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Graduate Certificate in Hydraulic Engineering

## \* Computational Hydraulics

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Computational Hydraulics is a critical area of study in the Graduate Certificate in Hydraulic Engineering. This field involves the use of numerical methods and computational tools to simulate and analyze fluid flow and hydraulic systems' behavior. The following are some key terms and vocabulary that are essential in understanding Computational Hydraulics:

1. **Numerical Methods:** These are mathematical techniques used to solve complex problems that cannot be solved analytically. Numerical methods involve approximating the solution to a problem by dividing it into smaller, more manageable parts. In Computational Hydraulics, numerical methods are used to simulate fluid flow and hydraulic systems' behavior.
2. **Computational Fluid Dynamics (CFD):** This is a branch of fluid mechanics that uses numerical methods and computational tools to analyze and simulate fluid flow. CFD is used to model various fluid flow phenomena, including turbulence, multiphase flow, and heat transfer.
3. **Finite Element Method (FEM):** This is a numerical method used to solve partial differential equations that describe a wide range of physical phenomena, including fluid flow and structural mechanics. FEM involves dividing a complex domain into smaller, simpler elements and solving the governing equations for each element.
4. **Shallow Water Equations (SWE):** These are a set of partial differential equations that describe the behavior of fluid flow in shallow water bodies, such as rivers and channels. SWE is used to model various hydraulic phenomena, including flood waves, hydraulic jumps, and river flow.
5. **Reynolds Number (Re):** This is a dimensionless quantity that describes the ratio of inertial forces to viscous forces in a fluid. Re is used to determine whether a flow is laminar or turbulent.
6. **Turbulence:** This is a complex and chaotic flow behavior that occurs when the velocity of a fluid exceeds a certain critical value. Turbulence is characterized by the presence of random fluctuations in velocity and pressure.
7. **Multiphase Flow:** This is a type of flow that involves the simultaneous flow of two or more immiscible fluids, such as oil and water. Multiphase flow is common in various industrial applications, including oil recovery, chemical processing, and power generation.
8. **Hydraulic Jump:** This is a sudden rise in the water level that occurs when the flow velocity decreases abruptly. Hydraulic jumps are common in various hydraulic structures, including spillways, weirs, and flumes.
9. **Pipe Flow:** This is a type of flow that occurs in pipes and channels. Pipe flow is described by the Navier-Stokes equations, which describe the motion of fluid in a pipe.
10. **Open Channel Flow:** This is a type of flow that occurs in open channels, such as rivers and canals. Open channel flow is described by the Saint-Venant equations, which are a set of partial differential equations that describe the conservation of mass and momentum in open channels.

Practical Applications:

Computational Hydraulics has various practical applications in engineering and science. For example, CFD is

used to design and optimize various hydraulic structures, such as pumps, turbines, and hydraulic systems. SWE is used to model and predict flood events, which is critical in floodplain management and disaster response. FEM is used to analyze and design various engineering structures, such as bridges, dams, and buildings.

Challenges:

Computational Hydraulics presents several challenges, including the complexity of fluid flow and the need for high-performance computing resources. CFD simulations can be computationally expensive, requiring significant computational resources and time. SWE simulations can be challenging due to the nonlinear nature of the equations and the need for accurate boundary conditions.

Conclusion:

Computational Hydraulics is a critical area of study in the Graduate Certificate in Hydraulic Engineering. Understanding the key terms and vocabulary in this field is essential in analyzing and simulating fluid flow and hydraulic systems' behavior. While Computational Hydraulics presents several challenges, it also offers various practical applications in engineering and science.