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PRESIDENCY UNIVERSITY
BENGALURU

Department of Research & Development

Mid - Term Examinations - August 2024

Odd Semester: Ph.D. Course Work
Course Code: MEC 801
Course Name: Computational fluid dynamics
Department: Mechanical Engineering

Date: 12-08-2024
Time: 09.30am to 11.00am
Max Marks: 50
Weightage: 25%

Instructions:

(i) Read all questions carefully and answer accordingly.
(ii) Make suitable assumptions wherever required with justification.
(iii) ***Books, notes and data handbooks are allowed.***

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1. In the context of incompressible fluid flow, consider the simplified non-dimensional transport equation:

$$u\frac{\partial u}{\partial x} = \frac{1}{Re}\frac{\partial^2 u}{\partial x^2}$$

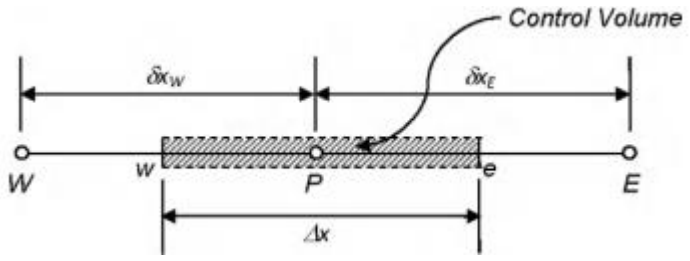
Where Re is the Reynolds number.
Provide a detailed explanation of why, in laminar flow conditions, the diffusion term (right-hand side) tends to dominate over the convective term (left-hand side). Contrast this with highly turbulent flow conditions, where the convective term becomes more significant. Discuss the implications of these dynamics in terms of flow stability and energy dissipation.

[30 M]
(CO:01 BL: Analyze)

2. Consider the one-dimensional steady-state diffusion term $\frac{\partial}{\partial x}\left(G\frac{\partial \phi}{\partial x}\right)$ in the context of a control volume. Demonstrate how this term is discretized to obtain the discretized equation at a central grid nodal point P, expressed as:

$$G\frac{\partial \phi}{\partial x}\bigg|_e A_E - G\frac{\partial \phi}{\partial x}\bigg|_w A_w$$

where A_E and A_w are the areas associated with the east and west faces of the control volume, respectively. Discuss the implications of this discretization approach on the accuracy and stability of numerical solutions.



[20 M]
(CO:02 BL: Analyze)