

# Brazosport College

## Syllabus for INTC 1401 – Principles of Industrial Measurements

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### **I. COURSE DESCRIPTION:**

**INTC 1401 - Principles of Industrial Measurements. CIP 1504040011**

Principles and devices for the measurement of process variables such as temperature, pressure, flow, level, and basic control functions.

**Credit Hours:** 4 (3 lecture, 2 lab)

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Brandon Hartman

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Stephen Reckner

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Mark Stoltenberg

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Gary Hicks

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Jeff Detrick

January 2019

**A. Prerequisite:** N/A

**Required skill level:** College level reading and writing. Math: College-level with corequisite (placement code 3).

**II. COURSE OBJECTIVES**

TOPIC	OBJECTIVES
<b>Introduction to Instrumentation</b>	<ol style="list-style-type: none"><li>1. Discuss the evolution and importance of process instrumentation to the process industries.</li><li>2. Explain the importance of process instrumentation to a process technician.<ul style="list-style-type: none"><li>• Eyes and ears of the process technician</li><li>• Tool for monitoring and troubleshooting process control</li><li>• Effective communications with instrument technician for troubleshooting and repairs</li></ul></li><li>3. Define terms associated with instrumentation:<ul style="list-style-type: none"><li>• local</li><li>• remote</li><li>• indicating</li><li>• recording</li><li>• pneumatic</li><li>• electronic</li><li>• process variables</li><li>• controlling</li><li>• analog</li><li>• digital<ul style="list-style-type: none"><li>○ DCS (Distributive Control Systems)</li><li>○ PLC (Programmable Logic Control)</li></ul></li><li>• control loop</li><li>• differential (delta <math>\Delta</math>)</li><li>• split range</li></ul></li><li>4. Describe the major process variables controlled in the process industries and define their units of measurement:<ul style="list-style-type: none"><li>• Flow (gallons per minute, pounds per minute, pounds per hour, barrels per hour, etc.)</li><li>• Pressure (psig, psia)</li><li>• Temperature (Fahrenheit, Celsius)</li><li>• Level (percent, inches of water column, interface)</li><li>• Analytical (ppm, percentage, ratio, pH, etc.)</li><li>• Other (vibration, variable speed control, proximity switches, amp-meter, etc.)</li></ul></li><li>5. Explain the relationship between common process variables:<ul style="list-style-type: none"><li>• What happens to the pressure in a closed container when temperature increases/decreases?</li><li>• What happens to the temperature in a closed container when</li></ul></li></ol>

TOPIC	OBJECTIVES
<b>Introduction to Instrumentation (cont.)</b>	<p>pressure increases/decreases?</p> <ul style="list-style-type: none"> <li>• What happens to vessel bottom pressure when height of liquid increases/decreases?</li> <li>• What happens to boiling point of a material when pressure increases/decreases?</li> <li>• What happens to the volume of a material when temperature increases/decreases?</li> <li>• What happens to the density of a material when temperature increases/decreases?</li> <li>• What happens to the differential pressure when the flow increases/decreases?</li> </ul>
<b>Process Variables, Elements and Instruments - Pressure</b>	<ol style="list-style-type: none"> <li>1. Define units of measurement associated with pressure and pressure instruments: <ul style="list-style-type: none"> <li>• PSIG (pounds per square inch gauge)</li> <li>• PSIA (pounds per square inch atmospheric)</li> <li>• bars</li> <li>• Inches H<sub>2</sub>O</li> <li>• Inches Hg (mercury)</li> <li>• mm Hg Abs</li> <li>• Inches Hg Vac</li> <li>• atmospheres</li> </ul> </li> <li>2. Identify the three components that affect the force exerted by molecules: <ul style="list-style-type: none"> <li>• Speed (temperature)</li> <li>• number of molecules</li> <li>• mass (liquid)</li> </ul> </li> <li>3. Identify common types of pressure-sensing/measuring instruments used in the process industries: <ul style="list-style-type: none"> <li>• gauges</li> <li>• differential pressure cells</li> <li>• manometers</li> <li>• strain gauge</li> </ul> </li> <li>4. Describe the purpose and operation of pressure-sensing/measuring instruments used in industrial settings.</li> <li>5. Using a standard calculator and conversion formulas convert between pressure scales such as the following: <ul style="list-style-type: none"> <li>• pounds per square inch gauge (psig) and pounds per square inch absolute (psia)</li> <li>• inches of mercury (in. Hg) and inches of water (in. H<sub>2</sub>O)</li> <li>• psi (pounds per square inch) and inches of water column.</li> </ul> </li> </ol>

