QP Code: D133941	Total Pages:02	Name:
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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 $\vec{A} = (2xy - 3yz)\hat{\imath} + (x^2 + axz - 4z^2)\hat{\jmath} - (3xy + byz)\hat{k}$ 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, $sec^2x. tan\, y\, dx + sec^2y. tan\, x\, dy = 0$
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 $\vec{r} = x\hat{\imath} + y\hat{\jmath} + z\hat{k}$
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, $R = 300\Omega$, $L = 60$ mH, $C = 0.50$ μF, $V = 50$ Volt, ω= 10,000 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 $(x^3 + y^3)\, dy = x^2y\, dx$
16	Solve $x\left(\frac{dy}{dx} + y\right) = 1 - y$
17	Express $z\hat{\imath} + x\hat{\jmath} + 2y\hat{k}$ 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)
Section C	
Answer any ONE .Each Question carries 10 marks (1x10=10 Marks)	
19	(i). If $\vec{r} = x\hat{\imath} + y\hat{\jmath} + z\hat{k}$, show that: (a). $grad\, r = \frac{\vec{r}}{r}$ (b). $grad\, \left(\frac{1}{r}\right) = \frac{\vec{r}}{r^3}$ (ii). If $\vec{r} = x\hat{\imath} + y\hat{\jmath} + z\hat{k}$ and $u = x^2 + y^2 + z^2$, Find $div.(u\vec{r}\,)$ in terms of u.
20	(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. (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. (iii). The glider is given an initial displacement $x_0 = +0.015\, m$ and an initial velocity $v_{0x} = +0.40 m/s$ (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.