Teaching Computational Skills and Problem-Solving with MATLAB and Simulink Workshop
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UTILIZING MATLAB TO ENHANCE LEARNING & PROBLEM-SOLVING

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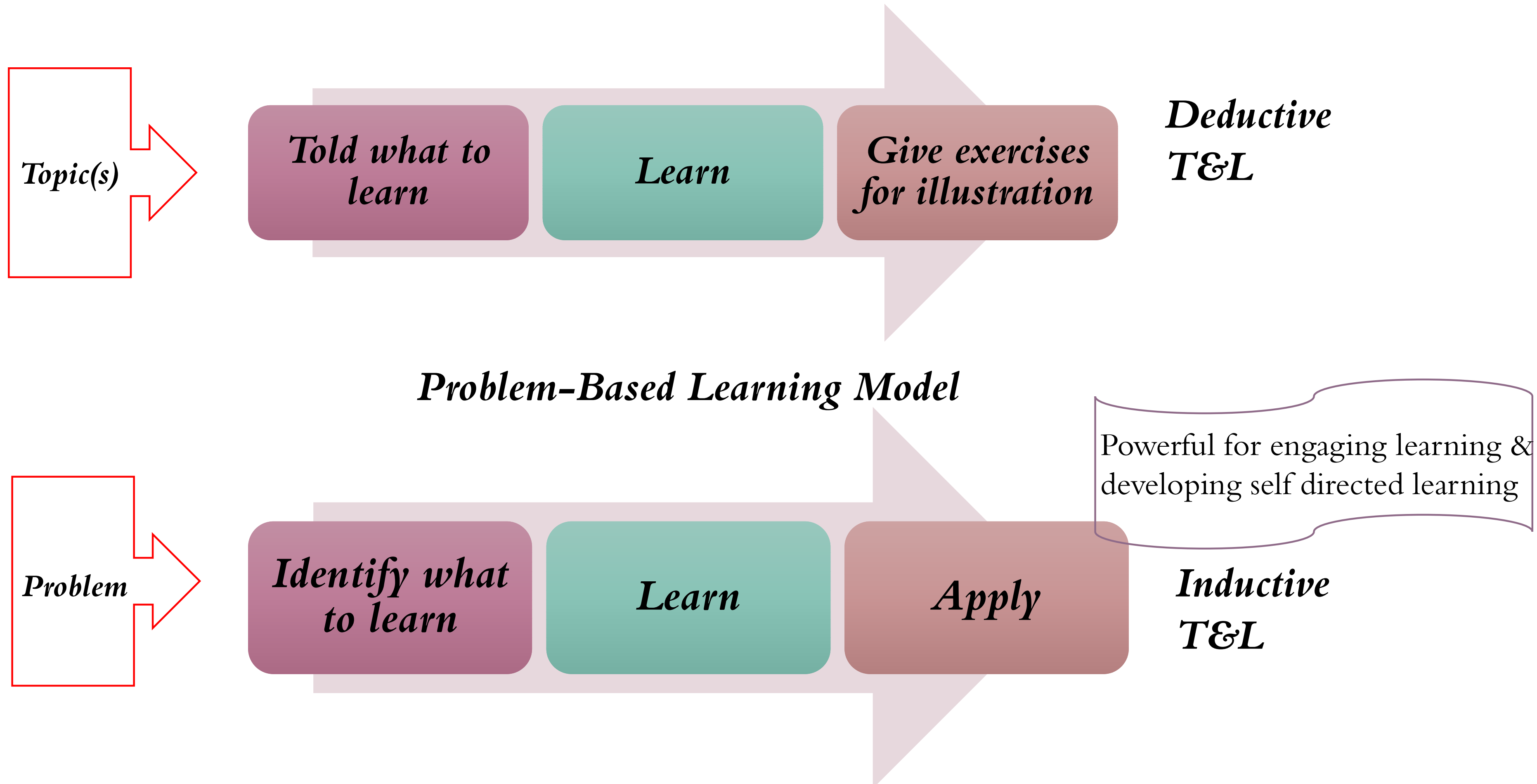
Khairiyah Mohd-Yusof is the President for the Society of Engineering Education Malaysia, Deputy Secretary General of the Academy of Professors Malaysia, and the founding Director of Universiti Teknologi Malaysia Centre for Engineering Education. She first used MATLAB as a graduate student in the US in 1990 in the Advanced Process Control course. She feels fortunate that she has been assigned to teach Process Control since her early days in UTM because most Chemical Engineering instructors do not like the subject, allowing her to improve and innovate the course to help students to learn better.