TOPIC	OBJECTIVES
<b>Process Variables, Elements and Instruments – Temperature</b>	<ol style="list-style-type: none"> <li>1. Define units of measure associated with temperature and temperature instruments: <ul style="list-style-type: none"> <li>• differential (delta)</li> <li>• temperature scales <ul style="list-style-type: none"> <li>○ Fahrenheit</li> <li>○ Celsius/Centigrade</li> </ul> </li> </ul> </li> <li>2. Describe the effect heat energy has on the movement of molecules.</li> <li>3. Identify common types of temperature-sensing/measurement devices used in the process industries: <ul style="list-style-type: none"> <li>• resistance temperature detector (RTD)</li> <li>• thermometer</li> <li>• thermocouple</li> <li>• temperature gauge</li> <li>• bimetallic strip</li> </ul> </li> <li>4. Describe the purpose and operation of various temperature sensing/measurement devices used in the process industries.</li> <li>5. Using a standard calculator and conversion formulas, complete Fahrenheit and Celsius conversions.</li> </ol>
<b>Process Variables, Elements and Instruments – Level</b>	<ol style="list-style-type: none"> <li>1. Define terms associated with level and level instruments: <ul style="list-style-type: none"> <li>• ullage (outage)</li> <li>• inage</li> <li>• interface level</li> <li>• direct/indirect measurement</li> <li>• meniscus</li> </ul> </li> <li>2. Name the most common types of level-sensing/measuring devices used in the process industries: <ul style="list-style-type: none"> <li>• gauge/sight-glass (reflex or clear glass)</li> <li>• differential pressure cells</li> <li>• floats</li> <li>• displacer</li> <li>• bubblers</li> <li>• nuclear devices</li> <li>• ultrasonic devices</li> <li>• tape/ball</li> <li>• radar</li> </ul> </li> <li>3. Describe the purpose and operation of various types of level sensing/measuring devices.</li> <li>4. Discuss hydrostatic head pressure in relation to level measurement.</li> <li>5. Describe the relationship between temperature and level measurement as it relates to the density of liquid.</li> <li>6. Describe the relationship between temperature and level measurement as it relates to the volume of a liquid.</li> </ol>

TOPIC	OBJECTIVES
<b>Process Variables, Elements and Instruments – Flow</b>	<ol style="list-style-type: none"> <li>1. Define terms associated with flow and flow measuring instruments: <ul style="list-style-type: none"> <li>• fluids (gases and liquids)</li> <li>• metered displacement</li> <li>• laminar</li> <li>• turbulent</li> <li>• differential pressure</li> <li>• weight measurement</li> </ul> </li> <li>2. Name the most common types of flow-sensing/measuring devices used in the process industries: <ul style="list-style-type: none"> <li>• orifice plate</li> <li>• venturi tube</li> <li>• flow nozzle</li> <li>• pitot tube</li> <li>• annubar tube</li> <li>• rotometers</li> <li>• magmeter</li> <li>• turbine meters</li> <li>• mass flow meter (Corioliss)</li> <li>• vortex meter</li> <li>• ultra-sonic</li> <li>• others</li> </ul> </li> <li>3. Describe the purpose and operation of flow-sensing/measurement devices used in process industries.</li> <li>4. Explain the difference between total volume flow and flow rate.</li> <li>5. Explain the difference between mass flow and volume flow</li> </ol>
<b>Process Variables, Elements and Instruments – Analytical</b>	<ol style="list-style-type: none"> <li>1. Define terms associated with analytical instruments: <ul style="list-style-type: none"> <li>• pH (acid/base) and ORP (oxidation reduction potential)</li> <li>• conductivity</li> <li>• Optical Measurements</li> <li>• Chromatography</li> <li>• Combustion</li> <li>• TOC (total organic carbon)</li> </ul> </li> <li>2. Identify the most common types of analytical devices used in the process industries: <ul style="list-style-type: none"> <li>• gas/liquid chromatograph</li> <li>• ORP (oxidation reduction potential)/ pH meter</li> <li>• conductivity meter</li> <li>• Color analyzers</li> <li>• optical analyzers</li> <li>• turbidity analyzer/meter</li> <li>• opacity analyzer/meter</li> <li>• TOC (total organic carbon) analyzer</li> </ul> </li> </ol>

