cylindrical cup.

Task

(a) Establish whether the rural community is supposed to start implementing the project.
(b) Represent the yields on the graph using calculus and determine
   (i) Intervals where each variety is better
   (ii) Volume of the cup formed.

END