Unit 42: Hydraulics

Level: **5**

Credits: **15**

Ofqual Code: **H/618/8119**

Introduction

The action, management and distribution of fluids in relation to built structures is critical. In civil engineering, it is necessary to ensure that we are able to manage the pressures that water may put on structures, either through its flow or the forces exerted and how to resist these. In building services, the balance between necessary pressures to ensure flow and distribution of fluids (through heating/cooling systems or domestic water supplies), and the sizing of pipes to support this flow, will determine efficiency and effectiveness of a system.

However, fluids are dynamic; their behaviour changes based on a range of factors. Thus, the ability to estimate and manage their forces, rates of flow and suitable systems for control requires specialised calculations, equipment and maintenance.

In this unit, students will explore principles of hydrostatic and hydrodynamic fluids, calculate a range of factors and use these calculations to arrive at practical hydraulic solutions.

Learning Outcomes

By the end of this unit, students will be able to:

LO1 Calculate forces related to fluids at rest and in motion

LO2 Develop practical solutions for the distribution of fluids within correctly sized pipes

LO3 Apply concepts of physics to develop solutions to hydrostatic and hydrodynamic problems

LO4 Calculate the hydrostatic pressure exerted on substructures for a given context.

Essential Content

LO1 **Calculate forces related to fluids at rest and in motion**

Flow calculation

Bernoulli's equation

Hydraulic radius

Velocity distribution

Reynolds number

Darcy-Weisback equation

Manning's equation

Energy

The energy principle

The energy equation

Hydraulic grade

Energy grade

Energy loss/gain

Friction losses

LO2 **Develop practical solutions for the distribution of fluids within correctly sized pipes**

Flow in pipes

Darcy-Weisback equation

Chezy's equation (Kutter's equation)

Discharge

Head loss

Pipeline discharge

Orifice equation

Open channel flow

Steady/uniform flow

Manning's equation

Specific energy/critical depth

Subcritical/supercritical flow

Non-uniform flow

LO3 **Apply concepts of physics to develop solutions to hydrostatic and hydrodynamic problems**

Fluid properties

Density

Viscosity

Fluid behaviour

Viscous flow

Laminar flow

Turbulence

Boundary layer

LO4 **Calculate the hydrostatic pressure exerted on substructures for a given context**

Hydrostatic pressure

Forces on plane

Forces on submerged surfaces

Pascal's law

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Calculate forces related to fluids at rest and in motion		**D1** Assess pipework sizes to determine their efficiency in a given context.
P1 Solve a Darcy-Weisback equation for a given pressure pipe system. **P2** Solve a Manning's equation for a given open channel flow situation.	**M1** Discuss the differences and similarities between different types of hydrodynamic systems and calculations.	
LO2 Develop practical solutions for the distribution of fluids within correctly sized pipes		
P3 Calculate the head loss for a given pipeline. **P4** Define pipe sizes for a given set of flow parameters.	**M2** Evaluate pipe sizes to determine the flow type that will occur.	
LO3 Apply concepts of physics to develop solutions to hydrostatic and hydrodynamic problems		**D2** Critically analyse proposals for subsurface structures in response to the hydrostatic pressure in a given context.
P5 Evaluate a hydraulic condition in order to determine the parameters of the problem. **P6** Illustrate a proposed solution to a hydraulic problem, using drawings or models.	**M3** Compare proposed solutions to a hydraulics problem, highlighting the merits of different solutions.	
LO4 Calculate the hydrostatic pressure exerted on substructures for a given context		
P7 Calculate the pressure exerted on a foundation wall in a given context. **P8** Determine the pressure exerted on a subsurface floor in a given context.	**M4** Evaluate the ability of a given subsurface wall and floor to resist the forces exerted by liquid in a given context.	

Recommended Resources

Print resources

DOUGLAS, J. (1971), *Solution of Problems in Fluid Mechanics*, Pitman

DOUGLAS, J., GASIOREK, J., GASIOREK, J., SWAFFIELD, J. (2001), *Fluid Mechanics*, Addison-Wesley Longman Limited

WARD-SMITH, J. (2011), *Mechanics of Fluids*, Ninth Edition, CRC Press

WYNN, P. (2014), *Hydraulics for Civil Engineers*, Inst of Civil Engineers Pub

Web resources

https://bit.ly/3BVZZ7y	**Chartered Institution of Civil Engineering Surveyors** (Professional Body)
https://bit.ly/3fsrTP1	**Institution of Civil Engineers** (Professional Body)

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 8: Mathematics for Construction
- Unit 17: Civil Engineering Technology
- Unit 19: Principles of Structural Design
- Unit 21: Geotechnics & Soil Mechanics
- Unit 31: Advanced Structural Design
- Unit 34: Further Mathematics for Construction
- Unit 45: Advanced Materials.