TOPIC	OBJECTIVES
<b>Process Variables, Elements and Instruments – Analytical (cont.)</b>	<ul style="list-style-type: none"> <li>• spectrophotometers               <ul style="list-style-type: none"> <li>a. UV (ultraviolet)/VIS (visible)</li> <li>b. IR (Infrared)</li> </ul> </li> <li>• O<sub>2</sub> analyzer</li> <li>• LEL (lower explosive limits)</li> </ul> <ol style="list-style-type: none"> <li>3. Describe the purpose of analytical devices used in process industries.</li> <li>4. Discuss how analytical data affects the role of the process technician.</li> <li>5. Explain the difference between on-line versus laboratory analysis.</li> </ol>
<b>Miscellaneous Measuring Devices</b>	<ol style="list-style-type: none"> <li>1. Define terms associated with miscellaneous measuring devices:               <ul style="list-style-type: none"> <li>• load cells</li> <li>• density</li> <li>• vibration</li> <li>• rotational speed</li> <li>• amperage</li> <li>• decibels</li> </ul> </li> <li>2. Identify common types of miscellaneous measuring devices:               <ul style="list-style-type: none"> <li>• Vibration meter</li> <li>• load cells</li> <li>• proximity sensors (pickups for speed)</li> <li>• Amp meters.</li> <li>• decibel meters, etc.</li> </ul> </li> </ol>
<b>Introduction to Control Loops (Simple Loop Theory)</b>	<ol style="list-style-type: none"> <li>1. Describe process control:               <ul style="list-style-type: none"> <li>• Process Variables (PV)</li> <li>• measuring means (primary element/transmitter)</li> <li>• controller (set point)</li> <li>• final control element (valve or louvers)</li> </ul> </li> <li>2. Explain the function of a control loop.</li> <li>3. Identify the functions of a control scheme:               <ul style="list-style-type: none"> <li>• Sensing</li> <li>• Measuring</li> <li>• comparing</li> <li>• transducing-(converting)</li> <li>• controlling</li> </ul> </li> <li>4. Describe the differences between “open” and “closed” control loops.</li> <li>5. Explain signal transmission:               <ul style="list-style-type: none"> <li>• Pneumatic</li> <li>• Electronic</li> <li>• Analog</li> <li>• Discreet</li> <li>• Digital</li> <li>• Mechanical</li> </ul> </li> </ol>

TOPIC	OBJECTIVES
<b>Control Loops: Controllers</b>	<ol style="list-style-type: none"> <li>1. Define terms associated with controllers: <ul style="list-style-type: none"> <li>• direct acting</li> <li>• reverse acting</li> <li>• set point</li> <li>• auto/manual switch</li> <li>• local/remote switch</li> <li>• tuning <ul style="list-style-type: none"> <li>○ proportional band/gain</li> <li>○ integral/reset</li> <li>○ derivative/rate</li> </ul> </li> </ul> </li> <li>2. Given a drawing or actual device, identify and describe the operation of the following: <ul style="list-style-type: none"> <li>• local controller</li> <li>• remote controller</li> <li>• split-range controller</li> <li>• ratio controller</li> <li>• Cascade/Remote Set Point (RSP) controller</li> </ul> </li> <li>3. Describe an application which would require the following devices: <ul style="list-style-type: none"> <li>• local controller</li> <li>• remote controller</li> <li>• split range controller</li> <li>• ratio controller</li> <li>• Cascade controller</li> </ul> </li> <li>4. Define “bumpless” transfer of auto to manual-control.</li> <li>5. Define the “bumpless” transfer of manual to auto control.</li> <li>6. Describe the process for switching from auto control to manual control on a local controller.</li> <li>7. Describe the process for switching from manual control to automatic control on a local controller.</li> <li>8. Demonstrate various control skills, such as: <ul style="list-style-type: none"> <li>• make set point adjustments on a local controller</li> <li>• operate a local controller in manual mode</li> <li>• make set point adjustments on a remote controller</li> <li>• switch from manual to automatic control on a remote controller without bumping the process</li> </ul> </li> <li>9. Given a simulator or actual device, determine whether a control loop is in or out of control and identify the information used to make the decision.</li> </ol>

