



NATIONAL OPEN UNIVERSITY OF NIGERIA
PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA
FACULTY OF SCIENCES
DEPARTMENT OF PHYSICS
2025_2 EXAMINATIONS

COURSE CODE: PHY 312
COURSE TITLE: MATHEMATICAL METHODS FOR PHYSICS I
CREDIT UNIT: 3
TIME ALLOWED: (3 HRS)
INSTRUCTION: Answer question 1 and any other *THREE* questions

QUESTION 1

- (A) A Fourier series $f(x)$ is given by $f(x) = a_0 + \sum_{n+1}(a_n \cos nx + b_n \sin nx)$
Solve for coefficient a_0, a_n and b_n [13 marks]
- (B) Obtain the Fourier series of a certain periodic function with a period of 2π defined as
 $f(x) = \begin{cases} -k & \text{when } -\pi < x < 0 \\ +k & \text{when } 0 < x < \pi \end{cases}$ [12marks]

QUESTION 2

- (A) Determine the Legendre polynomial $P_2(x)$ using Rodriguez's Formula [6marks]
- (B) Classify the following equations either elliptic, hyperbolic or parabola
- i. $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$ [3marks]
- (ii) $\frac{\partial^2 u}{\partial x^2} + \alpha^2 \frac{\partial^2 u}{\partial x^2} = 0$ [3marks]
- (iii) $\frac{\partial^2 u}{\partial x^2} + \alpha \frac{\partial u}{\partial y} = 0$ [3marks]

QUESTION 3

- (A) Given that $Z = Ae^{pt} \sin Px$, show that $\frac{\partial^2 Z}{\partial t^2} + \frac{\partial^2 Z}{\partial x^2} = 0$ [7marks]
- (B) Solve the differential equation $\frac{\partial^2 u}{\partial x^2} = 6x^2(2y - 1)$ given the boundary conditions that at $x = 0, \frac{\partial u}{\partial x} = \sin 2y$ and $u = \cos y$. [8marks]

QUESTION 4

- (A) Verify that $\phi(x, y, z) = \frac{1}{\sqrt{x^2 + y^2 + z^2}}$ satisfies the partial differential equation:
 $\frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial y^2} + \frac{\partial^2 \phi}{\partial z^2} = 0$ [7marks]
- (B) Find the general solution of the following differential equation: (i) $x'' - 4x = 0$ [4marks]
(ii) $T'' + 4T = 0$ [4marks]

QUESTION 5

Given that relation $2 \frac{n}{x} J_n(x) = J_{n-1}(x) + J_{n+1}(x)$. Evaluate the following:

- (i) $J_{\frac{3}{2}}(x)$ [5marks]
- (ii) $J_{-\frac{3}{2}}(x)$ [5marks]
- (iii) $J_{\frac{5}{2}}(x)$ [5marks]

QUESTION 6

- (A) Determine the half range Fourier cosine series to represent the function $f(x) = 3x$ in the range $0 < x < \pi$ [8marks]
- (B) Show that when $Z = e^{-t} \sin \theta$, then $\frac{\partial^2 Z}{\partial t \partial \theta} = \frac{\partial^2 Z}{\partial \theta \partial t}$ [7marks]