# Study Guide for CM3110
# Module 3 Fluid Mechanics Continued
# Morrison Spring 2021

Test subjects in this course are cumulative. Anything on a study guide from a prior exam may be the subject of a current exam.

Exam 3 will cover, in addition to Exam 1-2 topics, momentum dimensional analysis, using classical fluid mechanics solutions, macroscopic momentum balances, fluidized beds, packed beds, momentum boundary layers, and fluid mechanics troubleshooting (advanced).

***<u>To do well on the test, you should be able to do the following:</u>***

Using classical fluid mechanics solutions. Calculate flow rates and/or pressure drops in the following circumstances (steady flow in all cases; If data correlations are needed give them and define all variables)

1. Flow in a circular tube (laminar and turbulent)
2. Flows in noncircular cross sections (laminar and turbulent); Explain hydraulic diameter
3. Flow through a packed bed (slow and fast)
4. Flow around a sphere (creeping and noncreeping; describe the distinction between viscous or skin drag and form drag); explain drag coefficient
5. Flow around an obstacle (creeping and noncreeping; describe the distinction between viscous or skin drag and form drag)

Dimensional analysis in momentum transfer (complex fluid flow systems, drag on surfaces)

6. Explain the meaning of "data correlation;" explain where we obtain data correlations
7. Explain the purpose of dimensional analysis in fluid flow engineering
8. List, define, and explain the use of at least three dimensionless numbers in fluid mechanics
9. List two circumstances in which we use the results of dimensional analysis to calculate an engineering quantity of interest in fluid flow engineering. Indicate when the data correlations enter into the calculation.
10. List two data correlations for Fanning friction factor (give the name if it has one and the equation with symbols identified). Indicate when the data correlations enter into the calculation.
11. List two data correlations for drag coefficient (give the equation; identify symbols). Indicate when the correlations enter into the calculation.
12. Predict drag in pipe flow $\mathcal{F}_{drag}$ or drag on an object in uniform flow (also $\mathcal{F}_{drag}$) from flow rate, material properties, and geometry

Macroscopic momentum balances (steady flow)

13. Calculate fluid force on the walls (wall drag $\mathcal{F}_{drag}$) of an internal flow when streamlines are not straight
14. Calculate wall drag in a straight tube of arbitrary cross section (steady, pressure-driven flow)

Unit operations (momentum-transfer dominated)

15. List and describe the flow regimes for a fluidized bed
16. Define incipient fluidization in a fluidized bed
17. Calculate the velocity at the moment of incipient fluidization in a fluidized beds
18. Calculate the flow rates and pressure drops in packed beds for slow and rapid flows
19. Identify circumstances when compressible fluid modeling is appropriate in chemical engineering practice

Momentum Boundary layers

20. Define a momentum boundary layer and describe what is fundamentally different in the regions within the boundary layer and the region outside of the boundary layer (outer flow or free-stream flow)
21. Explain the role of fluid viscosity in the flow outside of the momentum boundary layer (*outer flow*)
22. List three engineering flow scenarios in which the flow has a boundary-layer character
23. Identify the engineering quantity that can be most accurately calculated from the outer flow.
24. Identify the engineering quantity that can be most accurately calculated from the inner flow (within the boundary layer)

Fluid mechanics troubleshooting (advanced)

25. From among fluid mechanics tools (fluid statics, mechanical energy balance, microscopic momentum balance, <u>macroscopic momentum balance</u>) identify the method that will result in the missing desired quantity (pressure drop, shaft work, frictional losses, flow rate, velocity profile, drag, force on the wall, (stretch) torque, (stretch) rotational speed, terminal velocity, pump efficiency, etc.)
26. List, in an order that works, the steps for determining a quantity with the fluid mechanics tools at your disposal (advanced)