B.A. /B.Sc. Part-III (Honours) Examination, 2020 (1+1+1)
Subject: Mathematics
Paper: VIII

Time: 2 Hours Full Marks: 50

The figures in the margin indicate full marks.
Candidates are required to write their answers in their own words as far as practicable.
[Notation and Symbols have their usual meaning]

1. Answer *any seven* questions: 7×5 = 35

(a) Define relative error. Find the number of significant figures in the approximate number 0.4625 when the relative error is given by 0.2×10^{-2}. 2+3

(b) Show that Newton-Raphson method has quadratic rate of convergence. 5

(c) Describe the Gauss-Seidel iteration method of solving a system of linear equations. State the conditions for convergence of this method. 4+1

(d) Establish Newton-Cotes' numerical integration formula (closed type). 5

(e) Show that the sum of the Lagrangian coefficients is unity. 5

(f) Verify that the Simpson's 1/3 rule is exact for polynomial of degree less than or equal to 3. 5

(g) Prove that the n-th order divided difference of a polynomial of degree n is constant. 5

(h) Define degree of precision of a quadrature formula. For any numerical quadrature formula with $(n+1)$ nodes prove that it's degree of precision $\geq n$. 2+3

(i) Describe the bisection method to find a root of the equation $f(x) = 0$ when $f(a) \cdot f(b) < 0$, a, b be two specified numbers. Is this condition necessary to get a root using this method ? Justify your answer. 3+2

2. Answer *any three* questions: 3×5 = 15

(a) Using binary arithmetic, obtain the value of $(94.5)_{10}$ - $(43.75)_{10}$ after converting the numbers to binary forms. 5

(b) For computing n!, write a program in C language. 5

(c) Write the necessary C statements to evaluate $f(x) = \begin{cases} x^2 + \cos(2x), & \text{if } x < 2 \\ 4, & \text{if } x = 2 \\ x^3 + \sin(3x), & \text{if } x > 2 \end{cases}$ 5

(d) Compare 'while', 'do-while' and 'for' loops in C. 5

(e) Write a program in C to compute the roots of a quadratic equation with real coefficients.

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[Notation and Symbols have their usual meaning]

2. Answer *any seven* questions: 7×5 = 35

(j) Define relative error. Find the number of significant figures in the approximate number 0.4625 when the relative error is given by 0.2×10^{-2}. 2+3

(k) Show that Newton-Raphson method has quadratic rate of convergence. 5

(l) Describe the Gauss-Seidel iteration method of solving a system of linear equations. State the conditions for convergence of this method. 4+1

(m) Establish Newton-Cotes' numerical integration formula (closed type). 5

(n) Show that the sum of the Lagrangian coefficients is unity. 5

(o) Verify that the Simpson's 1/3 rule is exact for polynomial of degree less than or equal to 3. 5

(p) Prove that the n-th order divided difference of a polynomial of degree n is constant. 5

(q) Define degree of precision of a quadrature formula. For any numerical quadrature formula with $(n+1)$ nodes prove that it's degree of precision $\geq n$. 2+3

(r) Describe the bisection method to find a root of the equation $f(x) = 0$ when $f(a) \cdot f(b) < 0$, a, b be two specified numbers. Is this condition necessary to get a root using this method ? Justify your answer. 3+2

2. Answer *any three* questions: 3×5 = 15

(a) Write a FORTRAN program for computing $n!$ for a given positive integer n. 5

(b) Translate the following mathematical expressions into FORTRAN equivalent form:

(i) $\frac{x^3}{3}\log_e|x-y|-\left(\frac{ax+by}{cx+dy}\right)^{\frac{1}{3}}$,

(ii) $x^{\frac{2}{3}}+y^{\frac{2}{3}}-e^{|x|}$ 5

(c) Write a FORTRAN program to search for the prime numbers between 3 and 20. 5

(d) Mention the advantages and disadvantages of assembly language over high level language. 5

(e) Write a FORTRAN program to compute the roots of a quadratic equation with real coefficients. 5