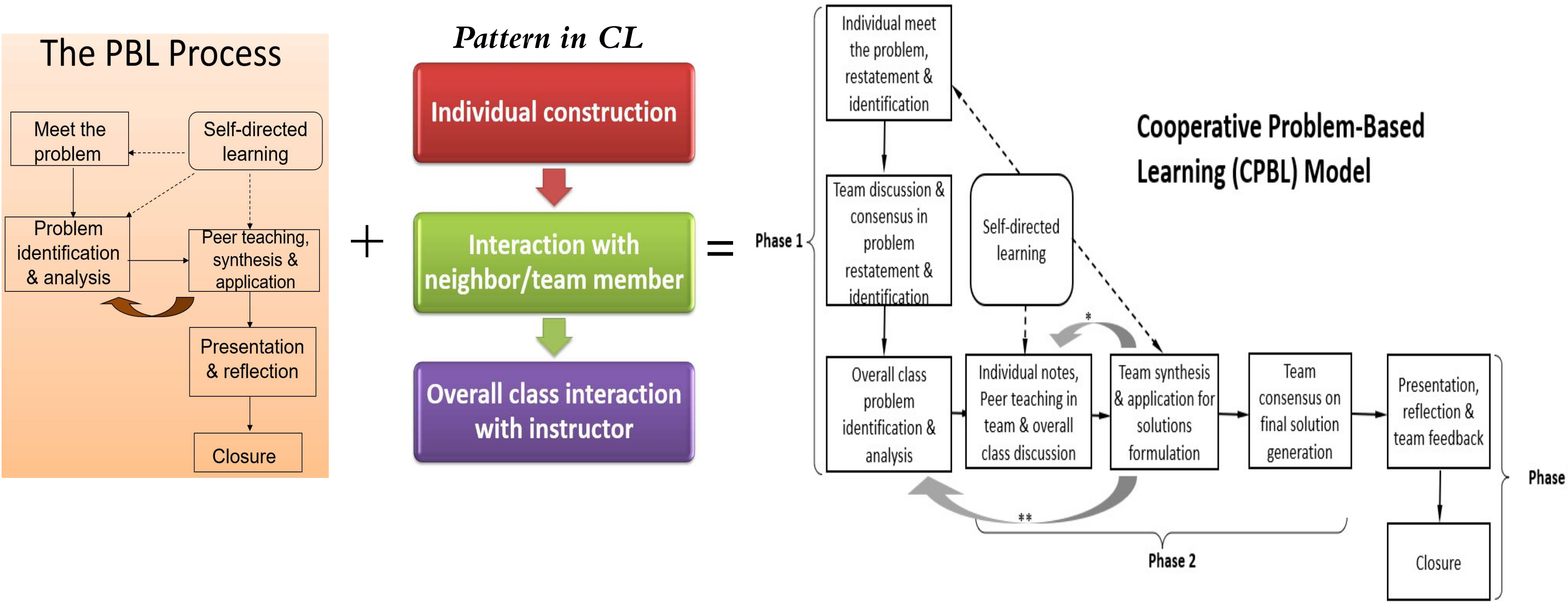
She is a practitioner and researcher of student-centered approaches in engineering education and is currently on the Editorial and Advisory Boards of several journals, such as the ASEAN Journal of Engineering Education, Journal of Engineering Education, Journal of Education for Chemical Engineers and European Journal of Engineering Education. For her work, she had received several awards including the 2018 IFEES Duncan Fraser Global Award for Excellence in Engineering Education, 2017 Student Platform on Engineering Education Mentoring Award and 2015 Frank Morton IChemE Global Award for Chemical Engineering Education Excellence.

Issues in Teaching Chemical Engineering Undergraduates Process Control & Dynamics

- ❖ Highly mathematical content → lost in mathematics, not able to relate physically what is happening
- ❖ Complex problem-solving became one of the required attributes of engineering graduates under the Washington Accord
- ❖ Students not motivated to learn and understand a deep level to be able to solve complex problems
- ❖ How to develop complex problem-solving skills?
- ❖ Fast-changing world and virtual resources → need to develop self-directed learning