TOPIC	OBJECTIVES
<b>Control Loops: Primary Sensors, Transmitters, and Transducers</b>	<ol style="list-style-type: none"> <li>1. Describe the function of measuring instruments (pressure, temperature, level, and flow) and explain their role in the overall control loop process.</li> <li>2. Describe the purpose and operation of the transmitter (D/P Cell) in a control loop.</li> <li>3. Compare and contrast the transmitter input and output signals (communication).</li> <li>4. Discuss differential pressure cell (D/P) in relation to the transmitter signal.</li> <li>5. Describe the function of a transducer (signal converter). <ul style="list-style-type: none"> <li>• I (current) to P (pneumatic)</li> <li>• P (pneumatic) to I (current)</li> </ul> </li> <li>6. Describe the relationship between air (3 psig to 15 psig) and electric signals (4 ma to 20 ma).</li> <li>7. Given a process control scheme, explain how a control loop functions.</li> </ol>
<b>Instrument Air Systems</b>	<ol style="list-style-type: none"> <li>1. Describe the purpose of instrument air systems</li> <li>2. Describe the various types of instrument air systems <ul style="list-style-type: none"> <li>• Instrument air</li> <li>• Nitrogen</li> <li>• Process gases</li> </ul> </li> <li>3. Discuss potential causes of instrument air failure <ul style="list-style-type: none"> <li>• Compressor shuts down</li> <li>• Wet/dew point (dryers)</li> <li>• Plugging (scale, rust)</li> <li>• Backup air failure</li> <li>• Regulator failure</li> <li>• Incorrect manifold alignment</li> </ul> </li> <li>4. Discuss corrective actions for each of the following scenarios: <ul style="list-style-type: none"> <li>• Compressor shut down</li> <li>• Wet (dew point)</li> <li>• Plugging</li> <li>• Backup air failure</li> <li>• Regulator failure</li> <li>• Incorrect manifold alignment</li> </ul> </li> </ol>
<b>Control Valves and Final Control Elements</b>	<ol style="list-style-type: none"> <li>1. Explain the purpose and operation of the following: <ul style="list-style-type: none"> <li>• control valves <ul style="list-style-type: none"> <li>○ three-way valve</li> <li>○ gate valve</li> <li>○ globe valve (needle valve)</li> <li>○ butterfly valve</li> </ul> </li> </ul> </li> </ol>



TOPIC	OBJECTIVES
<b>Control Valves and Final Control Elements (cont.)</b>	<ol style="list-style-type: none"> <li>2. Explain the purpose and operation of the following: <ul style="list-style-type: none"> <li>• valve positioner</li> <li>• manual operation (hand-jack)</li> <li>• transducer (converter)</li> </ul> </li> <li>3. Define terms associated with valves and other final control elements: <ul style="list-style-type: none"> <li>• “air to close” (fail open)</li> <li>• “air to open” (fail closed)</li> <li>• fail last/in-place/as is</li> <li>• double-acting diaphragm valve actuator</li> <li>• double-acting piston valve actuator</li> <li>• solenoid</li> <li>• variable speed motor</li> </ul> </li> <li>4. Given a drawing or actual device, identify the main components of a control valve. <ul style="list-style-type: none"> <li>• Body</li> <li>• Bonnet</li> <li>• Disc</li> <li>• Actuator</li> <li>• Stem</li> <li>• Seat</li> <li>• Spring</li> <li>• Valve positioner</li> <li>• Hand-jack</li> </ul> </li> <li>5. Describe three types of final control elements and provide an application for each type: <ul style="list-style-type: none"> <li>• control valve – manipulates a process flow (liquid/gas) in response to a control signal</li> <li>• damper/louver – manipulates an air flow to control draft setting or temperature setting</li> <li>• motor – start, stop or variable speed in response to a control signal</li> </ul> </li> <li>5. Describe the role of the final control element as it relates to the process and the control loop.</li> <li>6. Given a drawing or actual instrument, identify and describe the operation of the following: <ul style="list-style-type: none"> <li>• instrument air regulator</li> <li>• louver, damper, final control element</li> <li>• variable speed motor used as a final control element</li> </ul> </li> <li>7. Explain reasons why the action of a valve actuator may not correspond with the action of the valve. <ul style="list-style-type: none"> <li>• Calibration</li> <li>• Valve stroke</li> <li>• Direct verses indirect action</li> <li>• Incorrect air supply pressure / contamination</li> </ul> </li> </ol>

