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Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2013/2014

COURSE NAME	:	COMPUTER PROGRAMMING
COURSE CODE	:	BDU 10103
PROGRAMME	:	1 BDC / 1BDM
EXAMINATION DATE	:	JUNE 2014
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **TWO (2)** QUESTIONS IN PART A AND **ONE (1)** QUESTION IN PART B

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

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SECTION A

Q1 The trigonometric function of cos (x) in power series representation is given as

$$\cos(x) = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \frac{x^8}{8!} + \dots + \frac{(-1)^n x^{2n}}{(2n)!}$$

for all real x

Provide the flow chart and computer code. The developed computer code should have following features :

a) User can key in for any order N of the series and any value of x.
b) On the monitor screen appear a comparison result between above series function and the intrinsic internal cosine function provided by the FORTRAN compiler in term of their values and percentages difference between them.

(30 Marks)

Q2 Given two functions y(x) and z(x) are defined respectively in the form as :

$$y(x) = \begin{cases} \left(x^3 + 2.5x + 12\right)\dfrac{6x+1}{x^2 + x + 12} ; & 0 \le x \le 2 \\ x\sqrt{3x+1} + 4 ; & 2 < x \le 4 \\ \log_{10}\left(4x^2 + 14\right); & 4 < x \le 6 \end{cases}$$

and

$$z(x) = \begin{cases} 3x^2 + 6\left|x+3\right| + 2; & 0 \le x \le 3 \\ \ln\left(3x^2 + 9\right); & 3 < x \le 6 \end{cases}$$

Provide the flow chart and computer code. The result should appear on the monitor screen as follows:

a) User can key in name of output file and the interval between two successive points dx.
b) On the monitor screen appears the result in the form of table is shown below

Computational Result :

No	x	y	z
1	0.000	......	......
2	0.010	......	......
3	0.020	....	......
......	......	......	......
......	......	......	......
......	......	......	......
......	......	......	......
N-1	5.900	....	......
N	6.000	....	......

(30 Marks)

Q3 Numerical integration approach called as Gauss – Legendre Quadrature method introduces that the integral function , $\int_a^b \mathbf{f(x)}\,dx$, can be approximated as :

$$\int_a^b \mathbf{f(x)}\,dx = \frac{b-a}{2}\int_{-1}^{1} \mathbf{f}\left(\frac{b-a}{2}\xi + \frac{b+a}{2}\right) d\xi \approx \frac{b-a}{2}\sum_{k=1}^{N} \mathbf{W}(\xi_k)\,\mathbf{f}\left(\frac{b-a}{2}\xi_k + \frac{b+a}{2}\right)$$

where :

ξ_k is the kth zero of the Legendre Polynomial $P_n(\xi)$

$\mathbf{W}(\xi_k)$ is the weighting function of $\mathbf{f}(\xi_k)$

The values of these two coefficients, ξ_k and $\mathbf{W}(\xi_k)$, are depended on the selected order of Gauss Legendre Integration Method has been applied, In the case of fourth order, the Gauss – Legendre Quadrature's coefficients ξ_k and $\mathbf{W}(\xi_k)$ are given in Table Q3 as below.

Table Q3 The values of ξ_k and W(ξ) of Fourth Orders Gauss – Legendre Integration Method

Fourth Orders Gauss – Legendre Quadrature yhyhMethod		
k	Abscissas ξ_k	Weighting $\mathbf{W}(\xi_k)$
1	-0.861136311594	0.347854845137
2	-0.339981043585	0.652145154863
3	0.339981043585	0.652145154863

4	0.861136311594	0.347854845137

If function f(x) is given by :

$$\mathbf{f(x) = 10x^2 + 2|x - 1| + 10}$$

Provide the flow chart and computer code for this numerical integration approach. The computer code should allow user to key in the value of the integral boundary a and b as input.

(30 Marks)

PART B

Q4 The coordinate of upper and lower surface of Naca - X airfoil is given in Table Q4. The number of points distributed for each surface is 49.

