



LABORATORY PLANNING GUIDE

L41 v2 Advanced Fluid Mechanics Laboratory

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Covered subjects according to the curriculum

Major topics of learning content:

- 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
- experiments from the field of flow around bodies
 - * velocity measurement of flows with Pitot tube
 - * boundary layer analysis on a flat plate with flow along the plate
 - * drag of bodies
 - * demonstration of the Coanda effect
 - * visualisation of streamlines
- experiments from the field of steady incompressible flow
 - * velocity measurement of flows with Pitot tube and Pitotstatic tube
 - * free jets
 - * flow in a pipe elbow
 - * proof of Bernoulli's principle
- determine drag and lift coefficients for different models
- pressure distribution when flowing around drag bodies
- investigation of flutter
- wake measurement
- generation of fog for demonstrations in fluid mechanics
- flow and pressure measurement methods
- function of nozzle, orifice, Venturi nozzle
- losses due to pipe bends and pipe angles and changes in cross section
- losses in shut-off valves and fittings
- losses in pipe sections connected in parallel and/or in series
- determining pipe friction factors and resistance coefficients
- opening characteristics in shut-off valves and fittings
- supersonic flow in the de Laval nozzle
- determine the speed of sound in air
- demonstration of potential flow in a Hele-Shaw cell for visualising flow lines
- visualisation of streamlines in
 - * flow around drag bodies: cylinder, guide vane profile, square, rectangle
 - * flow through models: nozzle contour, sudden contraction or enlargement
 - * flow separation, flow with 90° deflection
 - * vortex formation, demonstration of Karman vortices
- modelling the flow around bodies by overlaying parallel flow and sources and/or sinks
 - * formation of Rankine half-bodies
 - * demonstration of a dipole
- demonstration of a packed column with water, with air and with air/water counterflow mode:
 - * wall effect

- * stream formation
- * stagnation point
- * flooding point
- water hammers as a function of flow rate and as a function of valve closing time
- basic principles of open-channel flow:
 - * uniform and non-uniform discharge
 - * flow formulae
 - * flow transition (hydraulic jump)
 - * energy dissipation (hydraulic jump, stilling basin)
 - * flow over control structures
 - * weirs (sharp-crested, broad-crested, ogee-crested, siphon)
 - * comparison of the measuring weirs (Cipoletti, Rehbock, Thomson)
 - * discharge measuring with a Venturi flume
 - * free and submerged overfall at the Crump weir
 - * observation of downstream hydraulics jumps
 - * discharge at a sill
 - * discharge under gates
 - * flow-measuring flumes
 - * local losses due to obstacles
 - * transient flow: waves
 - * vibrating piles
 - * sediment transport
 - * different elements for energy dissipation: chute blocks, baffle blocks and end sills
 - * culvert outlet with free or submerged discharge
 - * investigations on waves: amplitude, frequency, forces, velocity, shapes and reflections
 - * absorption of wave forces

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
- 11 different workstations
- Each experiment base unit is floor standing
- The base units are equipped by different experiment accessories
- 4 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

Trainer: Specialized engineer of G.U.N.T. Gerätebau GmbH, Germany.

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:

- 2 x cold water
- 2 x drain

Laboratory computer network:

- 2 internet connections for staff
- 4 internet connection for students

Location:

- Laboratory space min 96 m²
- This laboratory should be installed on the ground floor

Schedule of requirements

Item No.	Description	Quantity
Item 1	Hydrostatics trainer	1 pcs.
Item 2	Aerodynamics trainer	1 pcs.
Item 2.1	Boundary layers	1 pcs.
Item 2.2	Bernoulli's principle	1 pcs.
Item 2.3	Drag forces	1 pcs.
Item 2.4	Flow in a pipe bend	1 pcs.
Item 2.5	Coanda effect	1 pcs.
Item 2.6	Free jet	1 pcs.
Item 2.7	Visualisation of streamlines	1 pcs.
Item 3	Open wind tunnel	1 pcs.
Item 3.1	Drag body sphere	1 pcs.
Item 3.2	Drag body hemisphere	1 pcs.
Item 3.3	Drag body circular disc	1 pcs.
Item 3.4	Drag body circular ring	1 pcs.
Item 3.5	Drag body square plate	1 pcs.
Item 3.6	Drag body flag	1 pcs.
Item 3.7	Drag body cylinder	1 pcs.
Item 3.8	Drag body streamline body	1 pcs.
Item 3.9	Drag body aerofoil NACA 0015	1 pcs.
Item 3.10	Drag body paraboloid	1 pcs.
Item 3.11	Drag body concave shape	1 pcs.
Item 3.12	Aerofoil with slat and slot flap	1 pcs.
Item 3.13	Pressure distribution on a cylinder	1 pcs.
Item 3.14	Pressure distribution on an aerofoil NACA 0015	1 pcs.
Item 3.15	Pressure distribution on an aerofoil NACA 54118	1 pcs.
Item 3.16	Pressure distribution on an aerofoil NACA 4415	1 pcs.
Item 3.17	Aerofoil, spring-mounted	1 pcs.
Item 3.18	Boundary layer analysis with Pitot tube	1 pcs.
Item 3.19	Electronic displacement measurement	1 pcs.
Item 3.20	Model "Bernoulli"	1 pcs.
Item 3.21	Wake measurement	1 pcs.
Item 3.22	Pitot tube	1 pcs.
Item 3.23	Pitot tube, small	1 pcs.
Item 3.24	Pitotstatic tube	1 pcs.
Item 3.25	Tube for static pressure	1 pcs.
Item 3.26	Three-component force sensor	1 pcs.
Item 3.27	16 tube manometers, 600mm	1 pcs.
Item 3.28	Fog generator	1 pcs.
Item 3.29	Electronic pressure measurement, 18x 0...500Pa	1 pcs.
Item 3.30	System for data acquisition	1 pcs.

Item No.	Description	Quantity
Item 4	Fluid mechanics trainer	1 pcs.
Item 5	Flow of compressible fluids	1 pcs.
Item 6	Potential flow	1 pcs.
Item 7	Visualisation of flow fields	1 pcs.
Item 8	Flow through packed columns	1 pcs.
Item 9	Water hammer in pipes	1 pcs.
Item 10	Pipe networks	1 pcs.
Item 11	Experimental flume 86x300mm	1 pcs.
Item 11.1	Extension element of the experimental flume	1 pcs.
Item 11.21	Sluice gate	1 pcs.
Item 11.22	Radial gate	1 pcs.
Item 11.23	Set of plate weirs, 4 types	1 pcs.
Item 11.24	Broad-crested weir	1 pcs.
Item 11.25	Crump weir	1 pcs.
Item 11.26	Siphon weir	1 pcs.
Item 11.27	Ogee-crested weir with pressure measurement	1 pcs.
Item 11.28	Ogee-crested weir with 2 weir outlets	1 pcs.
Item 11.29	Elements for energy dissipation	1 pcs.
Item 11.31	Sill	1 pcs.
Item 11.32	Culvert	1 pcs.
Item 11.33	Set of piers, 7 profiles	1 pcs.
Item 11.35	Venturi flume	1 pcs.
Item 11.41	Vibrating piles	1 pcs.
Item 11.42	Sediment trap	1 pcs.
Item 11.43	Sediment feeder	1 pcs.
Item 11.44	Wave generator	1 pcs.
Item 11.45	Plain beach	1 pcs.
Item 11.51	Level gauge	2 pcs.
Item 11.52	Pitotstatic tube	1 pcs.
Item 11.53	Velocity meter	1 pcs.
Item 11.54	10 tube manometers	1 pcs.