

QP Code: D133941		Total Pages:02	Name:
			Register No.
THIRD SEMESTER UG DEGREE EXAMINATION, NOVEMBER 2025			
(CUFYUGP)			
PHY3MN201: Mathematical Methods for Physics			
2024 Admission onwards			
Maximum Time :2 Hours		Maximum Marks :70	
Section A			
All Questions can be answered. Each Question carries 3 marks (Ceiling : 24 Marks)			
1	If $\phi = 3x^2y - y^3z^2$, find $grad \phi$ at the point $(1, -2, -1)$.		
2	Determine the constants a and b such that the curl of the vector $\vec{A} = (2xy - 3yz)\hat{i} + (x^2 + axz - 4z^2)\hat{j} - (3xy + byz)\hat{k}$ is zero.		
3	If $z = 1 + i$, find z^2 and $\frac{1}{z}$. Plot them on the Argand diagram.		
4	If $u + iv = (x + iy)^3$, Show that $\frac{u}{x} + \frac{v}{y} = 4(x^2 - y^2)$		
5	Find the modulus and principal argument of the complex number $\sqrt{\frac{1+i}{1-i}}$		
6	Solve the differential equation, $\sec^2 x \cdot \tan y \, dx + \sec^2 y \cdot \tan x \, dy = 0$		
7	Solve the differential equation, $\sec x \frac{dy}{dx} = y + \sin x$		
8	Using Gauss's law, find the electric field inside and outside a spherical shell of radius R , which carries a uniform surface charge density σ .		
9	Convert the Cartesian coordinates of a point $P(0, 2, 2)$ into cylindrical coordinates.		
10	Convert the spherical polar coordinates $(r, \theta, \phi) = \left(2, \frac{\pi}{2}, \frac{\pi}{3}\right)$ of a point P to Cartesian coordinates (x, y, z)		
Section B			
All Questions can be answered. Each Question carries 6 marks (Ceiling : 36 Marks)			
11	(i). What is meant by directional derivative? (ii). Find the directional derivative of $\frac{1}{r}$ in the direction of \vec{r} where $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$		
12	(i). State and explain Ampere's law. (ii). Two long coaxial solenoids each carry current I , but in opposite directions. The inner solenoid (radius a) has n_1 turns per unit length, and the outer one (radius b) has n_2 . Find B in each of the three regions: (a) inside the inner solenoid, (b) between them, and (c) outside both.		
13	Find the complex number z if $arg. (z + 1) = \frac{\pi}{6}$ and $arg. (z - 1) = \frac{2\pi}{3}$		
14	In the series LCR circuit, $R = 300\Omega$, $L = 60 \text{ mH}$, $C = 0.50 \mu\text{F}$, $V = 50 \text{ Volt}$, $\omega = 10,000 \text{ rad/s}$. Find the reactances X_L and X_C , the impedance Z , the current amplitude I , the phase angle ϕ and the voltage amplitude across each circuit element.		
15	Solve the differential equation $(x^3 + y^3) \, dy = x^2 y \, dx$		
16	Solve $x \left(\frac{dy}{dx} + y \right) = 1 - y$		
17	Express $z\hat{i} + x\hat{j} + 2y\hat{k}$ in cylindrical co-ordinates.		

18	A long coaxial cable carries a uniform volume charge density ρ on the inner cylinder (radius a), and a uniform surface charge density on the outer cylindrical shell (radius b). This surface charge is negative and of just the right magnitude so that the cable as a whole is electrically neutral. Find the electric field in each of the three regions: (i) inside the inner cylinder ($s < a$), (ii) between the cylinders ($a < s < b$), (iii) outside the cable ($s > b$)
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Section C
Answer any ONE .Each Question carries 10 marks (1x10=10 Marks)

19	<p>(i). If $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$, show that:</p> <p>(a). $\text{grad } r = \frac{\vec{r}}{r}$</p> <p>(b). $\text{grad} \left(\frac{1}{r}\right) = -\frac{\vec{r}}{r^3}$</p> <p>(ii). If $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$ and $u = x^2 + y^2 + z^2$, Find $\text{div.}(u\vec{r})$ in terms of u.</p>
20	<p>(i). A spring is mounted horizontally, with its left end fixed. A spring balance attached to the free end and pulled toward the right. A force of 6.0 N causes a displacement of 0.030 m. Find the force constant k of the spring.</p> <p>(ii). The spring balance is replaced with a 0.50-kg glider, pulled it 0.020 m to the right along a frictionless air track, and released it from rest. Find the angular frequency, frequency and period of the resulting oscillation.</p> <p>(iii). The glider is given an initial displacement $x_0 = +0.015 \text{ m}$ and an initial velocity $v_{0x} = +0.40 \text{ m/s}$ (a) Find the period, amplitude, and phase angle of the resulting motion. (b) Write equations for the displacement, velocity, and acceleration as functions of time.</p>