

S5 HOLIDAY PACKAGE

OS e-learning platform.

Principal mathematics (Numerical Analysis).

Item 1.

You're a young engineer working on a bridge design project. To ensure the structural integrity of the bridge, you need to calculate the area under a specific curve that represents the stress on the bridge's foundation. The curve is modelled by the function $1/(3x-1)$, and you need to estimate the area under this curve between 1 and 2

Your team lead asks you to:

- (a) Use 6 ordinates to estimate the area to four decimal places.
- (b) (i) Determine the error in your estimation in part (a), correct to four decimal places.
- (ii) Suggest how the error may be reduced to ensure a more accurate calculation for the bridge's design.

Task.

Perform your duty.

Item 2.

As a student intern at a manufacturing plant, you've been tasked with understanding and simulating a control loop that manages the relationship between two critical variables, c and x . Your supervisor has provided you with a flowchart that outlines the logic of the control loop.

The flowchart has the following operations:

- Initially, $c = 1$, $x = 1$, and $d = 1$.
- The loop increments c by 1 and updates x by adding d to it.
- The loop checks if $c = 5$.
 - If yes, the current values of c and x are written out.
 - If no, d is incremented by 2.

Task.

- a). Represent your analysis on suitable flow diagram.
- b). Perform an analysis to show how the values of c and x are changing.
- c). State the relationship between c and x

Expected responses.

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Item 3

Emily is a high school student working on a project that combines her math and science classes. She's analysing data from an experiment where she measured the effect of sunlight on plant growth. The data points are

- When she exposes plants to no hours of sunlight, she notices 9.2 cm of plant growth
- When she exposes plants to 8 hours of sunlight, she notices 6.0 cm of plant growth
- When she exposes plants to 12 hours of sunlight, she notices 4.4 cm of plant growth
- When she exposes plants to 20 hours of sunlight, she notices 1.5 cm of plant growth

Emily needs to use this data to make predictions for her math project and understand the relationship between sunlight and plant growth for her science experiment. She needs to:

- (i) Find the amount of sunlight needed to achieve a plant growth 0.8cm.
 - (ii) Find the expected plant growth when the plant receives 5 hours of sunlight.
- However she lacks some advance knowledge of mathematics and she needs your hand in this.

Task.

Help Emily.

Item 4

Alex, a civil engineering student, is working on a project to design a new suspension bridge. While analysing the structural integrity of the bridge, Alex encountered a critical issue. The stress on a key support beam is modelled by the equation $x^3 - 3x + 1 = 0$, and Alex needs to find the potential stress points to ensure the bridge's stability.

However, Alex is struggling to solve the equation and is worried about meeting the project deadline. Alex's task is to:

- (a) Graphically analyse the model to determine the number of potential stress points in the interval $[-2, 2]$ and estimate their values.
- (b) To find the smallest stress point (root) of the model with high precision. Alex has tried but can't seem to get the calculations right and needs help to iterate until the result is accurate to four significant figures.

Task.

Help Alex resolve this critical issue and ensure the bridge's stability

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Item bank available