LABORATORY PLANNING GUIDE

L11 Solid Mechanics Laboratory

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Covered subjects according to the curriculum

Major topics of learning content:

- accumulation and resolution of forces with force parallelogram
- equilibrium of forces
- law of levers, determination of moments and equilibrium of moments
- combined lever systems
- forces in bearings
- deflection and resolution of force by fixed and free pulleys
- inclined plane; friction
- pulley blocks
- gear wheels
- graphical breakdown of forces by force parallelogram
- determination of the bar forces on various jib forms
- measurement of bar forces
- calculation of bar forces by the method of joints
- difference between static and dynamic friction
- friction forces as a function of normal force, sliding speed, material pairing, surface properties of the friction partners and size of the contact area
- slip/stick effect
- determination of friction coefficients
- measurement of the bar forces in various single plane trusses
- distribution of forces in the single plane truss dependent on the use of a surplus bar
- dependency on the external force: magnitude, direction and point of application
- comparison of measurement results with method of joints and Ritter’s method of sections
- calculation of the reactions arising from the static conditions of equilibrium
- application of the method of sections to calculate the internal forces and moments
  * under a point load
  * under multiple point loads
- calculation of the shear force diagram
- calculation of the bending moment diagram
- determination of the coefficient of friction of a threaded spindle with different materials
- determination of the respective thread efficiency
- axial tension force in a bolt joint dependent on the tightening torque
- axial tension force in a bolt joint dependent on the elastic deformation of a slotted block
- measurement of the breakaway torque, including different fitting situations of the bolt joint
- influence of angle of contact, coefficient of friction and belt force (Eytelwein’s rope friction formula)
- comparison flat belt - V-belt
- consequences of an incorrectly aligned belt
- displacement curves for cam mechanisms
  * arc/tangent/concave/asymmetric cam
• choice of roller tappet, cup tappet or trailing lever
• measurement of strain using strain gauges
• application of Mohr’s Circle for stress and strain analysis
• application of Mohr’s Circle for the triaxial stress state
• determination of the principal stresses on an open vessel (pipe) and on a closed vessel (tank)
• comparison of open / closed vessels
• determination of the Poissons ratio
• correlations between strain, pressure and stress in the plane biaxial stress state
• correlations between elongation, pressure and stress in the triaxial stress state

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
• 28 workstations with 9 different experiment units
• Each experiment unit on its own table to allow short prepare times
• 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 15 power sockets distributed according to lab layout

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

Location:
- Laboratory space min 72 m²
- This laboratory can 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>Fundamentals of statics</td>
<td>4 pcs.</td>
</tr>
<tr>
<td>Item 2</td>
<td>Forces in a crane jib</td>
<td>1 pcs.</td>
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<tr>
<td>Item 3</td>
<td>Forces in a simple bar structure</td>
<td>1 pcs.</td>
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<tr>
<td>Item 4</td>
<td>Dry friction</td>
<td>1 pcs.</td>
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<tr>
<td>Item 5</td>
<td>Forces in various single plane trusses</td>
<td>1 pcs.</td>
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<tr>
<td>Item 5.1</td>
<td>Mounting frame</td>
<td>1 pcs.</td>
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<tr>
<td>Item 5.2</td>
<td>Multi-channel measuring amplifier</td>
<td>1 pcs.</td>
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<tr>
<td>Item 6</td>
<td>Forces in an overdeterminate truss</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 6.1</td>
<td>Mounting frame</td>
<td>1 pcs.</td>
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<tr>
<td>Item 6.2</td>
<td>Multi-channel measuring amplifier</td>
<td>1 pcs.</td>
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<tr>
<td>Item 7</td>
<td>Beam on 2 supports: shear force &amp; bending moment diagrams</td>
<td>1 pcs.</td>
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<tr>
<td>Item 8</td>
<td>Thread testing</td>
<td>1 pcs.</td>
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<tr>
<td>Item 9</td>
<td>Screw connections testing</td>
<td>1 pcs.</td>
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<tr>
<td>Item 10</td>
<td>Belt friction apparatus</td>
<td>1 pcs.</td>
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<tr>
<td>Item 11</td>
<td>Cam mechanism</td>
<td>1 pcs.</td>
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<tr>
<td>Item 12</td>
<td>Stress and strain analysis on a thin-walled cylinder</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 12.1</td>
<td>Multi-channel measuring amplifier</td>
<td>1 pcs.</td>
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<tr>
<td>Item 13</td>
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Laboratory drawing