LABORATORY PLANNING GUIDE

L45 v2 Fluid Machinery Laboratory

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Covered subjects according to the curriculum

Major topics of learning content:

- investigation of an axial impulse turbine and of a reaction turbine with air flow
  - determination of power as a function of volumetric flow rate, pressure and speed
  - recording of torque characteristic
  - determination of the turbine efficiency
  - partial pressurisation (nozzle group circuit)
- operating behaviour and characteristic variables of a radial fan and of an axial fan
  - recording the fan characteristic (differential pressure as a function of the flow rate)
  - effect of the rotor speed on the pressure
  - effect of the rotor speed on the flow rate
  - effect of different rotor shapes on the fan characteristic and efficiency
  - determination of hydraulic power output and efficiencies
- pressure losses in pipes and pipe elbows
- flow in convergent/divergent nozzles
- supersonic flow in the de Laval nozzle
- determine the speed of sound in air
- compare calculation methods for incompressible and compressible flow
- use complete continuity equation
- determine mass flow using nozzle and volumetric flow rate using orifice
- record calibration curve for orifice
- record fan characteristic curve at different mass flows and speeds
- operating behaviour of centrifugal pumps
  - single pump operation
  - series pump operation
  - parallel pump operation
- principle of operation of a piston pump and of a gear pump
  - recording of pump characteristics
  - pressure curves of delivery pressure and cylinder pressure
  - influence of pulsation damping
  - p-V diagram
  - determination of efficiencies
- principle of operation of an axial, a reaction, a Pelton and an action turbine
  - relationship between torque and speed
  - efficiency dependent on speed
  - flow rate dependent on speed
  - hydraulic power and mechanical power depending on speed
- operating behaviour and characteristic variables of a radial compressor
  - recording of the compressor curve for both stages
  - effect of the rotor speed on the pressure
  - effect of the rotor speed on the flow rate
  - distribution of stage pressure ratios
  - effect of compression on the temperature increase
  - determination of hydraulic power output and efficiencies
- familiarisation with the basic principle of a multi-head diaphragm pump
- familiarisation with the basic principle of a rotary vane pump
- familiarisation with the occurrence of cavitation
- observation of cavitation effect in pumps
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
- 17 different workstations
- All workstations are floor standing or on a laboratory table
- 11 workstations are 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.

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 30 power sockets

**Water:**
- 2 x cold water
- 2 x drain

**Others:**
- Compressed air

**Laboratory computer network:**
- 2 internet connections for staff
- 11 internet connections for students

**Location:**
- Laboratory space min 72 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>
</tr>
</thead>
<tbody>
<tr>
<td>Item 1</td>
<td>Air-operated impulse turbine</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 2</td>
<td>Reaction turbine</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 3</td>
<td>Experiments with a radial fan</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 4</td>
<td>Experiments with an axial fan</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 5</td>
<td>Experiments with a centrifugal pump</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 6</td>
<td>Series and parallel connected pumps</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 7</td>
<td>Experiments with a piston pump</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 8</td>
<td>Experiments with a gear pump</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 9</td>
<td>Experiments with an axial turbine</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 10</td>
<td>Experiments with a reaction turbine</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 11</td>
<td>Experiments with a pelton turbine</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 12</td>
<td>Base unit for turbines</td>
<td>3 pcs.</td>
</tr>
<tr>
<td>Item 13</td>
<td>Experiments with an action turbine</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 14</td>
<td>Experiments with a radial compressor</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 15</td>
<td>Multi-head diaphragm pump</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 16</td>
<td>Rotary vane vacuum pump</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 17</td>
<td>Cavitation in pumps</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 17</td>
<td>Flow of compressible fluids</td>
<td>1 pcs.</td>
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</tbody>
</table>