Commonly used Teaching and Learning (T&L) Models





The PBL Process
Meet the problem
Self-directed learning
Problem identification & analysis
Peer teaching, synthesis & application
Presentation & reflection
Closure
+
Pattern in CL
Individual construction
Interaction with neighbor/team member
Overall class interaction with instructor
=
Cooperative Problem-Based Learning (CPBL) Model
Phase 1
Individual meet the problem, restatement & identification
Team discussion & consensus in problem restatement & identification
Self-directed learning
Overall class problem identification & analysis
Individual notes, Peer teaching in team & overall class discussion
Team synthesis & application for solutions formulation
Team consensus on final solution generation
Presentation, reflection & team feedback
Closure
*
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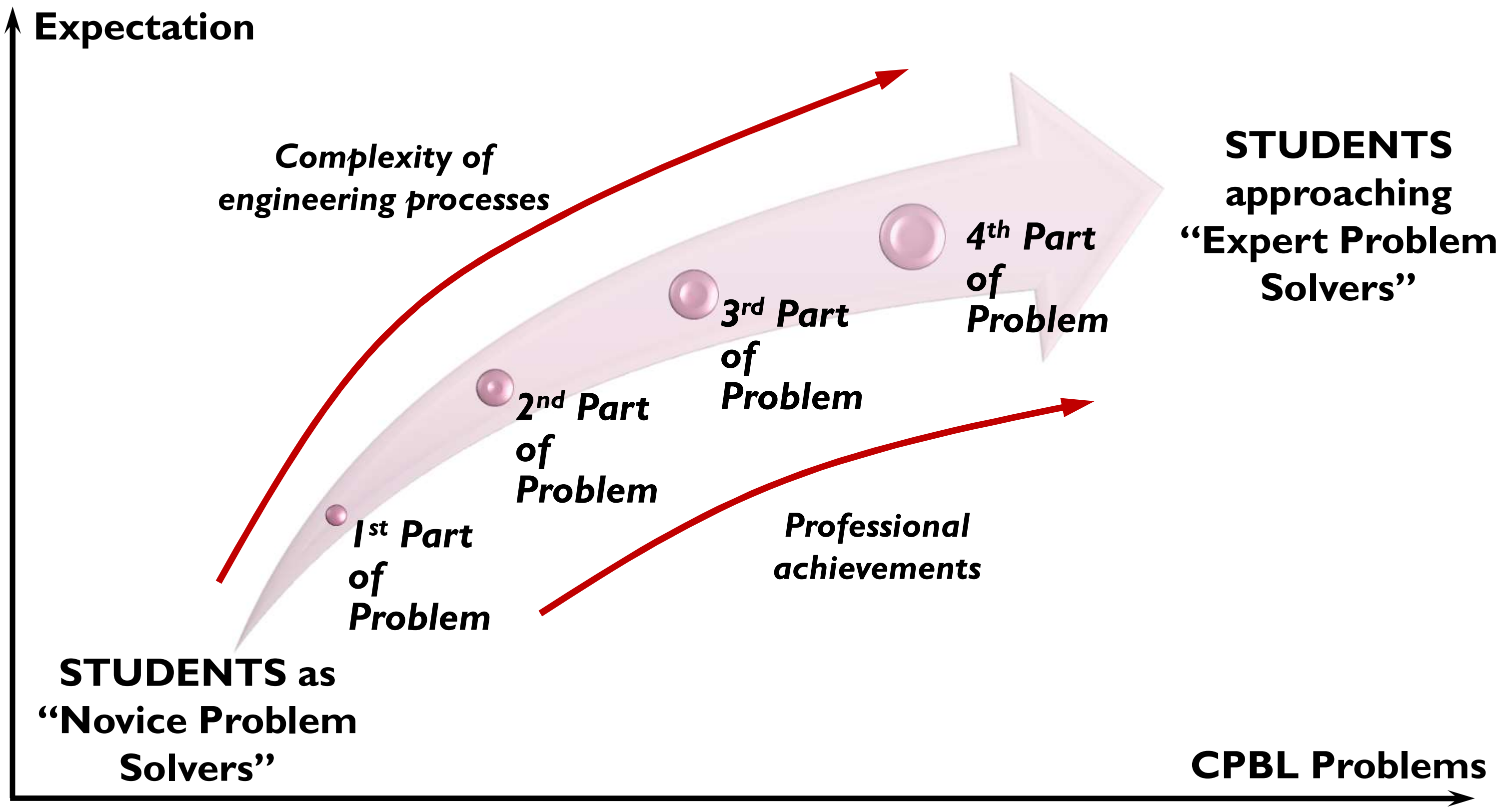
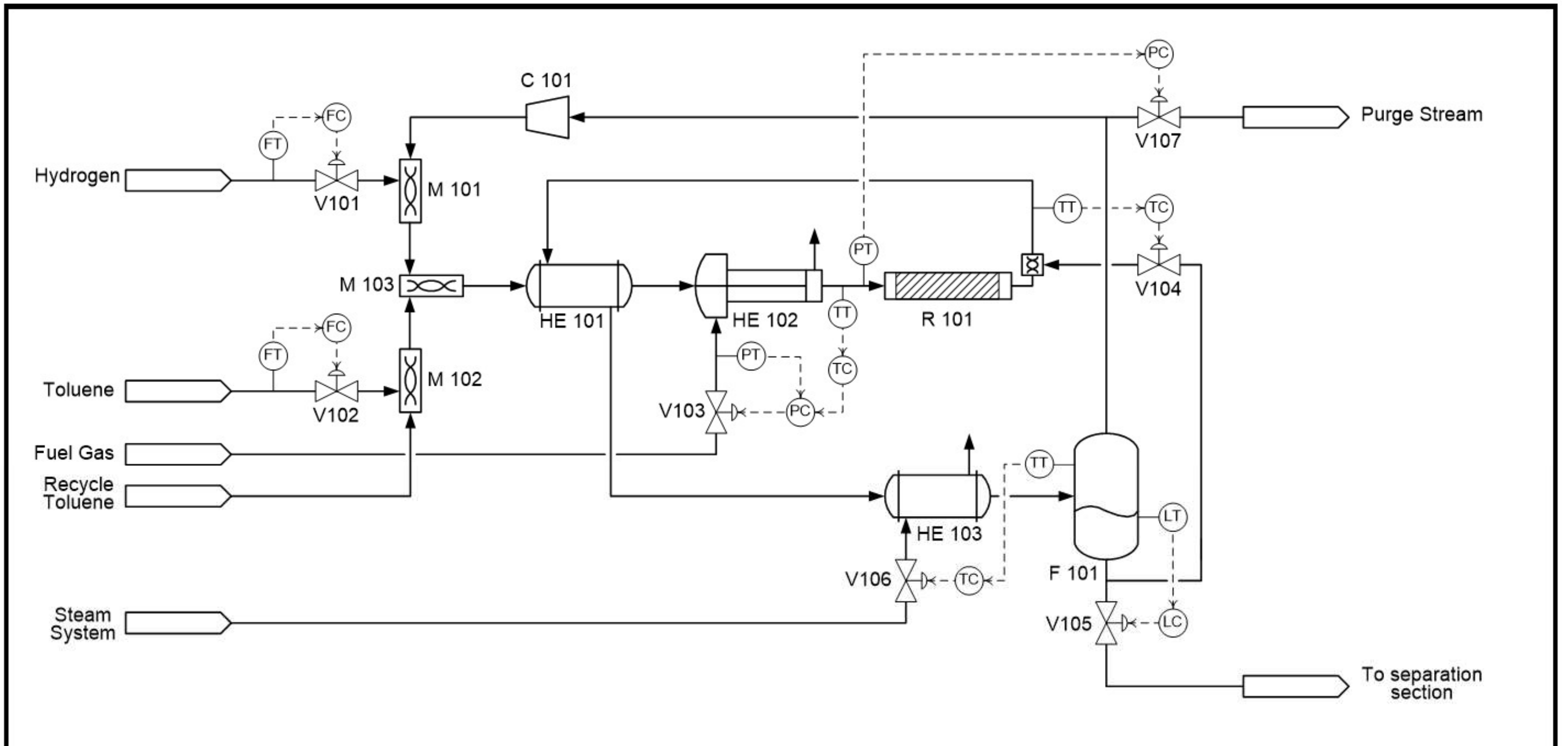
Phase 2
Phase 3

