

FACULTY OF **ENGINEERING**

DEGREE COURSE: **CIVIL AND ENVIRONMENTAL ENGINEERING**

MASTER DEGREE: **CIVIL ENGINEERING**

SUBJECT: COMPLEMENTS OF HYDRAULICS

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OBJECTIVES

- Understanding the main hydraulic processes, their principles and basic mechanics; whole description of mathematical equations under appropriate basic assumptions and boundary conditions;
- Improving the knowledge of hydraulic processes of pressure flows;
- Improving the knowledge of hydraulic processes of free-surface flows;
- Improving the knowledge of hydraulic processes of free-surface flows;
- understanding fundamentals in flow openings;
- understanding fundamentals in seepage flows;
- understanding fundamentals in physical hydraulic models;

CONTENTS

The course (9 CFU) is composed of 72 lessons; it is divided into five modules related to:

1. Pressure flows (4 CFU=32 lessons), focused on uniform flows in laminar and turbulent regime;
2. Free-surface flows (2 CFU=16 lessons), focused on non-uniform and unsteady flows and to solid transport;
3. Physical hydraulic models (1 CFU=8 lessons), focused on dimensional analysis and the theory of models;
4. Outflows from orifices (1 CFU=8 lessons), focused on different types of outflows;
5. Seepage flows (1 CFU=8 lessons) concerning phreatic and confined aquifers.

For each module the specific topics are illustrated as follows:

MODULE 1 – PRESSURE FLOWS

1. Introduction to the course
2. Physical properties of fluids
3. Navier-Stokes equations
4. Equation of global equilibrium
5. Uniform flows
6. Uniform laminar flows in circular ducts – part 1
7. Uniform laminar flows in circular ducts – part 2
8. Uniform laminar flows in circular ducts – part 3
9. Uniform laminar flows in circular ducts – part 4.
10. Uniform laminar flows between parallel planes – part 1
11. Uniform laminar flows between parallel planes – part 2

12. Self-evaluation test on uniform laminar flows
13. Turbulent flows – part 1
14. Turbulent flows – part 2
15. Turbulent flows – part 3
16. Turbulent flows – part 4
17. Turbulent flows – part 5
18. Turbulent flows – part 6
19. Turbulent flows – part 7
20. Turbulent flows – part 8
21. Turbulent flows – part 9.
22. Turbulent flows – part 10
23. Self-evaluation test on mean uniform turbulent flows
24. Unsteady flows – part 1
25. Unsteady flows – part 2
26. Unsteady flows – part 3
27. Unsteady flows – part 4
28. Unsteady flows – part 5
29. Unsteady flows – part 6
30. Unsteady flows – part 7
31. Self-evaluation test on unsteady flows.
32. Exercises

MODULE 2 – FREE-SURFACE FLOWS

33. Uniform flow in natural rivers – part 1
34. Uniform flow in natural rivers – part 2
35. Self-evaluation test on uniform flow in natural rivers
36. Non-uniform flow in natural rivers – part 1
37. Non-uniform in natural rivers – part 2
38. Non-uniform in natural rivers – part 3
39. Non-uniform in natural rivers – part 4
40. Non-uniform in natural rivers – part 5
41. Non-uniform in natural rivers – part 6
42. Non-uniform in natural rivers – part 7
43. Self-evaluation test on non-uniform flows in natural rivers
44. Unsteady flow in natural rivers – part 1
45. Unsteady flow in natural riverbed – part 2
46. Self-evaluation test on unsteady flows in natural rivers
47. Outlines on solid transport
48. Self-evaluation test on solid transport

MODULE 3 – PHYSICAL HYDRAULIC MODELS

49. Dimensional analysis – part 1
50. Dimensional analysis – part 2
51. Dimensional analysis – part 3
52. Self-evaluation test on dimensional analysis
53. Theory of models – part 1
54. Theory of models – part 2
55. Theory of models – part 3
56. Self-evaluation test on theory of models

MODULE 4 – FLOW OPENINGS

57. Orifices – part 1
58. Orifices – part 2
59. Weirs – part 1
60. Weirs – part 2
61. Weirs – part 3
62. Weirs – part 4
63. Hydraulic lens
64. Self-evaluation test on outflow from orifices

MODULE 5 – SEEPAGE FLOWS

65. Underground waters
66. Hydrodynamic properties of an aquifer
67. Seepage flows
68. Tests in equilibrium regime – part 1
69. Tests in equilibrium regime – part 2
70. Tests in unsteady regime – part 1
71. Tests in unsteady regime – part 2
72. Self-evaluation test on seepage flows

LEARNING OUTCOMES

At the end of the course, the student will be able to explain the main topics of the course and the resolution of application cases through an appropriate technical language.

ASSESSMENT

Written exam: multiple choice and open questions.

RECOMMENDED TEXTBOOKS

- Streeter, V.L., FLUID MECHANICS, McGraw-Hill Book Company, 1-568 pp.
- Massey, B., Ward-Smith, J., MECHANICS OF FLUIDS, Taylor and Francis Group, 1-709 pp.
- Chow, V.T., OPEN-CHANNEL HYDRAULICS, McGraw-Hill Book Company, 1-728 pp.
- Graf, W.H., Altinakar, M.S., FLUVIAL HYDRAULICS: FLOW AND TRANSPORT PROCESSES IN CHANNELS OF SIMPLE GEOMETRY, John Wiley and Sons, 1-682 pp.
- Adami, A., PHYSICAL HYDRAULIC MODELS, Marcianum Press, 1-346 pp.
- [Cedergren](#), H R., SEEPAGE, M DRAINAGE, AND FLOW NETS, John Wiley and Sons, 1-534 pp.