Example Problems in FIDAP
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For use only by Students at the University of Washington

This document is a collection of lists and pictures showing the examples that can be run using FIDAP to solve momentum and energy equations. There are three kinds of lists:
1. A numerical list of titles
2. A list sorted by how hard the problems are
3. A numerical list with pictures illustrating the problem
Example Problems in FIDAP - Numerical Listing

1. Flow in a Pipe
2. Parallel Flow Between Two Plates
3. Flow Past a Circular Cylinder
4. Flow in a Converging Channel
5. Non-Newtonian Flow in a Channel
6. Die-Swell Problem
7. Natural Convection in a Square Cavity
8. Developing Flow in a Vertical Channel
9. Jet Impingement in a Narrow Axi-symmetric Channel
10. Airflow Over Multiple Steps in a Channel
11. Airflow and Heating in a Tube Fin Heat Exchanger
12. Stokes Flow in a Wedge
13. Flow through a Poppet Valve
15. Spin Up of a Liquid in an Annulus
16. 3-D Flow Past a Heated Obstacle
17. Flow in a Turning Channel
18. Turbulent Flow Over a Backward-facing Step
19. Turbulent Flow in a Pipe
20. Attenuation of a Surface Disturbance
21. Development of a Drop
22. Slot Coater
23. Fountain Flow
24. Double Roll Coater
25. Piston Driven Drop Evolution
26. Thermocapillary Convection
27. Crystal Growth From a Melt
28. Merging Liquid Streams
29. Turbulent Flow in an Annular Turnaround Duct
30. Crystal Growth: Bridgman Technique
31. Chemical Vapor Deposition on a Heated and Tilted Plate
32. Radiation Heat Transfer in an Open Channel
33. Radiation Heat Transfer in a Square Cavity
34. Conduction Melting
35. Turbulent Flow in a Heated Channel
36. Chemical Vapor Deposition in a Horizontal Reactor
37. Flow of Plastic in a Profile Extrusion Die
38. Multiple Species Reaction
39. Mixing Tank
40. 3-D Die-Swell Problem
41. Isentropic Compressible Flow Over a Bump
42. Laminar Compressible Flow in a Pipe Elbow
43. Turbulent Compressible Flow Over a Sphere
44. Natural Convection in Steady Solidification
45. Particle-Laden Gas Flows Past Tubes
46. Oil Droplet Driven Flow in a Water Tank
47. Displacement of Two Fluids in a Confined Geometry
48. Filling and Solidification in a Mold
49. 3-D Mold Filling
50. Turbulent Combustion in s Swirl Burner
51. Turbulent Free-surface Flow Over a Cylindrical Obstruction
52. Flow Driven by a Moving Piston
Example Problems in FIDAP - Listing by size of problem

Small problems
1. Flow in a Pipe
2. Parallel Flow Between Two Plates
5. Non-Newtonian Flow in a Channel

Medium problems
3. Flow Past a Circular Cylinder
4. Flow in a Converging Channel
6. Die-Swell Problem
7. Natural Convection in a Square Cavity
8. Developing Flow in a Vertical Channel
9. Jet Impingement in a Narrow Axi-symmetric Channel
10. Airflow Over Multiple Steps in a Channel
12. Stokes Flow in a Wedge
13. Flow through a Poppet Valve
21. Development of a Drop
22. Slot Coater
23. Fountain Flow
24. Double Roll Coater
25. Piston Driven Drop Evolution
26. Thermocapillary Convection
34. Conduction Melting
35. Turbulent Flow in a Heated Channel
36. Chemical Vapor Deposition in a Horizontal Reactor
46. Oil Droplet Driven Flow in a Water Tank
47. Displacement of Two Fluids in a Confined Geometry

Big problems
11. Airflow and Heating in a Tube Fin Heat Exchanger
15. Spin Up of a Liquid in an Annulus
16. 3-D Flow Past a Heated Obstacle
17. Flow in a Turning Channel
18. Turbulent Flow Over a Backward-facing Step
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Example Problems in FIDAP - Description

1. Flow in a Pipe

Figure 2-1: Flow geometry and boundary conditions

2. Parallel Flow Between Two Plates
3. Flow Past a Circular Cylinder

Figure 3-1: Cylinder flow geometry and boundary conditions

Figure 3-2: Generated mesh from FI-GEN
4. Flow in a Converging Channel

\[ u = v = 0 \]

\[ p = 0.2 \]
\[ u \text{ free} \]
\[ v = 0 \]

\[ p = 0 \]
\[ u \text{ free} \]
\[ v = 0 \]

\[ u = v = 0 \]