Series of Problems

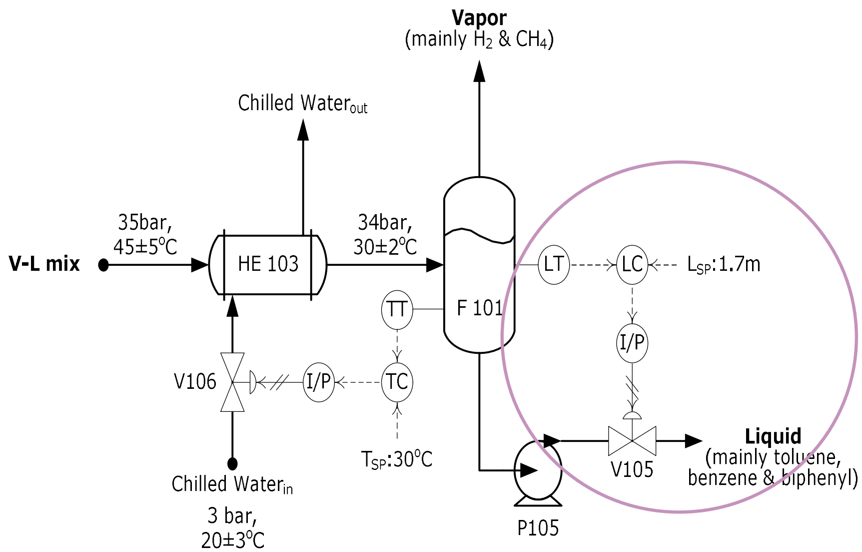
Scaffolding in organization of problems for a whole semester in a course





DRAWING OWNED BY:	PROJECT/PROCESS:	PIPING & INSTRUMENTATION DIAGRAM (P&ID):			
O-GAM GAMBANG AROMATIC (M) SDN. BHD.	**Hydrodealkylation of Toluene to Benzene**	**Hydrodealkylation Process (SECTION 01: REACTOR & FLASH VESSEL)**			
		Scale: NTS	Drawn: Faizal Esmael	Drawing No.: HDA.Plant/SN01/R101_V101	Date: 11th March 2021

Figure 1: Hydrodealkylation Process



Step Test: Level Controller (GdH)

$$+\text{ve slope} = \frac{(1.73051 - 1.71025)\text{m}}{(16.0 - 6.5\text{min})} = 2.133\times10^{-3}\ \frac{\text{m}}{\text{min}}$$

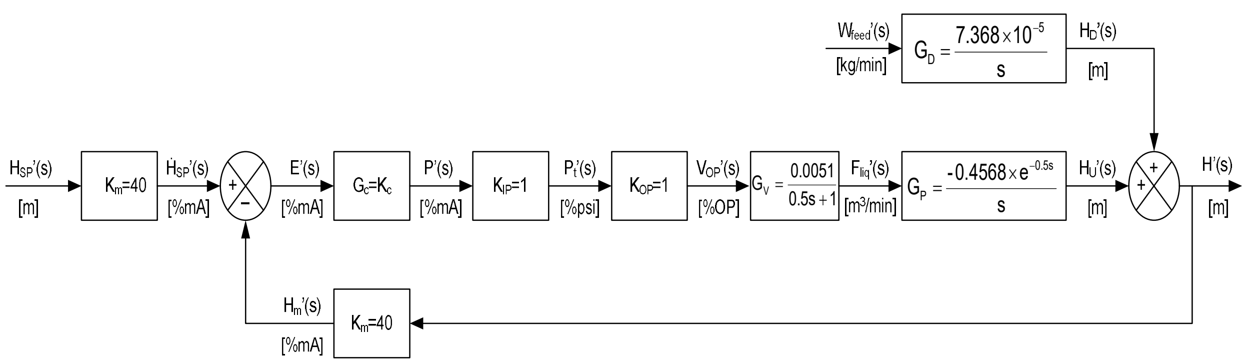
$$-\text{ve slope} = \frac{(1.71072 - 1.73047)\text{m}}{(37.0 - 26.5)\text{min}} = -1.881\times10^{-3}\ \frac{\text{m}}{\text{min}}$$

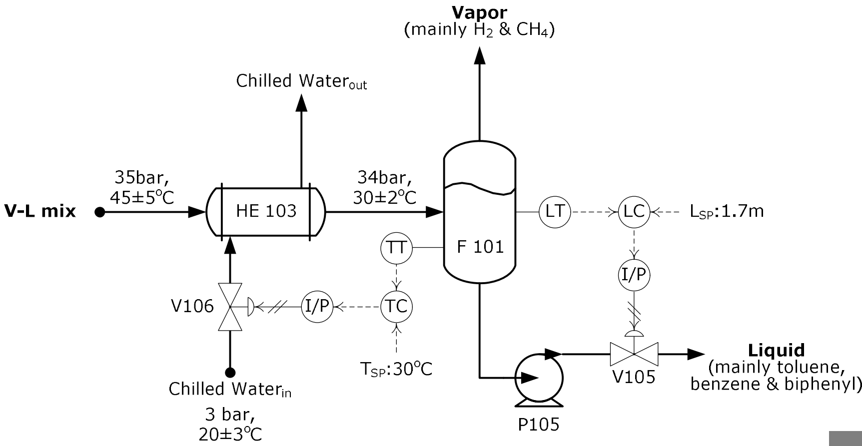
$$G_D(H) = \frac{H}{W_{feed}} = \frac{7.368\times10^{-5}}{s}\ \frac{\text{m/min}}{\text{kg/min}}$$

