

**Part A PhD Comprehensive Exam
Fluid Dynamics Field**

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Exam Content:

This exam will cover all topics in engineering Fluid Dynamics that are normally covered in an undergraduate mechanical engineering curriculum. The following text and chapters cover the material included in this exam.

Fluid Mechanics 5th Ed.
F. M. White
McGraw Hill Publishers

chapters 1-9

Questions:

The following are typical examples of questions:

- i) What is the difference between laminar and turbulent flow?
- ii) When is a flow unsteady?
- iii) Derive the expression for pressure drop in a pipe.
- iv) What is fully developed flow?
- v) What is the difference between flow in a bellmouth and flow in a sharp edged orifice?
- vi) What is a diffuser? What is it used for?
- vii) What is a nozzle? What is it used for?
- viii) What is angular momentum? Draw a simple pump impellor and explain how it works.
- ix) List important dimensionless variables for fluid flows and explain what they mean.
- x) What is potential flow?
- xi) What is a free vortex and forced vortex?
- xii) What causes the vortex on the tips of wings?
- xiii) What is vorticity?
- xiv) What equation governs potential flow?
- xv) Can Bernoulli's equation be applied to potential flow? Where?
- xvi) Why does a spinning cylinder generate lift in a flowing fluid?
- xvii) What is the Kutta condition?
- xviii) What is a boundary layer?
- xix) What is momentum thickness and displacement thickness?
- xx) What is the no slip condition?
- xxi) Where did the momentum integral come from?

- xxii) Why is there no pressure gradient in a flat plate flow?
- xxiii) What is flow separation?
- xxiv) Why does a wing stall at high angles of attack?
- xxv) Why do golf balls have dimples?
- xxvi) What is a Mach cone?
- xxvii) Why do nozzles choke?
- xxviii) What is a shock and why does it form?
- xxix) Describe the flow possibilities in a converging/diverging nozzle.

All of the above questions are open ended and may be expanded with supplementary questions – for example:

Derive the expression for pressure drop in a pipe.

- what is friction factor
- what is wall roughness
- draw a moody diagram
- What does Re represent?
- what happens at high Re
- what happens at low Re
- what happens if pipe is not round
- what happens at elbows, tees, valves
- what does fully developed mean
- what if the flow is not fully developed

or,

What is a diffuser used for?

- draw one and draw the pressure distribution along the centre line.
- is a diffuser hard to design, Why?
- what is flow separation?
- what is an adverse pressure gradient? What does it cause in a diffuser?
- show conservation of mass and linear momentum in the axial direction.
- what is different if you draw the control surface inside the diffuser wall or outside the diffuser wall?