Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2021

Course: Mathematical Physics — **Semester: I**
Program: B.Sc. (H) Physics and Integrate B.Sc. M.Sc. Physics — **Time 03 hrs.**
Course Code: PHYS 1011 — **Max. Marks: 100**

SECTION A

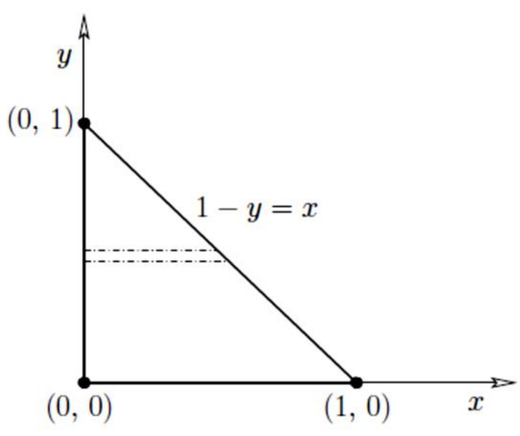
1. Each Question will carry 4 Marks
2. Instruction: Write the statement / Select the correct answer(s)

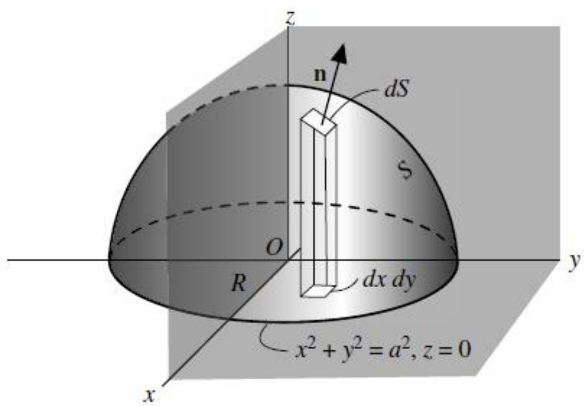
S. No.		Marks	CO
Q1	What are the key differences between Normal, Binomial, and Poisson Distribution?	**4**	**CO1**
Q2	A population grows at a rate of 5% per year. How long does it take for the population to double?	**4**	**CO2**
Q3	Solve the differential equation $(x^2 + y^2 + 2x)dx+2ydy=0$.	**4**	**CO2**
Q4	The curl of vector field $\vec{f}(x, y, z) = x^2\hat{i} + 2z\hat{j} - y\hat{k}$ is ?	**4**	**CO3**
Q5	Find the particular integral of $(D^3 - 3D^2+4)y= e^{2x}$.	**4**	**CO2**

SECTION B

1. Each question will carry 10 marks
2. Instruction: Write short / brief notes

Q6	a) If A is a Hermitian (skew-Hermitian) matrix, show that iA is a skew Hermitian (Hermitian) matrix. b) Define Dirac Delta function and list its important properties.	**10**	**CO1**
Q7	a) Define differentiability of a function at a given point. What is the necessary and sufficient condition for a function to be differentiable (State mathematically)? b) Write the expressions for the 'del' operator in Cartesian, cylindrical and spherical coordinates.	**10**	**CO1**
Q8	If $\vec{r} = x\hat{\imath} + y\hat{\jmath} + z\hat{k}$, then show that a) $\vec{\nabla} r = \frac{\vec{r}}{r}$ b) $\vec{\nabla}\left(\frac{1}{r}\right) = -\frac{\vec{r}}{r^3}$	**10**	**CO3**
Q9	Find complete solution of any of the following differential equations:	**10**	**CO2**

	$$(1+x)^2\frac{d^2y}{dx^2}+(1+x)\frac{dy}{dx}+y=\sin[2\log(1+x)]$$ OR $$(D^2-4D+4)y=8x^2e^{2x}\sin 2x$$		
SECTION-C **1. Each Question carries 20 Marks.** **2. Instruction: Write long answers.**			
Q10	(a) Find the angle between the surfaces $z=x^2+y^2$ and $z=\left(x-\frac{\sqrt{6}}{6}\right)^2+\left(y-\frac{\sqrt{6}}{6}\right)^2$ at the point $P=\left(\frac{\sqrt{6}}{12},\frac{\sqrt{6}}{12},\frac{1}{12}\right)$. (b) Find the constants a,b,c so that $\vec{F}=(x+2y+az)\hat{\imath}+(bx-3y-z)\hat{\jmath}+(4x+cy+2z)\hat{k}$ is irrotational and hence find the function φ such that $\vec{F}=\vec{\nabla}\varphi$	**20**	**CO3**
11	(a) Calculate the work done in moving a particle once around a circle C in the xy-plane if the circle has center at the origin and radius 3 and if the force field is given by $\vec{F}=(2x-y+z)\hat{\imath}+(x+y-z^2)\hat{\jmath}+(3x-2y+4z)k$. Does the work done in this case depend on path? Justify your answer. (b) Evaluate $$\int\int_S x\,y^2\,dx\,dy,$$ on the surface given below:  	**20**	**CO4**

	OR [Either do above (a) and (b) both, or the following] Suppose $\mathbf{F} = y\mathbf{i} + (x - 2xz)\mathbf{j} - xy\mathbf{k}$. Evaluate $\iint_S (\nabla \times \mathbf{F}) \cdot \mathbf{n}\, dS$ where S is the surface of the sphere $x^2 + y^2 + z^2 = a^2$ above the xy-plane  		
	END		