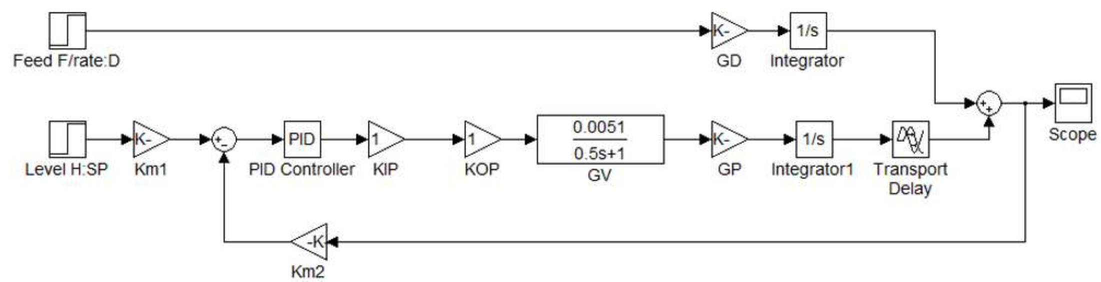
$$K_D = \frac{(-1.881\times10^{-3}) - (2.133\times10^{-3})\text{m/min}}{(40000 - 43270)\text{kg/hr}} = 1.228\times10^{-6}\ \frac{\text{m/min}}{\text{kg/hr}}$$

θ_D = 0 min

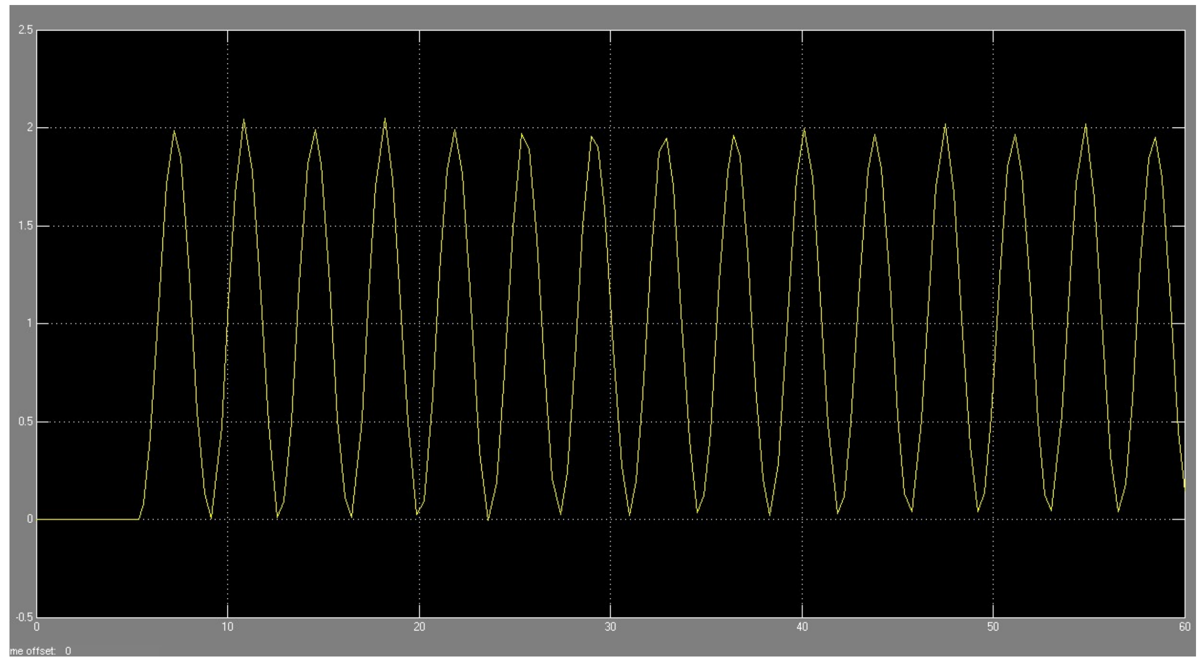
$$K_D = 7.368\times10^{-5}\ \frac{\text{m/min}}{\text{kg/min}}$$



