ENG1060: COMPUTING FOR ENGINEERS

PASS 9 – Week 11

2020 OCT NOV

TASK 1

Consider the following function:

$$h(x) = \int_0^4 (1 + e^{-x})\,\mathrm{d}x$$

Using the following parameters in your functions:

- **func:** the function/equation that you are required to integrate
- **a, b:** the integration limits
- **n:** the number of **points** to be used for the integration
- **I:** Integral estimate

A. Write a function capable of performing numerical integration of h(x) using the **composite trapezoidal rule**. Use your function to solve the equation with 7 points.

B. Write a function capable of performing numerical integration of h(x) using the **composite Simpson's 1/3 rule**. Use your function to solve the equation with 7 points.

TASK 2

An 11m beam is subjected to a load, and the shear force follows the equation

$$V(x) = 5 + 0.25x^2$$

where *V* is the shear force, and x is the length in distance along the beam. We know that *V* = d*M*/*d*x, and *M* is the bending moment. Integration yields the relationship

$$M = M_0 + \int_0^L V dx$$

If M_0 is zero and *L*=11, calculate *M* using

A. Analytical integration (pen and paper, then plug into MATLAB)

B. Composite trapezoidal rule using 13 points

C. Composite Simpson's 1/3 rule using 13 points

Use fprintf to print the answers to each part.

TASK 3

The force per unit length f on a sailboat mast can be represented by the following function:

$$f(z) = 200\left(\frac{z}{5+z}\right)e^{-2z/H}$$

where z is the elevation above the deck and H is the height of the mast. The total force F exerted on the mast can be determined by integrating this function over the height of the mast:

$$F = \int_0^H f(z)\,\mathrm{d}z$$

If H = 30,

A. Plot the force per unit length f against height z.
B. Use the quad or integral functions in MATLAB to determine the total force F exerted on the mast.
C. Determine the minimum number of segments required for the composite trapezoidal rule to achieve a percentage error of 0.01% or less compared to the answer in part B.
D. Repeat part C but this time using the composite Simpson's 1/3 rule.

TASK 4

The cross-sectional area of a channel can be computed as

$$A_c = \int_0^B H(y)\,\mathrm{d}y$$

where B is the total channel width (m), H is the depth (m), and y is the distance from the bank (m). In a similar fashion, the average flow Q (m^3/s) can be computed as

$$Q = \int_0^B U(y)H(y)\,\mathrm{d}y$$

where U is water velocity (m/s). The data for y, H and U are shown below.

y (m)	0	2	4	5	6	9
H (m)	0.5	1.3	1.25	1.8	1	0.25
U (m/s)	0.03	0.06	0.05	0.13	0.11	0.02

A. Plot H against Y, and U*H against Y on the same figure. Fit both sets of data with second-order polynomials and plot the fitted curves between y=0 and y=9 with increments of 0.1. Use these polynomials as function handles and use the composite trapezoidal rule to determine A_c and Q. Use 6 equally spaced points between the integral limits. Use fprintf to print the values of A_c and Q.
B. Instead of using a second-order polynomial as a fit, you are to use the raw data. Integrate using trapezoidal segments. Use fprintf to print the values of A_c and Q.

Hint: you can define polyval to a function. E.g. H_fn = @(x) polyval(p,x)