A Proposal for Wear and Tribology of Materials Lab

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I. Objectives of the Virtual Lab

The virtual lab on Wear and Tribology of Materials will provide insights of damage mechanisms along with visualization of damage mechanisms with changes in type of material, loading speed, sliding velocity and sliding distance.

II. List of experiments

A. Bulk Wear Tests:

1. Abrasive and Adhesive Wear of Material (metal on metal) and ceramic to polymer articulating pair.
2. Estimating wear rate via weight loss and volume loss method
3. Effect of lubrication (boundary film and hydrodynamic) on wear of materials
4. Effect of load on wear of materials
5. Effect of sliding speed on wear of materials

B. Micro-wear Tests:

6. Fretting Wear of Materials
7. Friction Hysteresis, and Estimation of Hertzian Contact Diameter
8. Friction log showing dependence of load, frequency and cycles on material
9. Micro-scratching of materials and damage assessment
10. Ramp loading and estimation of scratch toughness estimation in materials

*Alternatively, 3-4 additional experiments (minimum) may be developed to augment existing labs (www.vlab.co.in).

Note: Please list all related experiments available on the web (vlab.co.in) and compare your proposed experiments with them. Please justify why the proposed experiments are needed and exactly what gaps they fill.

III. Target group of users

- UG (1st Year/ 2nd Year) [highest priority for development]
- UG (3rd Year/ 4th Year) [next higher priority for development]

IV. Mapping of proposed lab with AICTE courses as per attached list of potential labs

- Tribology in Design and Program Elective III

V. Mapping of proposed lab with universities (minimum 3 universities)

- BITS-Pilani; DE G631; M.E. Design Engineering Program
- Indira Gandhi Institute of Technology, Sarang; HNMT0405/ HNMT0405; B. Tech: Metallurgical and Materials Engineering
- Vel Tech University Chennai; 1152ME109; B.Tech: Mechanical Engineering

- Savitribai Phule Pune University; ME42103; B. Tech: Mechanical Engineering
- IIT Dhanbad; MEC523; M. Tech: Mechanical Engineering
- IIT Kanpur; MSE312; M. Tech: Material Science Engineering
- Indira Gandhi Institute of Technology, Sarang; HNMT0405/ HNMT0405; B. Tech: Metallurgical and Materials Engineering
- IIT Palakkad; ME 3503; B. Tech: Mechanical Engineering

VI. **Expected timelines**

Presentation of proposal to domain experts' committee – 31st March 2022
Demo of First 3 Expts and Review – 30th June 2022
Demo of 5-6 Expts and review – 31st August 2022
Demo of 7-10 Expts and review – 31st October 2022
Final demo of 7-10 Expts – 15th November 2022
Hosting of lab (7-10 Expts) – 30th November 2022

Note 1: The LDC will coordinate the reviews and hosting

Note 2: The lab is supposed to be developed and hosted within 6 - 9 months from the date of approval

VII. **Budget** (Max. Rs 2 Lakhs per experiment with a ceiling of Rs 20 Lakhs per Lab)

Table I. Budget for < Wear and Tribology of Materials Lab>

S. No.	Equipment/Activity	Budget # (In Rupees)
1	Laptop / Machine(computer/laptop, weighing machine, ball-mill-jars, etc)	2.70
2	Manpower(*project engineer/scientist*)	4.80
3	Consumables (various materials including polymers, metals and ceramics, set-up, test-bed, chemicals, glassware, diamond polishing, gold-coating, sample mounting, etc)	4.00
4	Contingency (die-making, cast-material, crucible machining, indenter tip, heat treatment, material processing, repair, incidentals, miscellaneous, etc)	4.00
5	Honorarium for Lab Developer (Rs 20k per experiment; Ceiling of Rs 2 Lakhs per lab)	2.50
6	Miscellaneous	2.00
TOTAL		20 **lakhs**

To be released based on the recommendation of the review committee
Note: Institute overheads not to be included in the budget

VIII. **Justification of the budget requirements**

(a) Details of Laptop/Machine

Will require a dedicated computer/laptop for simulation, data keeping and concerted work. In addition, weighing machine will be needed for the weight loss measurements. Further, sample preparation may require tumbling mill, jars for ball mill as well.

(b) Details of Manpower (number, cost per man-months etc.)

i. Total man-months required

1 Project staff

ii. No. of project staff, cost per man-months

1 project engineer/scientist (~Rs. 40k per month).

iii. Honoraria for other staff associated with the project

Honoraria for Faculty developing the Virtual Lab: (A maximum of Rs. 2 lakhs honorarium for the developers & Rs. 25k for reviews)

Honoraria for Other staff associated with the project

Rs. 25k honorarium for the associated staff

(c) Details of Consumables

Procurement of various materials including polymers, metals and ceramics will cost some share, then the set-up of tests and test-bed will also cost some share. Further, use of required chemicals, glassware, diamond polishing, gold-coating, sample mounting, etc. will also eat away fund under this head

(d) Details of Miscellaneous cost

i. Internal Review (Optional, Rs 1000 per experiment)

ii. Field Trials- N.A.-

iii. Others User testing charges for Material characterization (microscopy characterization phase evaluation, surface profiling, etc)

IX. **Student Feedback and Learning**

- How will you collect feedback and use them?

i. We will collect feedback through feedback (online/offline) form and workshops

ii. There is also an associated email id for providing feedback

iii. An expansion or additional explanation will be added if the need arises.

- What is the actual learning component provided by the Virtual Lab?

i. Learning is through 'pre-test' and 'post-test' along with schematics, strong theory and simulations

ii. The simulations and prompts will help the user appreciate and understand the mechanism of wear

iii. The wear damage with respect to various materials and length scales will be also the learning outcome.

- After the Virtual Lab experience, would the student be able to perform the experiment in the real lab?

i. Yes, after the Virtual Lab experience, the student will have confidence to perform the experiment hands-on in the real lab

ANNEXURE-I

Important information for the development of Virtual Labs

(A Virtual Lab consists of 7-10 experiments)

X. **Link to some sample virtual labs**

https://python-iitk.vlabs.ac.in/ https://cs-iitd.vlabs.ac.in/ https://plchla-coep.vlabs.ac.in/

XI. **Technology Used**

- We will use HTML, CSS and Java Script (open source software) for front-end design
- For Back-end we will use JSON (open source software)

XII. **Required Components for virtual experiments**

- Step-by-step procedure of wear and tribology of materials
- Online manual with aim/objective and underlying theory
- Pre-test for understanding current status of user
- Simulator for assisting the learning on wear of materials
- Post-test for observing learning outcome after learning through virtual lab
- Related resources (web & NPTEL lectures)
- Additional help/feedback