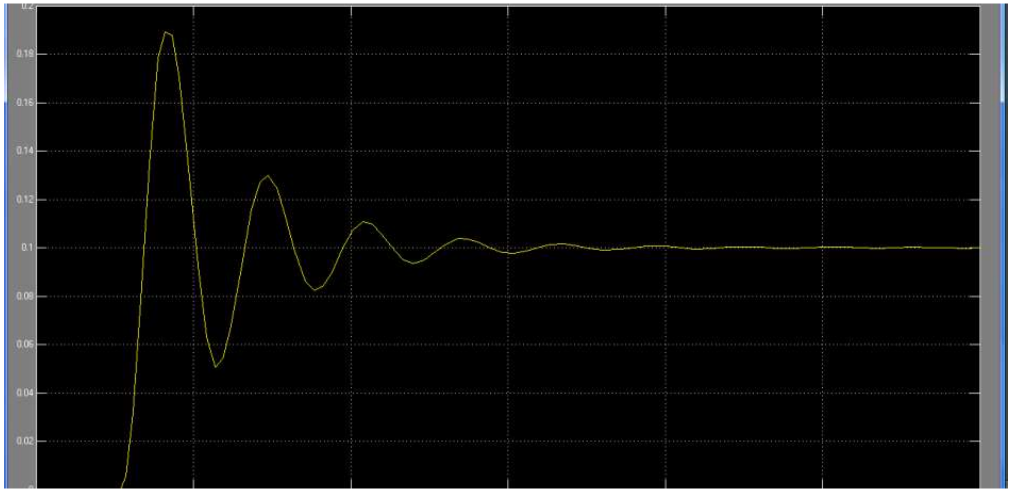


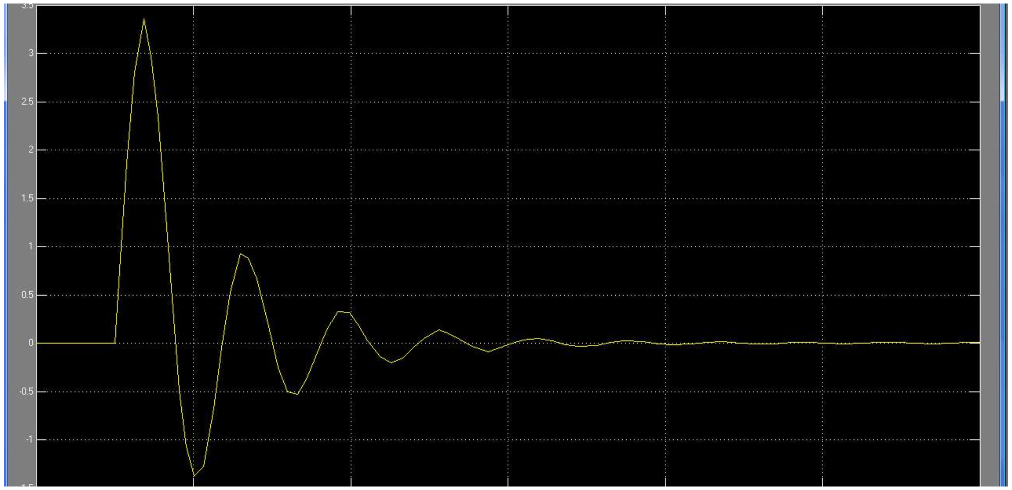


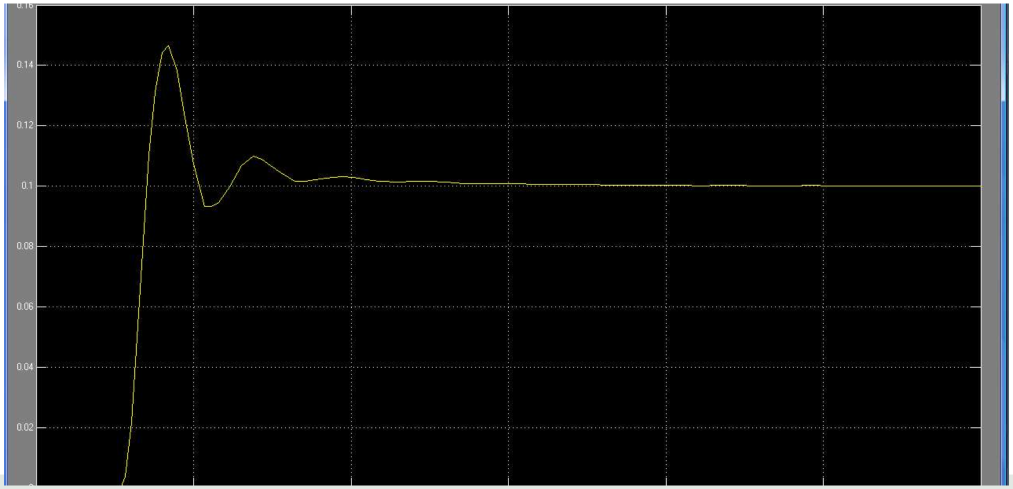
Level Control: Continuous cycling at critical stability

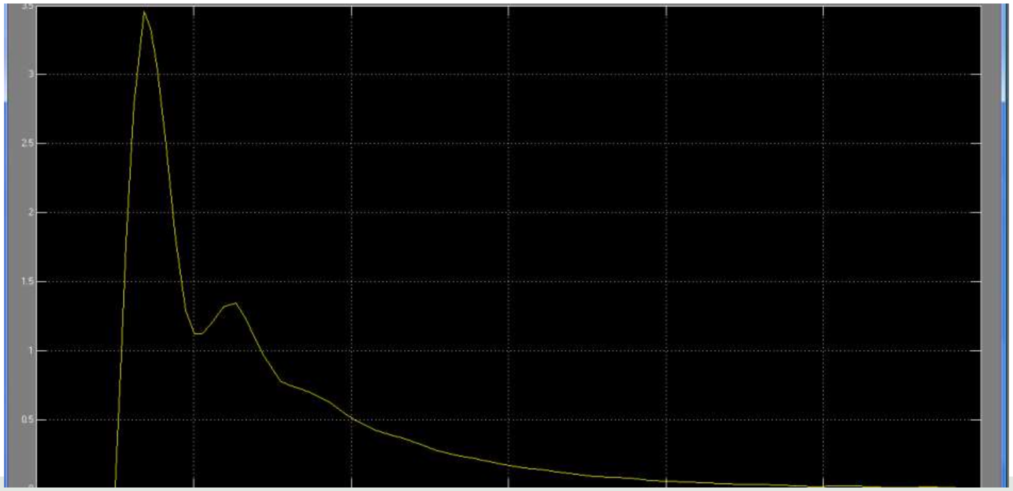


Level Control with fine tuning: Which is servo? Which is regulator?

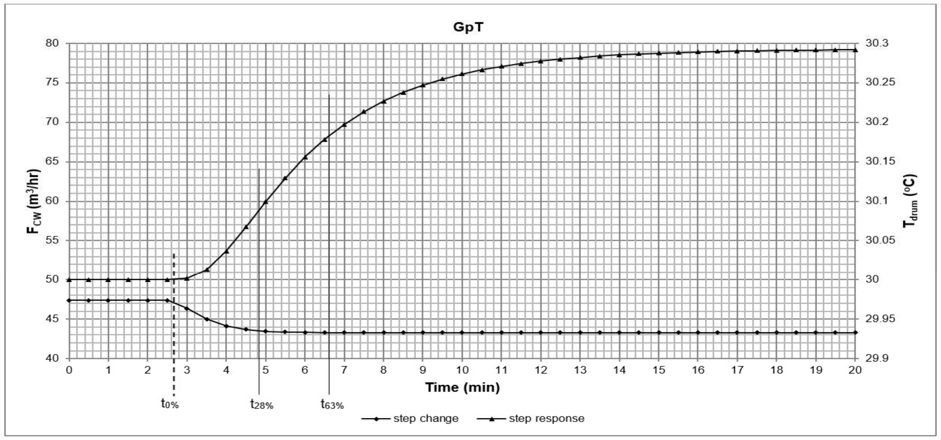








Step Test: Temperature Controller (GpT)



$$K_p = \frac{(30.292 - 30.00)^\circ C}{(43.2832 - 47.3721) m^3/hr} = -4.285 \frac{^\circ C}{m^3/min}$$

