

**BOWEN UNIVERSITY, IWO. OSUN STATE. NIGERIA**  
**COLLEGE OF AGRICULTURE, ENGINEERING, AND SCIENCES**  
**PHYSICS PROGRAMME**

FIRST SEMESTER EXAMINATION 2022/2023 SESSION

PHY 361: MATHEMATICAL METHODS IN PHYSICS (2 CREDITS)

DATE: FRIDAY, 17<sup>TH</sup> FEBRUARY, 2023

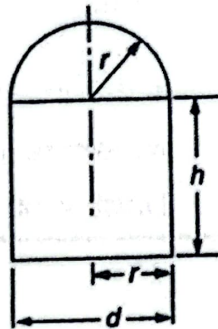
TIME: 8.30 A.M – 10.30 A.M

INSTRUCTION: ATTEMPT ANY THREE QUESTIONS. (23 marks each) + (1 extra mark for consistency)

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**QUESTION 1**

A hot water storage tank is a vertical cylinder surmounted by a hemispherical top of the same diameter. The tank is designed to hold  $400 \text{ m}^3$  of water. If the surface heat loss is to be a minimum, determine;



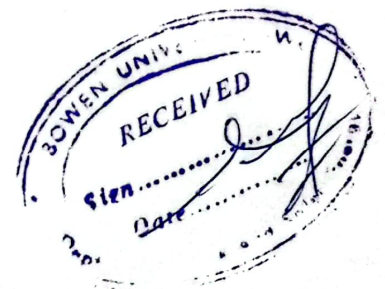
- a. the total height 'H = h + r' of the tank (10 marks)
- b. and the diameter 'r' of the tank (8 marks)
- c. Find the stationary points of the function;  $u = x^2 + y^2$  :  
subject to the constraint  $\phi = x^2 + 2y^2 + 2x - 2y + 1$  (5 marks)

**QUESTION 2**

- a. Using the Laplace transform method, solve the first order differential equation below

$$\frac{dx}{dt} - 2x = 4. \text{ Given that at } t=0, x = 4$$

(10 marks)



b. Find the Laplace transform of the following

(i)  $\sin 2t$

(4 marks)

(ii)  $4t$

(4 marks)

c. Find the inverse (Laplace) transform of  $\frac{9s - 8}{s^2 - 2s}$

(5 marks)

### QUESTION 3

a. If the Gamma function  $\Gamma(x)$ , is defined by the integral;

$$\Gamma(x) = \int_0^{\infty} t^{x-1} e^{-t} dt.$$

Show, that  $\Gamma(x+1) = x \Gamma(x)$

(7 marks)

b. Evaluate the following:

(i)  $\Gamma(7)$

(4 marks)

(ii)  $\Gamma(5)$

(4 marks)

c. Solve:  $\int_0^{\infty} x^7 e^{-x} dx$

(8 marks)

### QUESTION 4

a. (i) Define the term 'rank of a matrix'

(3 marks)

(ii) When is a matrix said to have rank 'r'?

(Where "r" could be 0,1,2,.....)

(3 marks)

b. Determine the rank of matrices below:

(i)  $\begin{bmatrix} 1 & 2 & 8 \\ 4 & 7 & 6 \\ 9 & 5 & 3 \end{bmatrix}$       (ii)  $\begin{bmatrix} 3 & 4 & 5 \\ 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}$

(10 marks)

c. (i) In matrix, when is an equation said to be consistent?

(3 marks)

(ii) Determine if this given equation below is consistent.

$$\begin{bmatrix} 1 & 3 \\ 2 & 6 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 4 \\ 5 \end{bmatrix}$$

(4 marks)

