OCD081

UNIVERSITY OF BOLTON

OFF CAMPUS DIVISION

MALAYSIA - KTG

BENG (HONS) MECHANICAL ENGINEERING

SEMESTER 1 EXAMINATION 2019/2020

ENGINEERING MODELLING AND ANALYSIS

MODULE NO. AME5004

Past Examination Paper

Date: Friday 17th January 2020 **Time: 3 Hours**

INSTRUCTIONS TO CANDIDATES:

There are FOUR questions on this paper.

Answer ALL questions.

All questions carry equal marks.

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Q1 a) A periodic function, $f(x)$ with period 2π is defined within the period $-\pi < x < \pi$ by

$$f(x) = \begin{cases} -2, & when \quad -\pi < x < -\dfrac{\pi}{2} \\ 2 & when \quad -\dfrac{\pi}{2} < x < \dfrac{\pi}{2} \\ -2 & when \quad \dfrac{\pi}{2} < x < \pi \end{cases}$$

i) Sketch the graph of the function, $f(t)$. (2 marks)

ii) Verify whether the function is odd, even or neither. (2 marks)

iii) Hence, obtain the Fourier series expansion of the function. (8 marks)

b) A liquid level control model system and its representation by a block diagram as shown in **Fig.Q1 a) and b).** Determine the way the output model of control system will vary with time if the controller is

i) proportional only with a gain of 2, (5 marks)

ii) integral only with an integral gain of 2. (8 marks)

Total 25 Marks

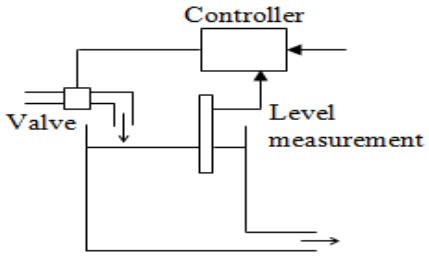

Fig.Q1 a)

Question 1b continued over the page. Please turn the page.

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Question 1b cont'd…

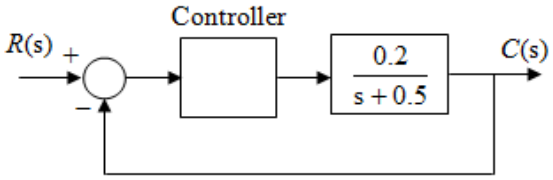

Fig.Q1 b)

Q2 a) Consider a set of linear system

$$9x_1 + x_2 + x_3 = b_1$$
$$2x_1 + 10x_2 + 3x_3 = b_2$$
$$3x_1 + 4x_2 + 11x_3 = b_3$$

Apply the Jacobi method to approximate the solution of the above system given that vector, $b = [10,\ 19,\ 0]^T$ .By using $[x_1^0,\ x_2^0,\ x_3^0] = [0,\ 0,\ 0]$, conduct until three iterations.

(9 marks)

b) Use the Gauss-Seidel iteration method to determine the approximate solution for the set of linear system given.

(12 marks)

c) Compare the result obtained with the analytical solution $[x_1, x_2, x_3] = [1,\ 2,\ -1]^T$. Thus, state and explain which method has a faster convergence?

(4 marks)
Total 25 Marks

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Q3 a) Given the integral,

$$f(x)=\int_0^2 \frac{1}{3x+4}dx$$

Evaluate $f(x)$ by taking 4 subintervals by using the Trapezoidal rule and compare it with the actual integration.

(13 marks)

b) A rectangular solid container has sides of length *x* mm, width *y* mm and height *z* mm as shown in the **Fig.Q3 (b).** At a certain instant the sides *x* and *y* are expanding at the rates of 1 mm/s and 1 mm/s respectively and side *z* is contracting at a rate of 1 mm/s.Find the rate of increase of diagonal AC of the rectangular solid container when x is 5 mm, y is 4 mm and z is 3 mm.

(12 marks)

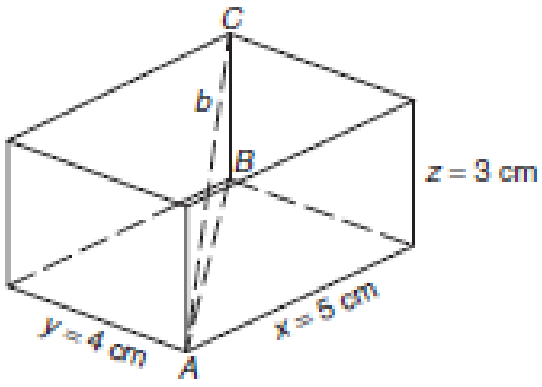

Fig.Q3 (b).

Total 25 Marks

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Q4 a) i) Three machines A,B and C produce respectively 50%,30% and 20% of the total number of items of a factory. The percentages of defective output of these machines are 3%,4% and 5%.If an item is selected at random, find the probability that the item is defective. (3 marks)

ii) Suppose an item is selected at random and is found to be defective. Find the probability that the item was produced by machine A. (3 marks)

b) i) Obtain a numerical solution using Euler's method for the differential equation

$$\frac{dy}{dx} = y - x,$$

with the initial conditions that at $x = 0, y = 2,$ for the range $x = 0(0.1)0.5.$ (12 marks)

ii) Sketch the graph for the above solution. (3 marks)

c) By an analytical method (using the integrating factor method), the solution of the above differential equation is given by $y = x + 1 + e^x$. Find the percentage error at $x = 0.3.$ (4 marks)

Total 25 Marks

END OF QUESTIONS

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