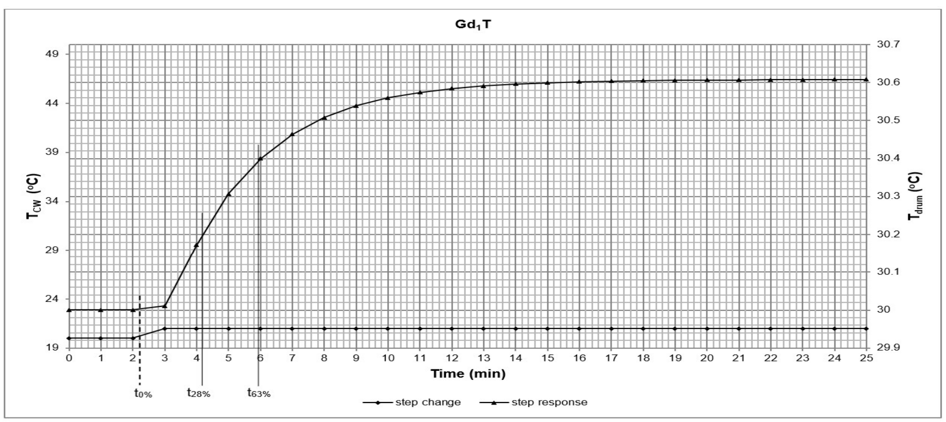
$\Delta T = 0.29^\circ C$

$\Delta T_{28\%} = 0.08^\circ C$
$\Delta T_{63\%} = 0.18^\circ C$

$$t_{28\%} = \theta + \frac{\tau}{3} = 4.7 - 2.5 = 2.2\,\text{min}$$
$$t_{63\%} = \theta + \tau = 6.5 - 2.5 = 4.0\,\text{min}$$

$\theta = 1.3$min
$\tau = 2.7$min

Step Test: Temperature Controller (Gd_1T)



$$K_{D1} = \frac{(30.61 - 30.00)^\circ C}{(21 - 20)^\circ C} = 0.61 \frac{^\circ C}{^\circ C}$$

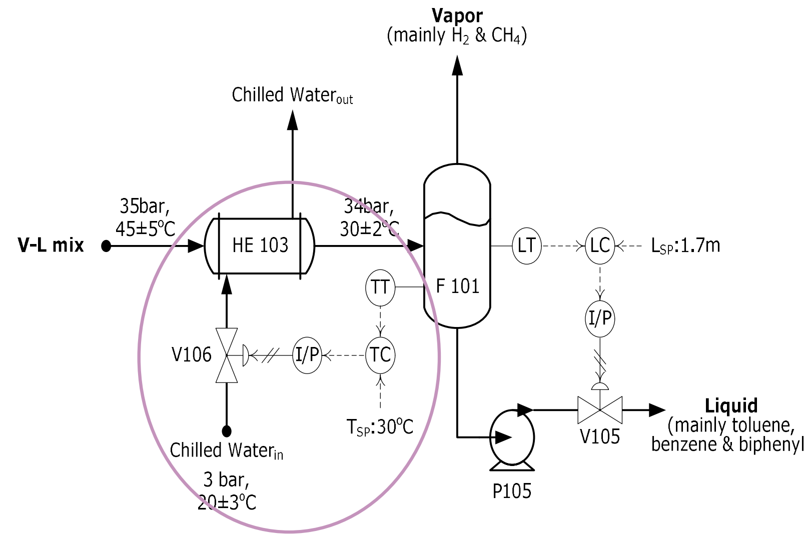
$$G_{D1}(T) = \frac{T_{drum}}{T_{CW}} = \frac{0.61e^{-1.1s}}{2.7s + 1} \frac{^\circ C}{^\circ C}$$

