Assignment #01

Total 2 problems

Due date : October 31, 2023

Upload on the PLATO system

1. **(Solution of 2D heat conduction equation)** Solve the heat conduction equation (Laplace equation) for the following problem. Use $L = W = 1$.

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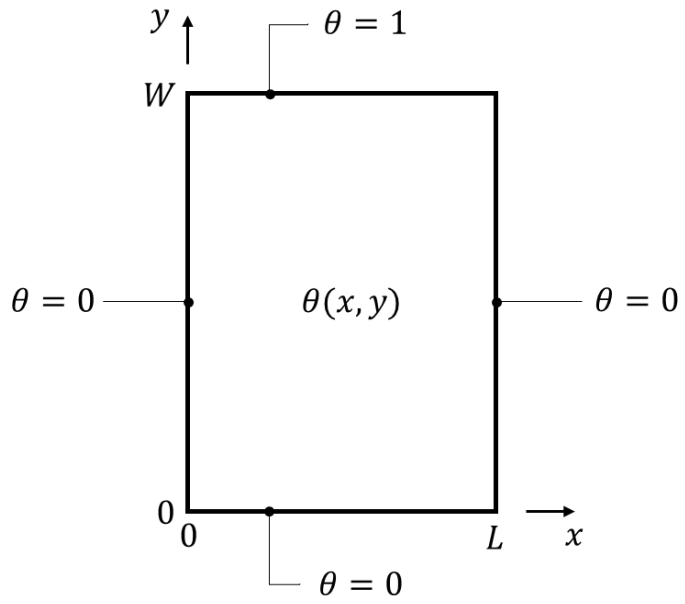
- Draw the contour plot and the temperature along the vertical centerline.
- Use at least two matrix solvers and two grids, and compare the results.
- Compare the results with the exact solution and show the error wrt various grid densities.



(GE)

$$\frac{\partial^2\theta}{\partial x^2} + \frac{\partial^2\theta}{\partial y^2} = 0$$

(BCs)

$$\begin{cases} \theta(0,y) = 0 \\ \theta(L,y) = 0 \\ \theta(x,0) = 0 \\ \theta(x,W) = 1 \end{cases}$$

(Exact solution)

$$\theta(x,y) = \frac{2}{\pi}\sum_{n=1}^{\infty} \frac{(-1)^{n+1}+1}{n} \sin\left(\frac{n\pi x}{L}\right) \frac{\sinh(n\pi y/L)}{\sinh(n\pi W/L)}$$

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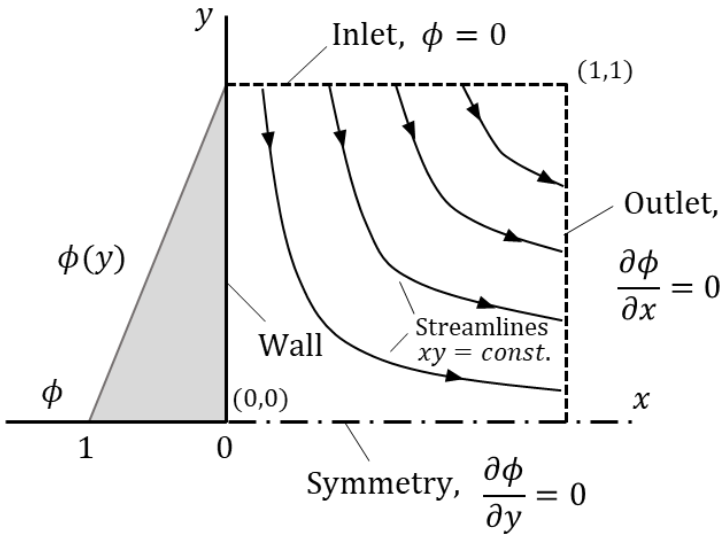
2. (Diffusion with convection) Solve the following convection-diffusion problem for i) steady and ii) unsteady state (t=0 – 2 or more).

- Draw the contour plot.
- Use at least two numerical schemes and unsteady solvers, and compare the results
- Estimate the error using the result from the finest grid.



(GE) $$\frac{\partial(\rho\phi)}{\partial t} + \frac{\partial(\rho u\phi)}{\partial x} + \frac{\partial(\rho v\phi)}{\partial y} = \frac{\partial}{\partial x}\left(\Gamma\frac{\partial\phi}{\partial x}\right) + \frac{\partial}{\partial y}\left(\Gamma\frac{\partial\phi}{\partial y}\right)$$

(Flow) $u = x \qquad v = -y$

(Properties) $\rho = 1.0, \quad \Gamma = 0.001 \text{ and } 0.01$ (steady)
$\rho = 1.2, \quad \Gamma = 0.1$ (transient)

(IC) $\phi = 0 \quad \text{at} \quad t = 0$

(BCs)

$$\begin{cases} \phi\big|_{x=0} = 1 - y & \dfrac{\partial\phi}{\partial x}\Big|_{x=1} = 0 \\ \dfrac{\partial\phi}{\partial y}\Big|_{y=0} = 0 & \phi\big|_{y=1} = 0 \end{cases}$$

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(General notes on the report)

- Use any assumption and methods (tools) of your own.
- Summarize your result in a **PPT slide**, **max 10 pages** total (including cover).
- Your report must include, i) Problem definition, ii) Numerical methods, iii) Results & discussion iv) References, and v) the code used (Attach to the document as an embedded file).