0.2

Figure 4-1: Mesh and boundary conditions for Hamel flow

5. Non-Newtonian Flow in a Channel

Figure 5-1: Geometry and boundary conditions for channel flow
6. Die-Swell Problem

Swell ratio: \( r_s = \frac{h_f}{h_0} - 1 \)

\[ u = 15(1 - y^2) \]
\[ v = 0 \]

Free surface
Fixed point

\[ h(x) \]

\[ h_f \]

\[ u = 0, \ v = 0, \ h_0 = 1 \]

\[ \partial h/\partial x = 0 \]

\[ u_n = 0, \ f_n = 2H, \ f_t = 0 \]

Figure 6-1: Geometry and boundary conditions for die-swell problem

7. Natural Convection in a Square Cavity

\[ u = v = 0, \ \frac{\partial T}{\partial n} = 0 \]

\[ T_1 \]

\[ T_2 \]

\[ u = v = 0, \ y \]

\[ z \]

\[ 1.0 \]

Figure 7-1: Square enclosure

7. Natural Convection in a Square Cavity
8. Developing Flow in a Vertical Channel

9. Jet Impingement in a Narrow Axi-symmetric Channel
10. Airflow Over Multiple Steps in a Channel

Figure 10-1: Channel flow with multiple obstructions

11. Airflow and Heating in a Tube Fin Heat Exchanger

Figure 11-1: Tube fin heat exchanger

11. Airflow and Heating in a Tube Fin Heat Exchanger
12. Stokes Flow in a Wedge

13. Flow through a Poppet Valve

\[ u_z = 0, \ u_r = 0, \ u_\theta = r \]

15. Spin Up of a Liquid in an Annulus

\[ u_z = 0, \ u_r = 0, \ u_\theta = r \]

\[ u_z = 0, \ u_r = 0, \ u_\theta = r \]

\[ \omega = 1 \]
16. 3-D Flow Past a Heated Obstacle

17. Flow in a Turning Channel
18. Turbulent Flow Over a Backward-facing Step

19. Turbulent Flow in a Pipe
20. Attenuation of a Surface Disturbance

Figure 20-1: Surface disturbance—problem geometry and boundary conditions

20. Attenuation of a Surface Disturbance
Figure 21-1: Geometry and boundary conditions for drop growth

Figure 21-2: Generated mesh from FI-GEN

21. Development of a Drop
22. Slot Coater

23. Fountain Flow
Radius of each cylinder = 100
Angle subtended = 28°

24. Double Roll Coater
25. Piston Driven Drop Evolution

Figure 25.1: Boundary conditions and mesh for piston drop evolution
26. Thermocapillary Convection

Figure 27-1: Boundary conditions for crystal growth
27. Crystal Growth From a Melt

28. Merging Liquid Streams

29. Turbulent Flow in an Annular Turnaround Duct

Figure 30-1: Schematic of Bridgman technique

30. Crystal Growth: Bridgman Technique
31. Chemical Vapor Deposition on a Heated and Tilted Plate

Figure 31-1: Computational domain and boundary conditions

32. Radiation Heat Transfer in an Open Channel

Figure 32-1: Computational domain

32. Radiation Heat Transfer in an Open Channel
33. Radiation Heat Transfer in a Square Cavity

Figure 33-1: Computational domain

34. Conduction Melting

Figure 34-1: Boundary conditions
35. Turbulent Flow in a Heated Channel

36. Chemical Vapor Deposition in a Horizontal Reactor

Figure 36-1: Schematic of a horizontal CVD reactor
37. Flow of Plastic in a Profile Extrusion Die

Figure 37-2: Computational mesh

38. Multiple Species Reaction

Figure 38-1: Geometric and boundary conditions

38. Multiple Species Reaction
39. Mixing Tank

Figure 39-2: Model geometry
40. 3-D Die-Swell Problem

Figure 40-1: Geometry and boundary conditions for die swell problem

41. Isentropic Compressible Flow Over a Bump

Figure 41-1: FL-GEN generated mesh
42. Laminar Compressible Flow in a Pipe Elbow

43. Turbulent Compressible Flow Over a Sphere
44. Natural Convection in Steady Solidification

45. Particle-Laden Gas Flows Past Tubes
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