LABORATORY PLANNING GUIDE

L25 Machine Diagnosis Laboratory

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Covered subjects according to the curriculum

Major topics of learning content:

- introduction to vibration measurement methods on rotating machinery systems
  - fundamentals of measurement of shaft and bearing vibrations
  - basic variables and parameters
  - sensors and measuring devices
  - influences of speed and shaft layout
  - influence of transducer positioning
- field balancing of rigid shafts
- influence of alignment between motor and flexible coupling
- understanding and interpreting frequency spectra
- use of a computerised vibration analyser
- correct application of FFT analysis
- measurement of rotation speed, vibration displacement, vibration velocity and acceleration
- assessment of the vibration state of a machine
- damage analysis of roller bearings and gears by means of envelope spectra
- detection of cracks in shafts by means of run-up curves and order analysis
- measurement of imbalance vibrations and field balancing of rigid rotors in 1 and 2 planes
- estimating service lives of roller bearings
- influence of the lubricant on the vibration spectrum
- identification of coupling faults from the vibration signal
- load dependency of running behaviour
- influence of gear rim hardness on claw couplings
- comparison of curved teeth, pin, flange and claw couplings
- influence of belt tension and speed on vibration behaviour
- influence of pulleys running untrue, and off-track running
- power split across multiple belt drive
- influence of slip on vibration running spectrum
- comparison between fault-free and damaged belts
- identification of gear damage from vibration behaviour
- influence of gearing type: spur toothed or helical
- experimental modal analysis of mechanical systems
- influence of bearing clearance and shock impact
- inconsistent torque characteristic
- wear measurement on piston rods
- observing and understanding cavitation in a centrifugal pump
  - visually
  - stroboscopically (stroboscope available as accessory)
- investigation of the operating vibrations of a centrifugal pump
- vibration measurement on fans
- measurement of blade pass frequency
- identification of the vibration induced by the blades from the vibration spectrum
- effect of dynamic imbalance on the fan
- influence of electromagnetic asymmetry on vibration behaviour
- influence of the gap on electromagnetic losses, efficiency and vibration
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
- 6 different workstations
- All 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 24 power sockets distributed according to lab lay-out.
Laboratory computer network:
- 2 internet connections for staff
- 6 internet connections for students
Location:
- Laboratory space min 48 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>Machinery diagnostic system, base unit</td>
<td>6 pcs.</td>
</tr>
<tr>
<td>Item 1.1</td>
<td>Laboratory trolley</td>
<td>6 pcs.</td>
</tr>
<tr>
<td>Item 1.2</td>
<td>Computerised vibration analyser</td>
<td>6 pcs.</td>
</tr>
<tr>
<td>Item 1.3</td>
<td>Elastic shaft kit</td>
<td>2 pcs.</td>
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<tr>
<td>Item 1.4</td>
<td>Crack detection in rotating shaft kit</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 1.5</td>
<td>Roller bearing faults kit</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 1.6</td>
<td>Couplings kit</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 1.7</td>
<td>Belt drive kit</td>
<td>4 pcs.</td>
</tr>
<tr>
<td>Item 1.8</td>
<td>Damage to gears kit</td>
<td>2 pcs.</td>
</tr>
<tr>
<td>Item 1.9</td>
<td>Crank mechanism kit</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 1.20</td>
<td>Cavitation in pumps kit</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 1.21</td>
<td>Vibrations in fans kit</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 1.22</td>
<td>Electromechanical vibrations kit</td>
<td>1 pcs.</td>
</tr>
<tr>
<td>Item 1.23</td>
<td>Brake &amp; load unit</td>
<td>4 pcs.</td>
</tr>
<tr>
<td>Item 1.24</td>
<td>Two displacement sensors</td>
<td>1 pcs.</td>
</tr>
</tbody>
</table>

### Laboratory drawing

![Laboratory drawing](image-url)