TOPIC	OBJECTIVES
<b>Control Valves and Final Control Elements (cont.)</b>	<ul style="list-style-type: none"> <li>• Sticking valve</li> <li>• Transducer operation</li> </ul> <ol style="list-style-type: none"> <li>8. Describe actions for troubleshooting the above.</li> <li>9. Compare and contrast a spring and diaphragm actuator to a cylinder actuator.</li> <li>10. Describe the purpose of a valve positioner and explain its operation.</li> <li>11. Explain the function of each of the three gauges located on a pneumatic valve positioner.               <ul style="list-style-type: none"> <li>• Air supply</li> <li>• Signal</li> <li>• Output signal to actuator</li> </ul> </li> <li>12. Given a signal pressure from an I/P determine what the valve position should be for the following:               <ul style="list-style-type: none"> <li>• Fail open</li> <li>• Fail closed</li> </ul> </li> </ol>
<b>Interlocks and Safety Features</b>	<ol style="list-style-type: none"> <li>1. Describe the purpose of interlocks.               <ul style="list-style-type: none"> <li>• Safety</li> <li>• Process</li> </ul> </li> <li>2. Describe the purpose of safety features.               <ul style="list-style-type: none"> <li>• Interlocks and valve actions</li> <li>• ESD (Emergency Shutdown Devices)</li> <li>• Limit switches (proximity, permissive)</li> <li>• Redundant instrumentation</li> <li>• Fail safe position</li> <li>• Over speed</li> </ul> </li> <li>3. Discuss potential consequences for bypassing or ignoring any of the safety features listed above.</li> </ol>
<b>Symbology; Process Diagrams – Part 1</b>	<ol style="list-style-type: none"> <li>1. Describe the types of drawings that contain instrumentation that an operator might use.</li> <li>2. Describe the lettering and numbering standards based on ISA (Instrumentation Society of Automation) instrumentation symbols.</li> <li>3. Describe how to determine the instrument type from the symbol information.</li> <li>4. Describe the standards for instrument line symbols.               <ul style="list-style-type: none"> <li>• Electrical</li> <li>• Pneumatic</li> <li>• Digital</li> </ul> </li> <li>5. Using a legend, correctly identify instrumentation on a drawing.</li> </ol>
<b>Process Diagrams – Part 2</b>	<ol style="list-style-type: none"> <li>1. Compare and contrast P&amp;IDs and PFDs.</li> <li>2. Given a PFD, trace process flows on the drawing and/or in the field locating major equipment.</li> </ol>

TOPIC	OBJECTIVES
<b>Process Diagrams – Part 2 (cont.)</b>	3. Given a P&ID with a legend, locate and identify the components:
<b>Instrumentation Sketching</b>	<ol style="list-style-type: none"> <li>1. Given a P&amp;ID, with a control loop, explain the relationship of one piece of instrumentation to another.</li> <li>2. Given a process flow diagram of a major system, add control loops: <ul style="list-style-type: none"> <li>• Flow</li> <li>• Level</li> <li>• Temperature</li> <li>• Pressure</li> </ul> </li> <li>3. Using training resources (process simulator, training unit, etc.) sketch instrumentation control loops.</li> </ol>
<b>Monitoring Process Variables</b>	<ol style="list-style-type: none"> <li>1. Explain the importance of monitoring process variables.</li> <li>2. Discuss the operator's leadership role, in relation to safety, when monitoring process variables.</li> <li>3. Given a P&amp;ID identify key process variables that should be monitored.</li> <li>4. Discuss hazards and consequences of deviation for operating outside normal control range of process variables.</li> <li>5. Given a scenario, explain proactive action for correcting an abnormal process variable.</li> </ol>
<b>Instrumentation Troubleshooting</b>	<ol style="list-style-type: none"> <li>1. Explain the extent of an operators role when troubleshooting problems with process instruments (i.e., identify and not repair, which may vary between sites).</li> <li>2. Identify typical malfunctions found in primary sensing elements and transmitters.</li> <li>3. Explain the importance of process knowledge in troubleshooting.</li> <li>4. Explain the proper use of equipment related to process troubleshooting.</li> <li>5. Discuss safety and environmental issues related to troubleshooting process instruments.</li> <li>6. Describe the symptoms of incorrect instrument calibration. <ul style="list-style-type: none"> <li>• Variation between local sight glass and level transmitter</li> <li>• Variation between local pressure gauge and pressure transmitter</li> <li>• Inconsistency among instruments</li> <li>• How do process changes affect accurate measurement? <ul style="list-style-type: none"> <li>○ Flow rate</li> <li>○ Density/specific gravity (composition)</li> <li>○ Temperature</li> <li>○ Pressure</li> </ul> </li> </ul> </li> </ol>

