Indian Institute of Technology Bhubaneswar

School of Infrastructure

Session: Autumn 2025

CAD Laboratory (CE4P001) Assignment No. 1

Date: August 09, 2025 Total Marks: 100

Instructions:

(1) Solve the assignment problem by writing Julia codes and uploading the files to your GitHub account.

(2) If two or more files in different GitHub account appear identical, each of them will be awarded ZERO.

Notations :

Zeroth-order tensors or scalars are represented by small letters. For eg. a

First-order tensors or vectors are represented by bold small letters. For eg. $\boldsymbol{a}$.

1. Consider that the height of a hill is described by the given scalar field as

$$h(x, y) = 200 - x^2 - 2y^2$$

(a) Plot the given scalar field as both a three-dimensional (3D) surface plot and a two-dimensional (2D) contour plot using Julia. (you may use the package **Plots.jl** for plotting).

(b) Plot the gradient of the scalar field using the automatic gradient calculation tool available in Julia (you may use the package called **CalculusWithJulia.jl**).

(c) Determine the gradient vector and plot the obtained gradient vector field (you may use the package called **Plots.jl** or **CalculusWithJulia.jl**). [20]

2. Consider a cyclone in the northern hemisphere described by the velocity vector field of the wind:

$$\boldsymbol{v}(x, y) = x\,\boldsymbol{e}_1 - y^2\,\boldsymbol{e}_2$$

where x and y are the coordinates in the horizontal plane, and $\boldsymbol{e}_1$ and $\boldsymbol{e}_2$ are unit vectors in the x- and y-directions, respectively.

(a) Plot the given vector field in Julia. (you may use the package called **Plots.jl** or **CalculusWithJulia.jl**).

(b) Plot the divergence of the vector field using automatic divergence calculation available in the Julia package called **CalculusWithJulia.jl**. Also, determine the divergence using the detailed calculation and plot the same. Compare both plots and verify the results.

(c) Determine the curl of the vector field using automatic curl calculation available in the Julia package **CalculusWithJulia.jl**. Also, determine the curl using detailed calculation and plot the same. Compare both plots and verify the results. [20]

3. Consider that the velocity of water particles in a river is described by the vector field

$$\boldsymbol{f} = e^x y^2 \boldsymbol{e}_1 + (x + 2y)\boldsymbol{e}_2$$

(a) Plot the given vector field in Julia. (you may use the package called **Plots.jl** or **CalculusWithJulia.jl**).
(b) Plot the divergence of the vector field using automatic divergence calculation available in the Julia package called **CalculusWithJulia.jl**. Also, determine the divergence using the detailed calculation and plot the same. Compare both plots and verify the results.
(c) Determine the curl of the vector field using automatic curl calculation available in the Julia package **CalculusWithJulia.jl**. Also, determine the curl using detailed calculation and plot the same. Compare both plots and verify the results. [20]

4. Write a Julia code for the solution of the beam problem shown in Fig. 1. Plot the bending moment diagram (BMD) and shear force diagram (SFD). Your code should be generic enough to take any value for the input variables l and q. [20]

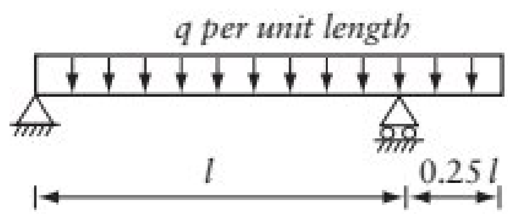

Figure 1

5. Write a Julia code for the solution of the beam problem shown in Fig. 2. Plot the BMD and SFD. Your code should be generic enough to take any value for the input variables l and q. [20]

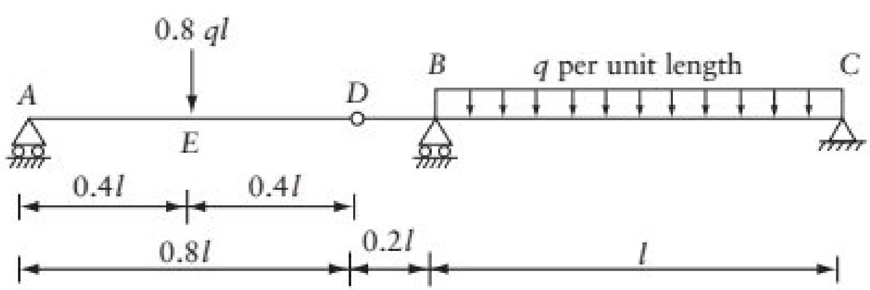

Figure 2