Faculty:	**FACULTY OF ELECTRICAL ENGINEERING**	
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SKEE/SKEM/SKEL 3742

FACULTY OF ELECTRICAL ENGINEERING
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INSTRUMENTATION LABORATORY
STUDENT PACK

LEVEL AND FLOW MEASUREMENT AND MONITORING

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1.	**Problem/Project Guide:**
	Instrumentation and measurement is one of the important requirement in industrial. Accurate and precise measurement relies on the reliability of the instruments used for data collection. Different instruments and sensors require different signal conditioning to provide compatible and measurable electrical signal to the data acquisition unit and monitoring system. In all automation systems, sensors are widely used in order to provide input or feedback signal to either DAQ unit or controllers. These signals are crucial as it directly influence the next decision making or the quality of the product. Characteristic of sensors are important when choosing a new sensor for a system and calibration is needed from time to time to ensure the reliability of the system. Continuous monitoring system allows better tracking of plant's behavior. SCADA system is normally used in various industries to improve the efficiency of managing the plant. This experiment requires the group to conduct scientific investigation of the provided sensors according to the problem given and finally provide a technical report with simulation of the activities carried out throughout the investigation. (a) **Problem-objectives** **<u>Sewage treatment plant</u>** Indah Water Konsortium (IWK) manages the public sewage treatment plants in Malaysia, your company has been awarded a contract to install level sensors in the clarifier tanks. You are assigned as the instrumentation engineer to investigate and identify the level sensor available that is to be installed into the clarifier tanks. **Hints:** Sensing product levels in containers involve a wide range of materials, including liquids, powders, slurries, and granular bulk. In all level measurement a sensing device, element, or system interacts with material inside a container. This interactions can be identified form the calibration process. A wide variety of physical principles are used to measure level. Common types include sight, pressure, electric, sonic, and radiation. A differential pressure sensor used to measure level has a direct relationship between the hydrostatic pressure caused by a column of liquid, the specific gravity of the liquid, and the height of the vertical column of liquid. In most cases, the specific gravity of a fluid is constant, so pressure (P) is directly proportional to liquid level (h). Use this relationship to find the relationship between the liquid level and differential pressure level sensor output. Ultrasonic level sensors measure the time it takes sound waves to travel through material. Ultrasonic instruments operate at frequencies inaudible to the human ear and at extremely low power levels, normally a few thousandths of a watt. The velocity of a sound wave is a function of the type of wave being transmitted and the density of the medium in which it travels. When a sound wave strikes a solid medium, such as a wall or a liquid surface, only a small amount of the sound energy penetrates the barrier; a large percentage of the wave is reflected. The reflected sound wave is called an echo. Use this relationship to find the relationship between the liquid level and the ultrasonic level sensor output. **<u>Wastewater treatment plant</u>** The Local Council have established these flow measurement guidelines under the Wastewater Ordinance which requires some industrial wastewater dischargers to meter their effluent to provide accurate flow data for surcharge reporting. You are working with the local council as an independent contractor to supervise the design a flow meter that can monitor the amount of

industrial wastewater discharged from companies, factories, and shopping complexes.

Hint:
You are required to define fluid flow and its importance as a process variable. Furthermore, you need to describe flow rate as it applies to flow measurement. You are required to calibrate a flowmeter (paddlewheel or capacitive). Use the flowmeter and to measure the friction factor for different flow rates and make conclusions from the results.

- To obtain a characteristic of the sensor responses in measurement.
- To analyze the sensors response by using instrumentation terminology.
- To produce a SCADA/ monitoring system/ simulator for the investigated sensors.