### III. STUDENT LEARNING OUTCOMES

OUTCOME	METHOD OF ASSESSMENT
Student will learn to use OHM's law to analyze DC electrical circuits	Student will learn aspects of solving circuit calculations and success will be evaluated by the following questions on the final exam: Questions: 1,2,3,4,5,6
Student becomes familiar with terms that identify electrical properties	Student's success will be evaluated by successfully answering the following questions on the final exam: Questions: 7,8,9
Student learns to identify the standard instrument signals found in Industrial control systems	Student's success will be evaluated by successfully answering the following questions on the final exam: Questions: 15,16
Student demonstrates understanding of the several pressure measuring scales by drawing a comparative chart.	Student's success will be evaluated by successfully answering the following questions on the final exam: Questions: 12,13,23
Student demonstrates understanding of temperature measurement by the use of Thermocouples and RTD's	Student's success will be evaluated by successfully answering the following questions on the final exam: Questions: 11,14,21,22,33,34
Student demonstrates understanding of pH measurement by explaining the principle and scale of measurement	Student's success will be evaluated by successfully answering the following question on the final exam: Questions: 27,28,30
Student demonstrates knowledge and understanding of the various parts of a control valve and explains the term "valve trim"	Student's success will be evaluated by successfully answering the following questions on the final exam: Questions: 48,49,50
Student will explain the use of a carrier gas in chromatography	Student's success will be evaluated by successfully answering the following questions on the final exam: Questions; 26, 31

Final exam questions for the assessments listed in the above chart:

OUTCOME	QUESTION #
P&ID's	26,27,30
Electrical	4,5,6,7,17,18,19,20
Temperature	31,32,33,35,36,37
Pressure	49
Level	53,54,55,56,61
Flow	62,66,67,68,70
Controllers	71,72,73,74,87,88
Valves	76,77,78,80,81,82

#### IV. TEXTBOOK OR COURSE MATERIAL INFORMATION

##### A. Textbook

1. Online access to course material provided by Instructor.
2. Calculator TI-30XIIS
3. Visorgogs Safety Glasses

Required course materials are available at the Brazosport College bookstore, on campus or online at <http://brazosport.edu/bookstore/home.html>. A student of this institution is not under any obligation to purchase a textbook from the college bookstore. The same textbook is/may also be available from an independent retailer, including an online retailer.”

**For Distance Education Courses include the following:** Contact the Brazosport College Bookstore with a credit card for course materials. Phone: 979-230-3651. Fax: 979-230-3653. Email: [bookstore@brazosport.edu](mailto:bookstore@brazosport.edu). Website: <http://brazosport.edu/bookstore/home.html>.

