

Unit 10 - Week 8: Vorticity-Stream Function Formulation

Course outline
How does an NPTEL online course work?
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Week 2: Classification of PDEs
Week 3: Finite Difference Method
Week 4: Elliptic Equations
Week 5: Parabolic Equations
Week 6: Hyperbolic Equations
Week 7: Stability Analysis
Week 8: Vorticity-Stream Function Formulation
<ul style="list-style-type: none"> ● Lec 1: Discretization vorticity-stream function equations using FDM ● Lec 2: Boundary conditions for flow problems ● Lec 3: Solutions of vorticity-stream function equations
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Week 9: MAC Algorithm
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Assignment 8

The due date for submitting this assignment has passed. Due on 2020-03-25, 23:59 IST.
 As per our records you have not submitted this assignment.

1) For a 2D steady Newtonian incompressible flow, the equation for stream function is 1 point

$\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} = -\omega_x$
 $\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} = -\omega_y$
 $\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} = -\omega_z$
 $\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} = 0$

No, the answer is incorrect.
 Score: 0
Accepted Answers:
 $\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} = -\omega_z$

2) For a 2D steady Newtonian incompressible flow, the equation for vorticity is 1 point

$u \frac{\partial \omega}{\partial x} + v \frac{\partial \omega}{\partial y} = \mu \left(\frac{\partial^2 \omega}{\partial x^2} + \frac{\partial^2 \omega}{\partial y^2} \right)$
 $u \frac{\partial \omega}{\partial x} + v \frac{\partial \omega}{\partial y} = \nu \left(\frac{\partial^2 \omega}{\partial x^2} + \frac{\partial^2 \omega}{\partial y^2} \right)$
 $u \frac{\partial \omega}{\partial x} + u \frac{\partial \omega}{\partial y} = \mu \left(\frac{\partial^2 \omega}{\partial x^2} + \frac{\partial^2 \omega}{\partial y^2} \right)$
 $u \frac{\partial \omega}{\partial x} + u \frac{\partial \omega}{\partial y} = \nu \left(\frac{\partial^2 \omega}{\partial x^2} + \frac{\partial^2 \omega}{\partial y^2} \right)$

No, the answer is incorrect.
 Score: 0
Accepted Answers:
 $u \frac{\partial \omega}{\partial x} + v \frac{\partial \omega}{\partial y} = \nu \left(\frac{\partial^2 \omega}{\partial x^2} + \frac{\partial^2 \omega}{\partial y^2} \right)$

3) For the figure shown below, the discretized equation at the top wall is given as 1 point

$u = U, v = 0$

 $u = 0, v = 0$

- $\omega_{i,N} = -\frac{2}{\Delta x^2} (\psi_{i,N} - \psi_{i,N-1} + U \Delta x)$
 $\omega_{i,N} = -\frac{2}{\Delta y^2} (\psi_{i,N} - \psi_{i,N-1} + U \Delta y)$
 $\omega_{i,N} = -\frac{2}{\Delta x^2} (\psi_{i,N-1} - \psi_{i,N} + U \Delta x)$
 $\omega_{i,N} = -\frac{2}{\Delta y^2} (\psi_{i,N-1} - \psi_{i,N} + U \Delta y)$

No, the answer is incorrect.
 Score: 0
Accepted Answers:
 $\omega_{i,N} = -\frac{2}{\Delta y^2} (\psi_{i,N-1} - \psi_{i,N} + U \Delta y)$

4) The boundary condition for stream function and vorticity for the bottom wall as show in the figure below is 1 point

$u = U, v = 0$

 $u = 0, v = 0$

- $\psi = const., \omega = \frac{\partial^2 \psi}{\partial y^2}$
 $\psi = const., \omega = -\frac{\partial^2 \psi}{\partial y^2}$
 $\frac{\partial \psi}{\partial y} = const., \omega = \frac{\partial^2 \psi}{\partial y^2}$
 $\frac{\partial \psi}{\partial y} = const., \omega = 0$

No, the answer is incorrect.
 Score: 0
Accepted Answers:
 $\psi = const., \omega = -\frac{\partial^2 \psi}{\partial y^2}$

5) For a 2D steady Newtonian incompressible flow ($\beta = \frac{\Delta x}{\Delta y}$), the discretized stream function equation at point 10 is 0 points

- $\psi_{10} = \frac{\beta^2 (\psi_{11} + \psi_9) + \psi_6 + \psi_{14} + \omega_{10} \Delta y^2}{2(1 + \beta^2)}$
 $\psi_{10} = \frac{\beta^2 (\psi_{11} + \psi_9) + \psi_6 + \psi_{14} + \omega_{10} \Delta x^2}{2(1 + \beta^2)}$
 $\psi_{10} = \frac{\beta^2 (\psi_6 + \psi_{14}) + \psi_{11} + \psi_9 + \omega_{10} \Delta y^2}{2(1 + \beta^2)}$
 $\psi_{10} = \frac{\beta^2 (\psi_6 + \psi_{14}) + \psi_{11} + \psi_9 + \omega_{10} \Delta x^2}{2(1 + \beta^2)}$

No, the answer is incorrect.
 Score: 0
Accepted Answers:
 $\psi_{10} = \frac{\beta^2 (\psi_{11} + \psi_9) + \psi_6 + \psi_{14} + \omega_{10} \Delta y^2}{2(1 + \beta^2)}$

6) For the figure shown below, the value of ψ_2 is 1 point

- $\psi_2 = -1$
 $\psi_2 = 0$
 $\psi_2 = 2$
 cannot be determined

No, the answer is incorrect.
 Score: 0
Accepted Answers:
 $\psi_2 = -1$

7) For the figure shown below, the outlet boundary condition for vorticity is 1 point

- $\omega_{M,j} = 0$
 $\omega_{M,j} = \omega_{M+1,j}$
 $\omega_{M,j} = \omega_{M-1,j}$
 $\omega_{M-1,j} = 0$

No, the answer is incorrect.
 Score: 0
Accepted Answers:
 $\omega_{M,j} = \omega_{M-1,j}$

8) In vorticity-stream function method, the wall can be considered as a streamline. 1 point

True
 False

No, the answer is incorrect.
 Score: 0
Accepted Answers:
 True