TABLE Q4 Data Coordinate of NACA – X Airfoil

Geometry of NACA – X Airfoil No of point : 49			
Upper Surface		Lower Surface	
XU	YU	XL	YL
0.00000	0.00000	0.00000	0.00000
0.00110	0.00900	0.00110	-0.00230
0.00430	0.01570	0.00430	-0.00570
0.00960	0.02700	0.00960	-0.00970
0.01700	0.03570	0.01700	-0.01280
0.02650	0.04400	0.02650	-0.01520
0.03810	0.05220	0.03810	-0.01720
...	...	...	...
...	...	...	...
...	...	...	...
0.69130	0.08590	0.69130	0.02340
0.72110	0.07930	0.72110	0.02530
0.75000	0.07270	0.75000	0.02670
0.77780	0.06610	0.77780	0.02740
0.80440	0.05960	0.80440	0.02770
0.82970	0.05320	0.82970	0.02730
0.85350	0.04710	0.85350	0.02630
0.87590	0.04110	0.87590	0.02480
0.89670	0.03550	0.89670	0.02280
0.91570	0.03020	0.91570	0.02050
0.93300	0.02520	0.93300	0.01790
0.94840	0.02040	0.94840	0.01510
0.96190	0.01600	0.96190	0.01220
0.97350	0.01190	0.97350	0.00920
0.98300	0.00820	0.98300	0.00630
0.99040	0.00500	0.99040	0.00370
0.99570	0.00250	0.99570	0.00170
0.99890	0.00070	0.99890	0.00040
1.00000	0.00000	1.00000	0.00000

In aerodynamics analysis, one may require to determine the ordinate airfoil at any given x position by using a numerical interpolation technique. Let it uses the Lagrange Interpolation method.

For a given pair of data set (x_i, y_i), $i=1,2,..,N$, the general form of Lagrange interpolation method provides the expression for obtaining the interpolated value y for a given x in the form as :

$$\mathbf{y}(\mathbf{x}) = \sum_{i=1}^{N} L_i(\mathbf{x}) y_i$$

where

$$L_i(\mathbf{x}) = \frac{(x-x_1)(x-x_2)\ldots(\mathbf{x}-\mathbf{x}_{i-1})(x-x_{i+1})\ldots(x-x_{N-1})(x-x_N)}{(x_i-x_1)(x_i-x_2)\ldots(\mathbf{x}_i-\mathbf{x}_{i-1})(x_i-x_{i+1})\ldots(x_i-x_{N-1})(x_i-x_N)}$$

for $i = 1,2, \ldots, N$ and $i \neq j$

If the number of points N set to be equal 4, this Lagrange interpolation method called as Four Points Lagrange Interpolation Method.
Provide the flow chart and computer code for this Four Points Lagrange Interpolation method applicable for any value of x.

(40 Marks)

Q5 The distribution of cross section areas A(x) for a convergent divergent nozzle are given by:

$$A(x) = 1.0 + \frac{1}{2}(A_1 - 1)\left[1 + \cos\left(\frac{\pi x}{0.35}\right)\right] \quad \text{for} \quad 0 \le x \le 0.35$$

And

$$A(x) = 1.0 + \frac{1}{2}(A_2 - 1)\left[1 - \cos\left(\frac{\pi(x - 0.35)}{0.65}\right)\right] \quad \text{for} \quad 0.35 \le x \le 1.0$$

Where : $A_1 = 1.5$ and $A_2 = 2.5$.

In the case of chocked flow, the distribution of Mach number along the nozzle can be obtained by solving the following equation.

$$\frac{\mathbf{A(x)}}{\mathbf{A^*}} = \frac{1}{\mathbf{M}}\left(\left(\frac{2}{\gamma+1}\right)\left[1+\left(\frac{\gamma-1}{2}\mathbf{M}^2\right)\right]\right)^{\frac{\gamma+1}{2(\gamma-1)}}$$

Where :

γ : heat coefficient ratio = 1.4
M : Mach number
A^* : Area reference = A_t for chocked flow condition
A_t : Nozzle throat area

As the Mach number is known, the flow properties in term of pressure P, Temperature T and density ρ can be determined from:

$$\frac{\mathbf{P}}{\mathbf{P_0}} = \left[1+\left(\frac{\gamma-1}{2}\mathbf{M}^2\right)\right]^{\frac{\gamma-1}{\gamma}}$$

$$\frac{\mathbf{T}}{\mathbf{T_0}} = \frac{1}{1+\left(\frac{\gamma-1}{2}\mathbf{M}^2\right)}$$

$$\rho = \frac{p}{R\,T}$$

In above equation the stagnation pressure P_0 and the stagnation temperature T_0, are given values as the flow condition in the reservoir. R is universal constant gas equal to 287 $J/^0K$.

Let use Newton Raphson iteration method for solving this problem, Provide the flow chart and computer code. This computer will produce the result which appears on the monitor screen as depicted below.

```
Calculation Result of Convergent – Divergent Nozzle
Nozzle Geometry : Anderson J.D. Jr Computational Fluid Dynamics
=========== ===========================
=
No      X      Area      Mach No      Pressure      Temperature
=========== ==========================
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(40 Marks)

- END OF QUESTION -