



LABORATORY PLANNING GUIDE

L61 Basic Renewable Energies Laboratory

Content

Covered subjects according to the curriculum..... 2

Main concept..... 3

Initial training provided for laboratory personnel 3

Requirements / Utilities 4

Schedule of requirements 4



Covered subjects according to the curriculum

Major topics of learning content:

- physical behaviour of solar cells under varying illuminance and temperature
 - * recording of current-voltage curves
 - * calculating current strength and achievable output based on the single diode model
 - * interconnecting solar cells in parallel and series connection
 - * effect of bypass diodes
 - * power degradation due to shading
- design and operation of a simple solar thermal system
 - * determining the net power
 - * energy balance on the solar collector
 - * influence of illuminance, angle of incidence and flow rate
 - * determining efficiency curves
 - * influence of various absorbing surfaces
- design and operation of an air-to-water heat pump
 - * representation of the thermodynamic cycle in the log p-h diagram
 - * energy balances
 - * determination of important characteristic variables: compressor pressure ratio, ideal coefficient of performance and real coefficient of performance
 - * operating behaviour under load
- design and function of a Pelton turbine
- design and function of a Francis turbine
 - * determination of torque, power and efficiency
- operating behaviour and characteristics of a centrifugal pump through experiments
 - * recording the pump characteristic curve at a constant pump speed
 - * recording the pump characteristics for different speeds
 - * power and efficiency curves
- conversion of kinetic wind energy into electrical energy
 - * function and design of a stand-alone system with a wind power plant
 - * determining the power coefficient as a function of tip speed ratio
 - * energy balance in a wind power plant
 - * determining the efficiency of a wind power plant

- fundamental principle and method of operation of a pneumatic conveyor system
 - * observation of different transport states dependent on solid content and air velocity
 - * determination of the velocity and of the solid content of the flow
 - * pressure loss dependent on solid content and air velocity
- fundamental principle and the method of operation of a hydrocyclone
 - * solid mass flow rate in feed, top and bottom flow
 - * liquid mass flow rate in feed, top and bottom flow
 - * characteristic values for sharpness of separation
 - * pressure loss at the cyclone dependent on the feed flow rate
 - * influence of solids density on characteristic values and pressure loss

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
- 13 workstations of 7 different types
- All workstations are floor standing
- 7 of the 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

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
- 400 V / 50 Hz / 3 phases – at least 1 power socket

Water:

- at least 4 x cold water and 4 x drain

Laboratory computer network:

- 2 internet connections for staff
- 7 internet connections for students

Location:

- Laboratory space min 108 m²
- This laboratory could be installed on any floor (e.g. ground floor or 1st floor)

Schedule of requirements

| Item No. | Description | Quantity |
|----------|--|----------|
| Item 1 | Solar cell measurements | 2 pcs. |
| Item 2 | Principles of solar thermal energy | 2 pcs. |
| Item 3 | Heat pump trainer | 2 pcs. |
| Item 4 | Base module for experiments in fluid mechanics | 6 pcs. |
| Item 4.1 | Operating principle of a Pelton turbine | 2 pcs. |
| Item 4.2 | Speed sensor | 2 pcs. |
| Item 4.3 | Operating principle of a Francis turbine | 2 pcs. |
| Item 4.4 | Speed sensor | 2 pcs. |
| Item 4.5 | Centrifugal pump | 2 pcs. |
| Item 5 | Energy conversion in a wind power plant | 1 pcs. |