(b) Milestone

By the end of	Descriptions
Week 1	Completion of design proposal which include (2 pages) - Group members introduction and task distributions - Review and explanation of choice of sensors - Experiments planning (equipment and list of materials and simulation software)
Week 2	Completion of data acquisition of sensors which may include - Circuit design - Experiments & data collection - Characteristic graph
Week 3	Completion of SCADA/ monitoring system/ simulator with sensors application that may include - Graphical user interface: characteristic graph, user input, trigger alarm/animation, threshold value. - Videos for Demonstration of experiments/ works Completion and Submission of Group Report

(c) Problem-solving Time-line

Activities	Week 1	Week 2	Week 3
1. Understanding/ identify problem/ design proposal			
2. Experiments/ testing/ measurement			
3. Analysis/ SCADA/ monitoring/ simulation & application			

(d) Report Writing

Your report may include the information here. For example,
Other than the general guide specified by the Laboratory Coordinator, your report for this laboratory must also include

- Review and circuit diagrams
- Data and graph as a results
- Photographs of the actual circuit construction
- Photographs of your group members
- Videos submission for recording evidence of group progress and project's demonstration/ application.

Discussion are mandatory for all the data obtained.

(e) Grading

Number	Assessment	%	Assessor
Week 1	Group Proposal	10%	Lecturer
	Individual In-Lab Activity	60%	
Week 2	Individual Report		
	Individual In-Lab Activity		
Week 3	Individual In-Lab Activity		
	Group Demonstration-just show experiment is working, not a presentation	10%	
Post Week 3 (Week 4)	Group Report	15%	
	Peer Review	5%	Student
	Total	100%	

PO Assessment

PO	Assessment	%	%
PO2 (Conduct experiment and analysis)	In-Lab - Analytical Marks	12%	24%
	In-Lab - Interview Marks	12%	
PO4 (Skills related to using tools)	In-Lab Proficiency Marks	12%	17%
	Group Demo (Flow)	5%	
PO6 (Communication)	Individual Report	10%	25%
	Group Report	15%	
PO7 (Teamwork)	In-Lab - Contribution	8%	13%
	Peer Review	5%	
PO11 (ethics)	In-Lab - Discipline	6%	6%
PO12 (Project Management)	Group Proposal	10%	15%
	Group Demo (Outcome)	5%	

(f) Questions That Can Help You Tackle The Problem

- What is the physical measurements that you wish to measure?
- How to obtain the characteristic of the sensors?
- What is the characteristics obtained? (discuss the results using metrological terminology)
- What is a calibration and monitoring process proposed?
- How do you define the characteristics of the instruments?

2. Equipments list:

Include **links** or information to manuals or other resources. For example,

(a) Digiac 1750: signal conditioning
(b) ED 6800B
(c) Multimeter
(d) Computer and SCADA
(e) Oscilloscope
(f) DC Voltage Supply
(g) Light meter, Distance meter, thermometer,
(h) Fluke Calibrator

	(i) List of sensors (i) Level and flow measurements (ii) Digiac 1750 : Speed sensors, Light sensors, temperature sensor (iii) Motor encoder (iv) Temperature sensors: RTD, NTC Thermistor, thermocouple (v) Displacement sensor: Ultrasonic sensor, Infrared Sensor (vi) Light sensor (j) PLC CP1H with analog input/output. (k) ARDUINO.
3.	**Components list:** Examples as follows,
	(a) Connector (b) Jumper wire, wire
4.	**Software:** Examples as follows
	(a) Matlab (b) Microsoft Excel (c) TinkerCAD
5.	**Additional resources:**
	Materials related to the problem/project. Can be technical papers, short manual on how to use Matlab/Simulink or other software for a particular problem/project, links to websites etc. Examples as follows, (a) Digiac 1750 – An introduction to transducers and Instrumentation (b) ED-6805, ED-6804B –Sensor unit, SU-6807B , SU-6808B , SU-6809B, SU-6810B (c) CU6802-signal converter unit (d) SCADA system guide (e) CX One Programmer (f) CX Supervisor
6.	**References:**
	Typically books with specific page numbers on the theoretical background (we don't want to burden our students too much since time is limited) or journal/conference papers if relevant. Examples as follows, (a) Instructions manuals of voltmeter and ammeter (b) Manual Digiac 1750 Manuals (c) Electrical Measurement and Instrumentation Module (d) IMP23119 manuals (e) File Attachment