FYUG/Sem-4/PY-CE1

2026
(Regular)
Physics (Core)
Paper Code : PY-CE-4214
Paper Name : Mathematical Physics - IV

Time : 2 hours ***Full Marks : 45***

The figures in the margin indicate full marks for the questions.

1. Choose the correct option : 1×4=4

a) The generating function for the Legendre polynomial is :

i) $\left(1-2xz+z^2\right)^{-1}$

ii) $\left(1-2xz+z^2\right)^{-\frac{1}{2}}$

iii) $\left(1-2xz-z^2\right)^{-\frac{1}{2}}$

iv) $\left(1+2xz-z^2\right)^{\frac{1}{2}}$

b) The value of δ_{ii} in n- space dimensions is :

i) 3 ii) d iii) 1 iv) n

c) What is the fundamental period of the function

$f(x)=\frac{a_0}{2}+\sum\left(a_n\cos nx+b_n\sin nx\right)$?

i) π ii) 2π iii) 4π iv) None of the above

d) The error in Simson's $\frac{1}{3}$ rule is proportional to :

i) h ii) h^2 iii) h^3 iv) h^4

Contd..

2. Answer the following questions : 2×3=6

a) What is the principle behind the Gauss elimination method ?

b) Write down the expressions for Fourier Coefficients.

c) Write down the tensorial expressions for $\vec{A}\cdot\vec{B}$ and $\vec{A}\times\vec{B}$.

3. Answer ***any three*** questions from the following : 5×3=15

a) Solve the following system using Gauss elimination :
$2x+y+z=5,\ 4x-6y=-2,\ -2x+7y+2z=9.$

b) Evaluate : $\int_{-\pi}^{\pi}\sin^2 x\,dx$ using orthogonality relations.

c) Show that $\delta_{ij}A_j=A_i$ and interpret the result.

d) Apply the bisection method to find a root of $x^3-x-1=0$ correct up to two iterations.

e) Derive Simpson's $\frac{1}{3}$ rule by approximating the integral $f(x)$ by a quadratic polynomial passing through three equally spaced points.

f) Expand $f(x)=x^2$ in Fourier series in the inetrval $(-\pi,\pi)$.

4. Answer ***any two*** questions from the following : 10×2=20

a) i) State the conditions under which Frobenius method is applicable to differential equations. 4

ii) Solve the differential equation $x^2y''+xy'-y=0$ using Frobenius method and obtain the series solution. 6

b) Using the recurrence relation for Legendre polynomial $P_n(x)$,

show that $\int_{-1}^{1} x P_n(x) P_{n-1}(x) dx = \frac{2n}{4n^2-1}$. Express associate Legendre polynomial $P_n^m(x)$ in terms of Legendre polynomial $P_n(x)$. 5+5=10

c) Write down the Hermite differential equation. Write down its generating function and show that $H_n'(x) = 2n H_{n-1}(x)$. 2+2+6=10

d) Express any arbitrary tensor T_{ij} in terms of its symmetric and antisymmetric parts. Show that the product of a symmetric and antisymmetric tensor is zero.

Write down the transformation laws for a covariant and a contravariant tensor. 2+4+4=10

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