A Proposal for Control Engineering Virtual Lab

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I. Objectives of the Virtual Lab

1. To provide the students with the knowledge and practice of the modeling of physical dynamical systems to become a proficient control Engineer
2. To prepare qualified engineers to build control algorithms.

II. List of experiments

S. No.	Name of Experiment	Pedagogy
1.	Analyze the transfer function and pole zero plot of a control system. To obtain: i. Pole zero, gain values from a given transfer function ii. Transfer function model from pole, zero, gain values iii. Pole, zero plot of a transfer function	Analysis
2.	Find and Plot the step and impulse response for a first order unity feedback system.	Evaluation
3.	Find and Plot the step and impulse response for a second order unity feedback system.	Evaluation
4.	Find and Plot the step and impulse response for a type ‘0’, type ‘1’, type ‘2’ systems.	Evaluation
5.	Show the effect of addition of zeros to the forward path transfer function of a closed loop system.	Analysis

6.	Show the effect of addition of poles to the forward path transfer function of a closed loop system.	Analysis
7.	Plot the root locus for the given transfer function and show i. Break away point ii. Intersection with Imaginary axis, iii. Range of K for Stability iv. Closed loop transfer function at any value of K.	Analysis
8.	Show the bode plot for a given transfer function of the system.	Evaluation
9.	Obtain Nyquist Plot of a system	Analysis
10.	Study the effect of PI, PD and PID controller on system performance	Understanding

III. Target Group

- UG, PG

IV. Mapping of proposed lab with AICTE course

- Control System (PCC-EE17)

V. Mapping of proposed lab with UGC approved universities

S. No.	Discipline	Lab Name	University Name	Semester
1	Electrical & Electronics Engineering (EEE)	Control System (EE332)	Muffakham Jha College of Engineering & Technology, Hydrabad	3rd
2.	Electronics & Instrumentation Engineering (EIE)	Control System (EE332)	Muffakham Jha College of Engineering & Technology, Hydrabad	4th
3.	Electrical & Electronics Engineering (EEE)	Control System (EE2257)	SSN College of Engineering Kalavakkam	3rd
4.	Electrical & Computer Engineering	Fundamentals of Control System (E6.LEC372)	Concordia University	3rd

5.	Electrical Engineering (EE)	Control System (3130905)	Amiraj College of Engineering & Technology	3rd
6.	Electrical & Electronics Engineering (EEE)	Control System (EE2257)	Dhanalakshmi College of Engineering	3rd
7.	Electrical Engineering (EEE)	Control System (EL181412)	Jorhat Engineering College, Asam	4th
8.	Electrical Engineering (EE)	Control System (01EE0403)	Marwadi University, Rajkot Gujrat	4th
9.	Electrical & Electronics Engineering (EEE)	Control System Lab (EE301P)	IIT Mandi	3rd
10	Electrical & Electronics Engineering (EEE)	Control System Lab (REE553)	AKTU Lucknow and Their Affiliated Colleges	5th
11.	Electronics and Communication Engineering (ECE)	Control System-I Lab (KIC-652)	AKTU Lucknow and Their Affiliated Colleges	6th
12.	Electronics and Instrumentation Engineering (EIE)	Control System Lab (RIC653)	AKTU Lucknow and Their Affiliated Colleges	6th
13.	Instrumentation and Control Engineering (ICE)	Control System-I Lab (NIC551)	AKTU Lucknow and Their Affiliated Colleges	5th
14.	Electronics and Communication Engineering (ECE)	Control System Lab (PEE652)	**Uttarakhand Technical University** and Their Affiliated Colleges	6th
15.	Electrical Engineering (EE)	Control Engineering Lab (EEM502)	Dayalbagh Educational Institute, Agra	5th

VI. Proposed date of completion – One Year from the date of grant sectioned

VII. Budget (Max. Rs 2 Lakhs per experiment)

Table I. Budget for Concrete Technology Lab

S. No.	Equipment/Activity	Budget #(In Lakh Rupees)
1	Hardware, software, and other equipment	Rs 5.0 Lakh
2	Manpower	Rs 7.2 Lakh
3	Consumables	Rs 0.4 Lakh
4	Contingency	Rs 2.7 Lakh
5	Miscellaneous	Rs 2.7 Lakh
6	Honoraria for Faculty developer	Rs. 2 Lakh
	TOTAL	**Rs 20 Lakh**

To be released on 30:40:30 proportion

VIII. Justification of the Budget requirement

(a) Details of Hardware and other equipment

S. No.	Device Specification	Quantity	Total Cost (in Lakh rupees)
1	Workstation with at least 8-Core CPU 8-Core GPU512GB Storage, 512GB storage, 8GB unified memory, 24-inch, 4.5K Retina display, Two Thunderbolt / USB 4 ports, Two USB 3 ports, Gigabit Ethernet	01	1.8
2	Online UPS with battery and peripheral		0.6

3	Mobile Computer Workstation with at least 10-Core CPU, 16 Core GPU, 16GB Unified Memory, 512GB SSD Storage, 16-core Neural Engine, 16.2-inch, Liquid Retina XDR display, Three Thunderbolt 4 ports, HDMI port, SDXC card slot, MagSafe 3 port, Magic Keyboard with Touch ID, Force Touch trackpad	01	2.6
		Total	5.0

(b) Details of Software (should be Free and open-source Software)

- Windows (or any other free Windows Distro)
- Html, css, java script, chart.js, MathJax

(c) Details of Manpower (no., cost per man-months, honoraria etc)

a. No. of project staff, cost per man-months –Development Engineer (1), Project Associate/JRF, Student interns (3)
b. Honoraria for Faculty developing the Virtual Lab –2.0 Lakh
c. Honoraria for Other staff associated with the project –

S. No.	Staff Designation	Number of staff	Salary Per Month	Total per annum (LPA)
1	Development Engineer/SRF	01	Rs. 30,000/-	3.6
2	Student Interns	03	Rs. 10,000/-	3.6
			Total	7.2

(d) Details of Consumables

Stationery products, printer refill, pen drives, digitizers, books etc.

