UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF MARINE ENGINEERING TECHNOLOGY

FINAL EXAMINATION
JANUARY 2017 SEMESTER

COURSE CODE	: LGB20103
COURSE NAME	: NUMERICAL METHODS
PROGRAMME NAME (FOR MPU: PROGRAMME LEVEL)	: BACHELOR OF ENGINEERING TECHNOLOGY (HONS) IN NAVAL ARCHITECTURE & SHIPBUILDING
DATE	: 07/07/2017 FRI
TIME	: 9.00 AM - 12.00 PM
DURATION	: 3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please read CAREFULLY the instructions given in the question paper.
2. This question paper has information printed on both sides.
3. This question paper consists of TWO (2) sections; Section A and Section B. Answer ALL questions in Section A and THREE (3) questions from Section B.
4. Please write yours answers on the answer booklet provided.
5. Write your answers only in BLACK or BLUE ink.
6. Answer all questions in English.

THERE ARE 7 PAGES OF QUESTIONS, INCLUDING THIS PAGE.

SECTION A (Total: 40 marks)

INSTRUCTION: Answer ALL questions.
Please use the answer booklet provided.

Question 1

(a) Define numerical computing and list the **Four (4)** characteristics of it.

(4 marks)

(b) List the **Three (3)** different types of programming structures? Explain each of those with flow chart.

(6 marks)

(c) Convert to the binary values of the decimal number 3.14579. (Consider 6 digits after decimal point for the binary values)

(6 marks)

(d) Define 'absolute error' and 'relative error'.

(4 marks)

Question 2

(a) Solve the following equation using Newton-Raphson method.

$$f(x) = 2x^3 - 11.7x^2 + 17.7x - 5$$

Given $x_0 = 3$ and convergence rate $E_r = 10^{-4}$. Do all calculation in 4 decimal points.

(10 marks)

(b) Solve the following equation using fixed point iteration method.

$$f(x) = \frac{1.5x}{(1+x^2)^2} - 0.65\tan^{-1}\left(\frac{1}{x}\right) + \frac{0.65x}{1+x^2} = 0,$$

Given $x_1 = 0.1$ and convergence rate $E_a = 10^{-5}$. Do all calculation in 4 decimal points.

(10 marks)

SECTION B (Total: 60 marks)

INSTRUCTION: Answer only THREE (3) questions.

Question 3

(a) Solve the linear system below by using Gauss-Jordan elimination method.

$$\begin{gathered} 2x_1 + 4x_2 - 6x_3 = -8 \\ x_1 + 3x_2 + x_3 = 10 \\ 2x_1 - 4x_2 - 2x_3 = -12 \end{gathered}$$

(10 marks)

(b) Solve the linear system below using Gauss-Seidel Iteration method. Do the calculations up to 2nd iteration.

$$\begin{gathered} 2x_1 + x_2 + x_3 = 5 \\ 3x_1 + 5x_2 + 2x_3 = 15 \\ 2x_1 + x_2 + 4x_3 = 8 \end{gathered}$$

(10 marks)

Question 4

(a) The value of e^x are shown in Table 1:

Table 1

x	1.0	1.2	1.4	1.8
e^x	2.7183	3.3201	4.0552	6.0496

It is observed that $e^c = 3$ for $c \approx 1.1$. Therefore, from the table given, evaluate the value of $P_2(1.1)$ accurately by using Lagrange interpolation polynomial method.

(10 marks)

(b) Inspect whether the following functions are splines or not.

$$f(x) = \begin{cases} x^2 - 3x + 1, & 0 \le x \le 1 \\ x^3 + x^2 - 3, & 1 \le x \le 2 \\ x^3 + 5x - 9, & 2 \le x \le 3 \end{cases}$$

(10 marks)

Question 5

(a) You are given values of $f(x) = xe^x$ as shown in Table 2:

Table 2

x	1.8	1.9	2.0	2.1	2.2
$f(x)$	10.8894	12.7032	14.7781	17.1489	19.8550

Calculate the above function for $f'(2.0)$ by using the following formulas and evaluate absolute error for each method. Give your answer at up to 4 decimal points.

i. $f'(x) \approx \frac{f(x+h)-f(x)}{h},\ h = 0.1$

(5 marks)

ii. $f'(x) \approx \frac{f(x+h)-f(x-h)}{2h},\ h = 0.2$

(5 marks)

iii. $f'(x) \approx 1/2\mathrm{h}\,(-f(x+2h) + 4f(x+h) - 3f(x)),\ h = 0.1$

(5 marks)

(b) Calculate the following integral using Simpson's 1/3 rule.

$$\int_0^{\pi/2} \sqrt{\sin(x)}\ dx$$

(5 marks)

Question 6

(a) Solve the differential equation by the simple Euler's method to estimate $y(1)$ using $h = 0.2$.

$$\frac{dy}{dx} = x^2(1 - 3y), \quad y(0) = 1$$

Compare your results with the exact answer given the analytical solution as

$$y(x) = \frac{2}{3}e^{-x^3} + \frac{1}{3}$$

(17 marks)

(b) Show graphically how Euler method solves the ordinary differential equation (ODE) with initial value problem.

(3 marks)

END OF EXAMINATION PAPER

Appendix 1 Formulas

Solution of Nonlinear Equation
$$x_{i+1} = x_i - \left[\frac{f(x_i)}{f'(x)}\right],\ i = 2,3,4 \ldots (1)$$ $$x_{i+1} = x_i - f(x_i)\left[\frac{x_i - x_{i-1}}{f(x_i) - f(x_{i-1})}\right],\ i = 2,3,4 \ldots (2)$$ $$x_{i+1} = g(x_i),\ i = 2,3,4 \ldots (3)$$
Numerical Differentiation
$$f'(x) = \frac{f(x+h) - f(x)}{h} \ldots (4)$$ $$f'(x) = \frac{f(x+h) - f(x-h)}{2h} \ldots (5)$$ $$f'(x) = \frac{-3f(x) + 4f(x+h) - f(x+2h)}{2h} \ldots (6)$$ $$f'(x) = \frac{3f(x) - 4f(x-h) + f(x-2h)}{2h} \ldots (7)$$ $$f''(x) \approx \frac{1}{\mathrm{h}^2}\left(f(x+h) - 2f(x) + f(x-h)\right) \ldots\ldots (8)$$
Numerical Integration
$$I_{S1} = (b-a)\frac{f(a) + 4f(x_1) + f(b)}{6} \ldots\ldots (9)$$
Ordinary Differential Equations initial value
$$y_{i+1} = y_i = y_0 + hf(x_i, y_i) \ldots \ldots (10)$$