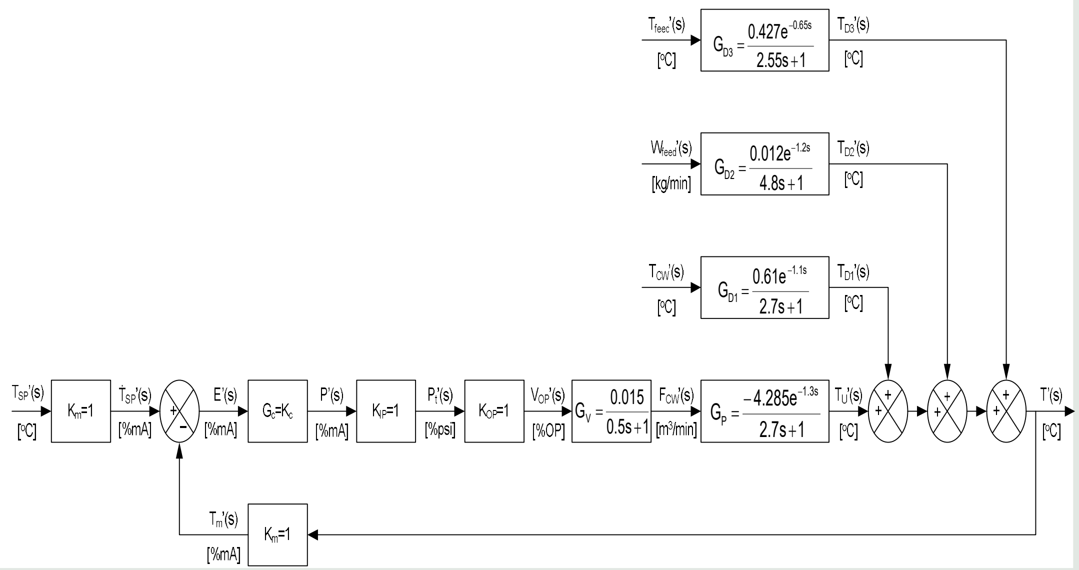
$\Delta T = 0.61^\circ C$

$\Delta T_{28\%} = 0.17^\circ C$
$\Delta T_{63\%} = 0.38^\circ C$

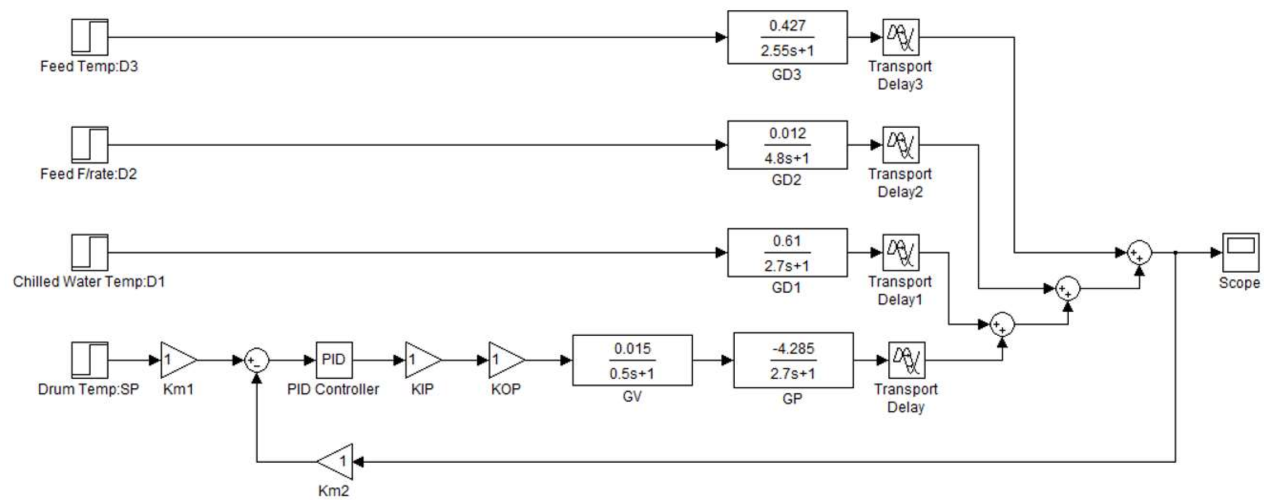
$$t_{28\%} = \theta + \frac{\tau}{3} = 4.0 - 2.0 = 2.0\,\text{min}$$
$$t_{63\%} = \theta + \tau = 5.8 - 2.0 = 3.8\,\text{min}$$

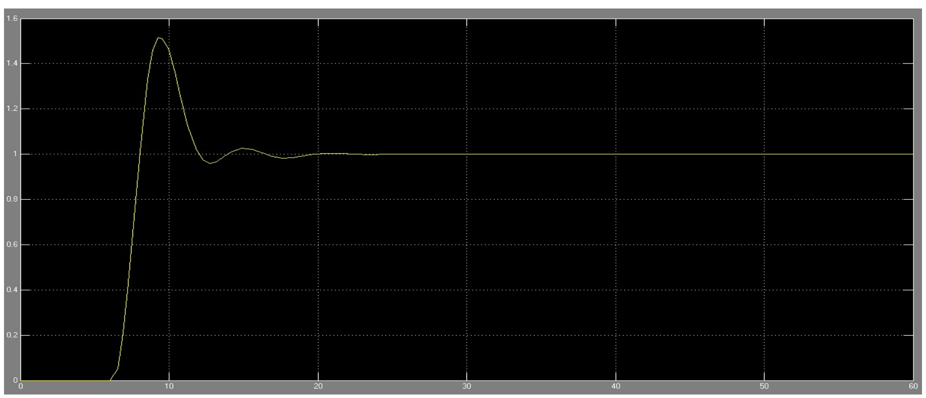
$\theta_{D1} = 1.1$min
$\tau_{D1} = 2.7$min

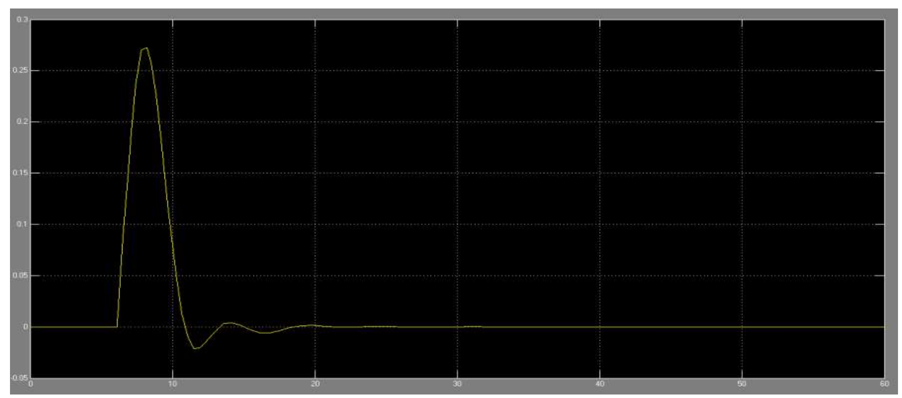




Feedback Block Diagram in SIMULINK: Temperature







Integration of problem/project for 3 first year courses: Latest effort to increase engagement and support in learning