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NATIONAL OPEN UNIVERSITY OF NIGERIA University Village, Plot 91, Cadastral Zone, Nnamdi Azikwe Express Way, Jabi-Abuja FACULTY OF SCIENCES Department of Mathematics 2021 Examinations

Course Code: MTH307 Course Title: Numerical Analysis II Credit Unit: 3 Time Allowed: 3 Hours Total: 70 Marks Instruction: Answer Question One (1) and Any Other 4 Questions

1. (a) Given the general second order Partial Differential Equation

$$L(u) = Au_{xx} + Bu_{yy} + Cu_{yy} - H(x, y, u, u_{x}, u_{y}) = 0$$

Classify the following equation into Parabolic, Elliptic and Hyperbolic.

i. $u_t = u_{xx}$

ii.
$$u_{tt} = u_{xx}$$

- iii. $u_{xx} + u_{yy} = 0$
- (b) When is Partial Differential Equation said to be Parabolic, Elliptic and Hyperbolic.

(5 marks)

(5 marks)

(c) Solve the Laplace equation $u_{xx} + u_{yy} = 0$, subject to the boundary conditions $u(x,0) = 1, u(0, y) = 0, u(1, y) = 0, u(x,1) = 1; 0 \le x \le 1, 0 \le y \le 1.$ (12 marks)

- 2. (a) Express the function x³ + 2x² x 3 in terms of Legendre polynomials.(5 marks)
 (b) Find the fourth degree least square polynomials to |x| over [-1, 1] by means of Legendre polynomials. (7 marks)
- 3. (a) Show that $T_n(x)$ satisfies the differential equation $(1-x^2)y'' xy' + n^2y = 0$

(5 marks)

(b) Convert the first 5 terms of the Taylor series expansion for e^x into Chebyshev

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polynomials.

4. (a) Determine the parameters in the formula

$$p(x) = a_o (x-a)^3 + a_1 (x-a)^2 + a_2 (x-a) + a_3 \text{ such that}$$

$$p(a) = f(a), \ p'(a) = f'(a), \ p(b) = f(b), \ p'(b) = f'(b).$$
(5 marks)

(b) Obtain the unique polynomial p(x) of degree 5 or less approximating the function

$$f(x)$$
, where $f(x_0) = 1$, $f'(x_0) = 2$. Also, find $p\left(\frac{(x_0 + x_1)}{2}\right)$. (7 marks)

- 5. (a) Distinguish between Trapezoidal and Simpson's rule. (5 marks)
 - (b) Evaluate $\int_{1}^{3} \frac{1}{x+1} dx$ using the Simpson's one-third rule with $h = \frac{1}{4}$, working with four

floating point arithmetic.

- 6. (a) State the properties of a cubic spline interpolation. (5 marks)
 - (b) Obtain the cubic spline from data below and compute y(1.5) and y'(1).

X	1	2	3
Y	-8	-1	18

(7 marks)

(7 marks)

(7 marks)