LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

B.Sc. DEGREE EXAMINATION – **PHYSICS**

THIRD SEMESTER – **NOVEMBER 2022**

UPH 3502 – MATHEMATICAL PHYSICS - II

Date: 03-12-2022 Dept. No. Max. : 100 Marks

Time: 09:00 AM - 12:00 NOON

	SECTION - A		
Q. No.	**Answer ALL questions**		
1.	**MCQ** **(5 x 1 = 5)**		
(a)	The partial differential equation $\frac{\partial^2 u}{\partial x^2} - \frac{1}{c^2}\frac{\partial^2 u}{\partial t^2} = 0$ is (i) Wave equation (ii) Heat equation (iii) Laplace equation (iv) Helmholtz equation	K1	CO1
(b)	Problems leading to solution of partial differential equations with __________ conditions are known as boundary value problems. (i) boundary (ii) initial (iii) boundary and initial (iv) none	K1	CO1
(c)	Newton's interpolation formula can be applied to ______ spaced data. (i) equally (ii) unequally (iii) both (iv) hard to say	K1	CO1
(d)	Linear property of Fourier transform is (i) $F\{f(x) + g(x)\} = F\{f(x)\} + F\{g(x)\}$ (ii) $F\{f(x) + g(x)\} = F\{f(x)\} + F\{g(x)\} + 2\, F\{f(x)\} * F\{g(x)\}$ (iii) $F\{f(x) + g(x)\} = F\{f(x)\} * F\{g(x)\}$ (iv) $F\{f(x) + g(x)\} = F\{f(x)\} - F\{g(x)\}$	K1	CO1
(e)	In Newton-Raphson method if the curve $f(x)$ is constant then ___________. (i) $f(x) = 0$ (ii) $f'(x) = c$ (iii) $f''(x) = 0$ (iv) $f'(x) = 0$	K1	CO1
2.	**Definition/Formula** **(5 x 1 = 5)**		
(a)	Partial Differential Equation	K1	CO1
(b)	Even and odd functions	K1	CO1
(c)	Interpolation	K1	CO1
(d)	Laplace equation	K1	CO1
(e)	Euler's modified method	K1	CO1

3.	**Match the following**	**(5 x 1 = 5)**		
(a)	Wave equation	Differential equations	K2	CO1
(b)	Heat equation	Signal processing	K2	CO1
(c)	Euler's Method	Integration	K2	CO1
(d)	Fourier Transform	Vibrating Strings	K2	CO1
(e)	Simpson's rule	Hot bodies	K2	CO1
4.	**State True or False**	**(5 x 1 = 5)**		
(a)	Heat equation is applied to a vibrating string.		K2	CO1
(b)	Wave equation is a third-order linear partial differential equation.		K2	CO1
(c)	The transform of the sum of two functions is given by a convolution integral.		K2	CO1
(d)	Extrapolation is the technique of computing the value of the function outside the range of given values.		K2	CO1
(e)	Simpson's one-third rule is used in numerical differentiation.		K2	CO1

SECTION – B

Answer any TWO of the following **(2 x 10 = 20)**

5.	Solve $\frac{\partial^2 u}{\partial r^2} + \frac{1}{r}\frac{\partial u}{\partial r} + \frac{1}{r^2}\frac{\partial^2 u}{\partial \theta^2} = 0$ by the method of separation of variables.	K3	CO2
6.	State and prove the convolution theorem in Fourier transform.	K3	CO2
7.	The following table displays the population of a town during the last six decades. Calculate the population in 2006 using any suitable interpolation formula.	K3	CO2
8.	Apply Newton-Raphson method to obtain a root of $x^3 - 2x - 5 = 0$, upto two decimal places.	K3	CO2

Table for question 7:

Year	1971	1981	1991	2001	2011	2021
Population in lakhs	12	15	20	27	39	52

SECTION – C

Answer any TWO of the following **(2 x 10 = 20)**

9.	Employ the method of least squares to fit a straight line through the following data	K4	CO3
10.	Write down one dimensional heat equation and solve it to obtain the general solution.	K4	CO3
11.	Calculate $\int_0^{\pi} sinx\, dx$ by using Trapezoidal rule. Compare the result with the result of actual integration.	K4	CO3

Table for question 9:

Voltage (V)	1	2	3	4
Current (mA)	1.7	1.8	2.3	3.2

12.	(a) Mention some applications of Fourier Transforms. (b) Find the Fourier transform of the function. $f(x) = e^{-ax^2},\ where\ a > 0.$ (3 + 7)	K4	CO3

SECTION – D

Answer any ONE of the following **(1 x 20 = 20)**

13.	(a) Derive the one-dimensional wave equation for a vibrating string. (10) (b) Obtain the D'Alembert's solution of 1D wave equation. (10)	K5	CO4
14.	Estimate the numerical solution of $\frac{dy}{dx} = x + y$ for x = 0 to 0.2 using Euler's method with the initial condition $x_o = 0$ and $y_o = 1$, taking h = 0.025.	K5	CO4

SECTION – E

Answer any ONE of the following **(1 x 20 = 20)**

15. Apply Newton's forward and backward interpolation formulae to find the temperature of an object during the 44th minute from the following data and compare the results. K6 CO5

Time (min)	10	20	30	40	50
Temperature (°C)	46	66	81	93	101

16. Write the Fourier Transform of the functions (15 + 5) K6 CO5

a) $f(x) = \begin{cases} 1 + \frac{x}{a}, -a < x < 0 \\ 1 - \frac{x}{a}, 0 < x < a \\ 0, otherwise \end{cases}$

b) $f(x) = \begin{cases} 1,\ for\ |x| < a \\ 0,\ for|x|\ > a \end{cases}$

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