LABORATORY PLANNING GUIDE

L40 v2 Basic Fluid Mechanics Laboratory

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Covered subjects according to the curriculum

Major topics of learning content:

- measurements of the pressure loss in laminar and turbulent flow
- determining the critical Reynolds number
- determining the pipe friction factor
- determining the discharge coefficient of plate weirs
- comparison of measuring weirs (Rehbock, Thomson)
- energy conversion in divergent/convergent pipe flow
- recording the pressure curve and the velocity curve in a Venturi nozzle
- study of the jet forces with different flow rates, flow velocities and deflection angles
- trajectory of the water jet at different outlet velocities
- determination of the contraction coefficient for different contours and diameters
- visualisation of streamlines:
  - flow around drag bodies
  - flow through changes in cross-section
  - influence of sources and sinks
  - how differently shaped weirs affect the flow
- pressure losses in different pipes, piping elements and fittings
- opening characteristics of angle seat valve and gate valve
- flow measurement with
  - orifice plate flow meter and measuring nozzle
  - Venturi nozzle
  - rotameter
- vertical flow from a tank
- investigation of free and forced vortices
- demonstrate formation and effect of water hammers
- determining the fan efficiency and fan characteristic
- the pressure distribution around a cylinder subject to transverse incident flow
- convective heat transfer of a cylinder in an air-flow tube
- experiments in the field of steady, incompressible flows by means of different measuring:
  - calculation of the flow rate and the flow velocity
  - recording the different velocity profiles in both the free jet and the pipe cross-section
- examination of the continuity equation and Bernoulli’s principle
- determination of the dynamic pressure
- investigation of the boundary layer on a flat plate
- study of buoyancy on a variety of bodies
- study of the density of liquids
- hydrostatic pressure, Pascal’s law
- communicating vessels
- determination of the centre of pressure
- study of surface tensions
- demonstration of capillarity
- Boyle’s law
- study of static and dynamic pressure component in flowing fluid
- learning of various methods of pressure measurement
**Main concept**

The laboratory is designed for accommodation of 24 students + 2 laboratory staff:

- 2 - 4 students form a team and work together at a workstation / training system
- 16 different workstations
- Each experiment base unit is floor standing
- The base units are equipped by different experiment accessories
- 1 workstation is equipped with a PC
- Each workstation is equipped with a manual containing technical information, basic theory, experiment instructions, evaluation help and safety advice.
- Student teams are scheduled to change workstations from lab session to lab session in order to perform the entire range of experiments within the course duration.
- Average time per experiment: 90 to 120 minutes.

2 workstations for laboratory staff (with PC and internet access)

1 printer for common use

1 cupboard for small parts, consumables, tools, paper etc.

1 large shelf for the storage of unused experiment accessories

**Initial training provided for laboratory personnel**


To be conducted immediately after installation and commissioning of the equipment.

General topics to be covered for any of the educational systems:

- Basic familiarization with the system.
- Functions and components.
- Overall system configuration aspects.
- Start-up and operational aspects.
- Conduction experiments, including evaluation and calculation.
- Using the system with and without the software (where applicable).
- Trouble shooting and maintenance aspects.
- Hands-on, practical familiarization aspects.
- Seminar participants with the delivered system.
- Details of the manuals.
- Safe operation and preventive maintenance.
Requirements / Utilities

Power supply:
- 230 V / 50 Hz / 1 phase – at least 25 power sockets distributed according to lab lay-out

Water:
- 12 x cold water
- 12 x drain

Laboratory computer network:
- 2 internet connections for staff
- 1 internet connection for students

Location:
- Laboratory space min 120 m²
- This laboratory could be installed on any floor (e.g. ground floor or 1st floor)

Schedule of requirements

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Description</th>
<th>Quantity</th>
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</thead>
<tbody>
<tr>
<td>Item 1</td>
<td>Base module for experiments in fluid mechanics</td>
<td>12 pcs.</td>
</tr>
<tr>
<td>Item 1.1</td>
<td>Pipe friction for laminar / turbulent flow</td>
<td>2 pcs.</td>
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<tr>
<td>Item 1.2</td>
<td>Plate weirs for HM 150</td>
<td>2 pcs.</td>
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<tr>
<td>Item 1.3</td>
<td>Bernoulli's principle</td>
<td>2 pcs.</td>
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<tr>
<td>Item 1.4</td>
<td>Measurement of jet forces</td>
<td>2 pcs.</td>
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<td>Item 1.5</td>
<td>Horizontal flow from a tank</td>
<td>2 pcs.</td>
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<tr>
<td>Item 1.6</td>
<td>Visualisation of streamlines</td>
<td>2 pcs.</td>
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<tr>
<td>Item 1.7</td>
<td>Losses in a pipe system</td>
<td>2 pcs.</td>
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<tr>
<td>Item 1.8</td>
<td>Vertical flow from a tank</td>
<td>2 pcs.</td>
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<tr>
<td>Item 1.9</td>
<td>Methods of flow measurement</td>
<td>2 pcs.</td>
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<td>Item 1.10</td>
<td>Vortex formation</td>
<td>2 pcs.</td>
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<td>Item 1.11</td>
<td>Hydraulic ram – pumping using water hammer</td>
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<td>Item 1.12</td>
<td>Osborne Reynolds experiment</td>
<td>2 pcs.</td>
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<tr>
<td>Item 1.13</td>
<td>Visualisation of streamlines in an open channel</td>
<td>2 pcs.</td>
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<tr>
<td>Item 1.14</td>
<td>Energy losses in piping elements</td>
<td>2 pcs.</td>
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<tr>
<td>Item 2</td>
<td>Principles of air flow</td>
<td>1 pcs.</td>
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<tr>
<td>Item 2.2</td>
<td>Power meter</td>
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<tr>
<td>Item 2.3</td>
<td>Electronic total pressure sensor</td>
<td>1 pcs.</td>
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<td>Item 2.4</td>
<td>Pressure distribution on a cylinder</td>
<td>1 pcs.</td>
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<tr>
<td>Item 2.5</td>
<td>Friction losses in pipe elements</td>
<td>1 pcs.</td>
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<tr>
<td>Item 2.6</td>
<td>Heat transfer at a cylinder in transverse flow</td>
<td>1 pcs.</td>
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<tr>
<td>Item 3</td>
<td>Air flow experimental plant</td>
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<td>Item 3.1</td>
<td>Venturi tube</td>
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<tr>
<td>Item 3.2</td>
<td>Measurement of boundary layers</td>
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<td>Item 4</td>
<td>Hydrostatics trainer</td>
<td>1 pcs.</td>
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<tr>
<td>Item 5</td>
<td>Pressure losses in pipes</td>
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