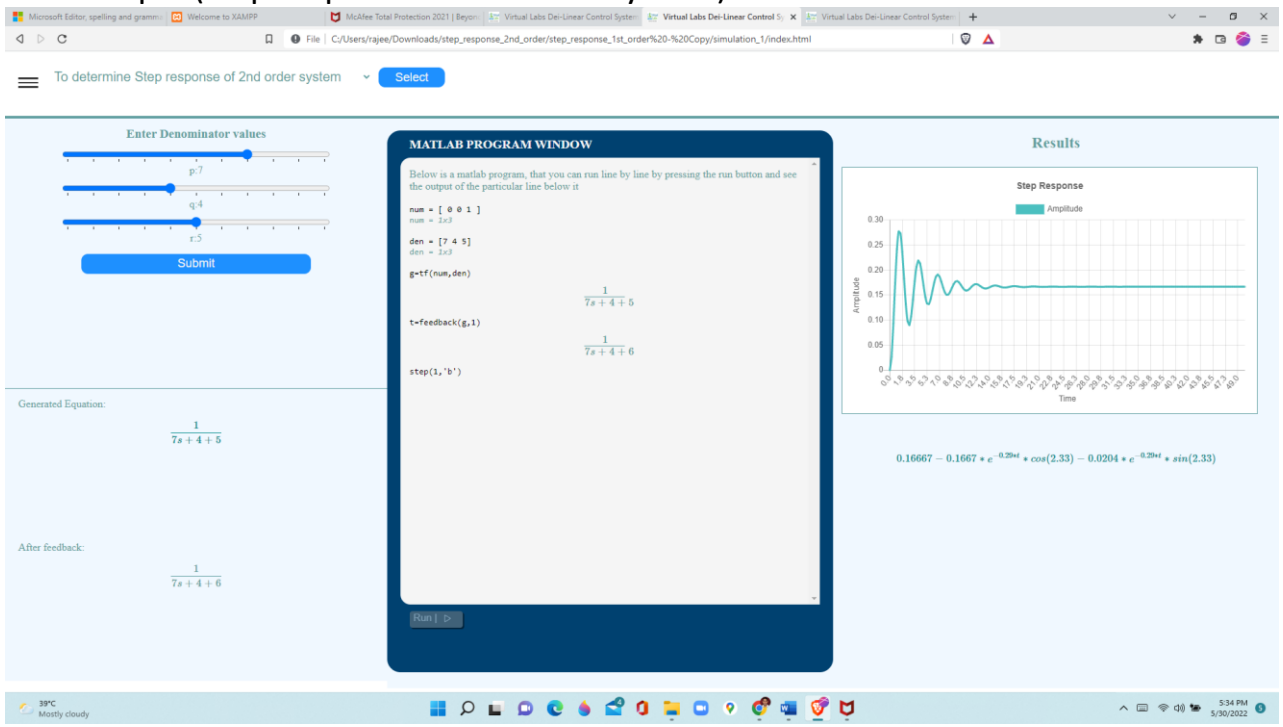
(e) Details of Miscellaneous cost

a. Production/manufacturing cost
b. Field Trials
c. Others

IX. Virtualization

➢ How do you intend to virtualize the experiments?

1. There is option for the user to insert the values. Also having the option to vary them.
2. There is visualization of the output according to the feed values.
3. Step by Step output visualization.
4. There is visualization of the graphical views of the plots and impressions of the pointed parameters.
5. An example (step response of 2nd order system) of the visualization is as below:



- How will the student get a feel for a 'real lab'?
    a. Student will virtually perform all the steps of the experiments which will provide them the feel of the 'real lab'.
    b. Students work will be validated in the form of mathematical outputs as well as in the form of plots.

- Will you be using animations? No
  We are using the real time simulation for various steps of experiments and graphical representation of results.

X. Technology Used

- Software to be used for Web interface (should be Free and open-source Software)
  Open source software such as Scilab would be used

- Software to be used for back-end (should be Free and Open-source Software)
  Open source software like Scilab would be used
- Any other

XI. How it improves or otherwise complements the existing efforts

- The proposed lab giving ease of access to students to the control systems experiments with varying quantities.
- By adjusting the quantities students will be able to learn how the system response will change according to the different inputs.
- There is no need to install a purchased software only open source will be used to develop the experiments.
- The experiments are device friendly. Students can perform experiments by using mobile, tablet, i-pad, laptop or desktop etc.

XII. Documentation

- Online manual – Yes
- Step-by-step procedure – Yes
- Pre-test – Yes

- Post-test – Yes
- Related resources – Yes
- Additional help – Yes

XIII. Expected outcome

- Hardware/software
- Website
- Manual and related material would be available

XIV. Student Feedback and Learning

- How will you collect feedback and use them?
- Feedback will be provided at the end of the experiment and the same will be used to improve the animation and content if required.

- What is the actual learning component?
- *An open-source software and powerful implementation hardware.*

- After the Virtual Lab experience, can the student perform the experiment in the real lab?
- *Students can easily perform and design the system after learning from the proposed lab.*