



B.E/B.TECH DEGREE EXAMINATIONS: NOV/DEC 2023

(Regulation 2018)

Fifth Semester

AERONAUTICAL ENGINEERING

U18AET5003: Computational Fluid Dynamics

COURSE OUTCOMES

CO1: Explain the fluid modeling approaches

CO2: Develop grids for different fluid flow applications.

CO3: Analyze fluid flow problems using panel methods

CO4: Make use of advanced simulation techniques to solve engineering applications using CFD codes such as Fluent, CFX, ROTCFD etc.,

CO5: Apply appropriate schemes to solve fluid flow problems.

CO6: Examine the CFD simulation results with validation

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 2 = 20 Marks)

(Answer not more than 40 words)

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|-----|---|-----|-------------------|
| 1. | What is the use of Stoke's hypothesis in momentum equation? | CO1 | [K ₃] |
| 2. | How do you describe the physical phenomenon "Energy flux"? | CO1 | [K ₃] |
| 3. | How can the results of fluid flow at conventional nodes be solved in finite volume method? | CO2 | [K ₃] |
| 4. | What are all the preliminary data are required for the estimation of unknown density in Lax-Wendroff method? | CO5 | [K ₃] |
| 5. | Derive the relationship between x-directional velocity and distance of j th panel to i th control point. | CO3 | [K ₃] |
| 6. | What modifications occur in the formulation of algebraic equations as a result of the Kutta condition being imposed in the Vortex panel method? | CO3 | [K ₃] |
| 7. | Specify the benefits of determining the numerical dissipation. | CO4 | [K ₃] |
| 8. | What are the different types of decisions available based on Von-Neumann stability analysis? | CO4 | [K ₂] |
| 9. | Enumerate the importance of continuity equation in pressure based CFD solvers. | CO5 | [K ₃] |
| 10. | Is it necessary to use a pressure correction technique for density-based CFD solvers? | CO5 | [K ₃] |

Answer any FIVE Questions:-

PART B (5 x 16 = 80 Marks)

(Answer not more than 400 words)

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|-----|----|---|----|-----|-------------------|
| 11. | a) | What is the use of conservation of momentum principle in CFD? Derive the momentum equations with neat block diagram. | 10 | CO1 | [K ₄] |
| | b) | Explain the computational procedures involved in conservative and non-conservative schemes based approximations. | 6 | CO1 | [K ₂] |
| 12. | a) | For the below given discretized structure, determine the unknown nodal temperatures through finite difference method. Take, the constant thermal conductivity is 1000 W/mK and uniform imposed heat generation is 1000 KW/m ³ . The governing equation is, $\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{q}{K} = 0$. | 10 | CO2 | [K ₄] |

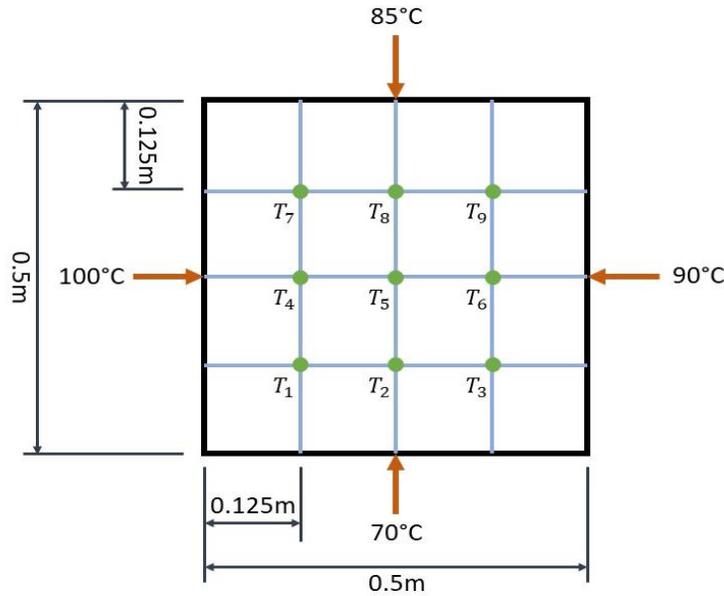


Figure 1. Discretized structure of 2-D test specimen

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|--------|---|----|-----|-------------------|
| b) | Describe the fundamental distinctions between the Lax-Wendroff and MacCormack methods. | 6 | CO5 | [K ₃] |
| | | | | |
| 13. a) | Derive the cumulative source sheet effect of velocity in normal direction. | 8 | CO3 | [K ₃] |
| b) | In panel methods, write the relationship of velocity potential for free stream velocity. Derive the velocity term in both tangential and normal directions. | 8 | CO3 | [K ₃] |
| | | | | |
| 14. | What are the consequences of implementing wall treatment in the boundary layer region? Using a schematic representation, derive the governing equations pertinent to the boundary layer region. | 16 | CO4 | [K ₄] |
| | | | | |
| 15. | Explain in detail the computational procedures that PISO (Pressure Implicit with Split Operator) pressure correction solvers utilize in order to approximate the properties of the fluid. | 16 | CO6 | [K ₄] |
| | | | | |
| 16. a) | Distinguish the Implicit and Explicit computing techniques for the given governing equation using finite difference method approximations. | 8 | CO5 | [K ₄] |
| | $\frac{\partial u}{\partial t} + a \frac{\partial u}{\partial x} = 0; \text{ Where, } a > 0; u > 0$ | | | |
| b) | Elaborate the stability analysis of first-order based hyperbolic equation using the Upwind Scheme (Forward Time Backward Space Scheme). | 8 | CO5 | [K ₄] |
