

Eq. (2) SARDAR PATEL UNIVERSITY  Bachelor of Science (Semester 5) Examination – 2022  US05CPHY22: Mathematical Methods  Date: $11/11/2022$ Friday  Time: $10:00$ am to $1:00$ pm  Total: 70 Marks  NOTE:  1. Figure to the right indicate full marks of the questions. 2. The symbols have their usual meaning.  Q-1 Multiple Choice Questions (1) In equation: $ds^2 = h_1^2 du^2 + h_2^2 dv^2 + h_3^2 dw^2$ ; $h_1, h_2 \otimes h_3$ are called	Seat No	0.:		No. of Printed Pages	: 2		
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(8) $y = ax^2 + bx + c$ is the equation of		(c) $\Delta u = v \Delta + \begin{vmatrix} av \\ du \end{vmatrix}$					
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(a) Parabola (b) Hyperbola	(8)	$y = ax^2 + bx + c$ is the equation of _		Hyperhola			

(c) Straight Line

(d) Ellipse

The forward difference operator  $\Delta$  defined as \_\_\_\_

(b)  $\Delta y_i = y_i - y_{i+1}$ (d)  $\Delta y_i = y_i - y_{i-1}$ 

(a)  $\Delta y_i = y_{i+1} - y_i$  (b)  $\Delta y_i = y_i - y_{i+1}$  (c)  $\Delta y_i = y_{i-1} - y_i$  (d)  $\Delta y_i = y_i - y_{i-1}$  In the Simpson's  $\frac{1}{3}$  rule, we have to use two subintervals of \_\_\_\_\_ width.

(a) Gradually increase

(b) Equal

(c) Gradually decrease

(d) Very large

Short Answer Questions (Attempt TEN out of TWELVE) Q-2

[20]

Define beta function. (1)

(2) Show that  $\beta(m, n) = \beta(n, m)$ .

Write Laplacian in terms of orthogonal curvilinear co-ordinates. (3)

(4)

Show that  $P_n(-\mu) = (-1)^n P_n(\mu)$ . Show that  $xJ'_n(x) = nJ_n(x) - xJ_{n+1}(x)$ . (5)

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<ul> <li>(6) Write Hermite's differential equation.</li> <li>(7) Write three-dimensional diffusion equation.</li> <li>(8) Write cosine series for f(x) when 0 ≤ x ≤ π. (Note: derivation is not required)</li> <li>(9) Find a<sub>0</sub> for f(x) = x + x² in the interval -π « x « π.</li> <li>(10) Write the principle of least squares.</li> <li>(11) Define interpolation and extrapolation.</li> <li>(12) Derive an equivalent equation of a straight line for y = ae<sup>bx</sup>.</li> </ul>	
<ul> <li>Q-3 (A) Prove that the product of sets of two triads of mutually orthogonal vectors are reciprocal to each other.</li> <li>(B) If u = x + 5, v = 2y - 4, w = 3z + 1 show that u, v, w are orthogonal and find ds² and metrical coefficients h<sub>1</sub>, h<sub>2</sub>, h<sub>3</sub>.</li> </ul>	[06] [04]
OR  Define orthogonal curvilinear co-ordinates and derive expression of curl in terms of orthogonal curvilinear coordinates.  (B) If $x = u  v \cos w$ , $y = u  v \sin w$ , $z = \frac{1}{2}  (u^2 - v^2)$ , find $h_1$ , $h_2$ , $h_3$ and show that $ds^2 = (u^2 + v^2)(du^2 + dv^2) + u^2v^2dw^2$	[06] [04]
<ul> <li>Q-4 (A) State and derive Rodrigue's formula.</li> <li>(B) Show that P<sub>n</sub>(μ) is the coefficient of h<sup>n</sup> in (1 – 2μh + h<sup>2</sup>)<sup>-1</sup>/<sub>2</sub>.</li> <li>(A) Derive the series solution of Bessel's differential equation in the form of ascending power of x.</li> <li>(B) Using equation: H<sub>n</sub>(x) = e<sup>x<sup>2</sup></sup>(-1)<sup>n</sup> d<sup>n</sup> e<sup>-x<sup>2</sup></sup>/dx<sup>n</sup>, find out H<sub>0</sub>(x) and H<sub>1</sub>(x).</li> <li>Q-5 (A) Define Fourier series and derive the expression of Fourier series for a periodic function f(x) in the interval (-π, π).</li> <li>(B) Derive one dimensional diffusion equation for one dimensional flow of electricity in a long-insulated cable.</li> </ul>	[06] [04] [06] [04] [06]
<ul> <li>(A) Obtain Fourier series for the expansion of f(x) = x sin x in the interval -π « x « π.</li> <li>(B) Derive one dimensional wave equation by considering a flexible string of length l tightly stretched between two points x = 0 and x = l on X - axis.</li> <li>Q-6 (A) Evaluate f(2.5) using Lagrange's interval the</li> </ul>	[06] [04]
(B) Derive Lagrange's interpolation formula.	[06] 04]
(A) Find the approximate value of $y = \int_0^{\pi} \cos x  dx$ using Simpson's 1/3 rule by dividing the range of integration into six equal parts. What is the analytical value of the above integral?  (B) Derive Simpson's 1/3 <sup>rd</sup> rule in composite form	06] 14]
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