##### B. Course Outline

**This is a sample outline which may vary with individual instructors. It will also vary based on whether the course is a summer course or a fall/spring course. Students should contact their instructor for the outline of the course they are taking.**

WEEK #	TOPIC
1	Overview of instrumentation and introduction to P&ID's Lab: Use P&ID's at pilot plants
2	Basic direct current electrical theory including OHM's Law and Kirchof's Laws Evaluation of series, parallel and combination series/parallel circuits Lab: Three resistor laboratory exercise and introduction to electrical multimeters
3	Review of basic electrical and P&ID's
4	Test Intro to temperature
5	Temperature scales and conversions for Fahrenheit, Celcius, Rankine, Kelvin Conduction convection and radiation principles Types of temperature measuring devices including Thermocouples, RTD's, Thermistors, Bimetallic , Pressure Spring and Infrared Thermometers. Lab: calibrate four wire thermocouple temperature transmitter
6	Introduction to pressure measurements and scales (Gauge, Vacuum and Absolute) Conversions between scales Introduction to Hydrostatic Head pressure equivalents and conversions ( INWC, INHg) Lab: Calibrate pressure switch and examine construction
7	Introduction to Level measurement using differential pressure Specific gravity concepts for liquid and gas Radar and ultrasonic level measurements Archimedes principle and displacer type level instruments Lab: Calibrate electronic differential pressure transmitter

8	Review of temperature, pressure and level sections
9	Test Intro to Flow measurement
10	Principles of measurement for mass and volumetric flows Flow principles including velocity profiles, laminar vs turbulent flow and Reynolds numbers Relationship of differential pressure to flow rate Orifice plates and their application in flow measurement Variable Area, Vortex, Magnetic, Doppler and Ultrasonic flow measurement principles Lab: Pressure regulator operational check, disassembly, reassembly and operational check
11	Control Valve types and construction for rising stem and rotary Accessories including positioners, handjacks and limit switches Inherent Flow Characteristics and internal components Troubleshooting and requirements for operation Flashing and Cavitation Calibrations for split ranging Lab: Control valve with positioner, operational check (Fisher 3610)
12	Controller principles of operation including direct and reverse action, Gain, Reset and Rate control tuning functions and PID equivalents Open Loop charts Lab: Controller loop hook up and check out ( Rosemount and Foxboro)
13	Review Controllers, Control Valves and Flow
14	Test Begin final review
15	Final review
16	Final

This course consists of eleven units. Appropriate laboratories are included.

1. An introduction to the devices and their application in chemical process control.
2. The standard control loop.
3. The control loop as applied in the control of:
  - a. temperature
  - b. pressure
  - c. level
  - d. flow
  - e. pH analysis
4. Signal transmission in chemical process control.
5. Electricity and electronics in process control.
6. Temperature detection devices.
7. Pressure detection devices and associated calculations.
8. Level detection devices and associated calculations.
9. Flow detection devices and associated calculations.
10. Some physical and chemical devices used in process control.
11. A more detailed study of general application of the devices of process control

**Important Semester Dates:**

Last Day to Withdraw from Classes– Check BC Academic Calendar at <http://catalog.brazosport.edu/index.php>

**V. STUDENTS WITH DISABILITIES**

Brazosport College is committed to providing equal education opportunities to every student. BC offers services for individuals with special needs and capabilities including counseling, tutoring, equipment, and software to assist students with special needs. For student to receive any accommodation, documentation must be completed in the Office of Disability Services. Please contact Phil Robertson, Special Populations Counselor at 979-230-3236 for further information.

**VI. ACADEMIC HONESTY**

Brazosport College assumes that students eligible to perform on the college level are familiar with the ordinary rules governing proper conduct including academic honesty. The principle of academic honesty is that all work presented by you is yours alone. Academic dishonesty including, but not limited to, cheating, plagiarism, and collusion shall be treated appropriately. Please refer to the Brazosport College Student Guide for more information. This is available online at <http://brazosport.edu/students/for-students/student-services/>

Academic dishonesty violates both the policies of this course and the Student Code of Conduct. In this class, any occurrence of academic dishonesty will be referred to the Dean of Student Services for prompt adjudication. Sanctions may be imposed beyond your grade in this course by the Dean of Student Services.

**VII. ATTENDANCE AND WITHDRAWAL POLICIES**

Class attendance contributes to your final grade, but you must attend class to successfully complete the course. If you are unable to complete this course, you must complete and submit a withdrawal form with the registrar's office. If the student decides to drop out of the class it is the responsibility of the student to initiate a withdrawal before the withdrawal deadline in order to get a "W" on their transcript. If this is not done the student will receive a grade based on test grades and class grades earned during their attendance and absence (i.e. zeros on all missed materials, exams, skills tests, and final exam).

**VIII. COURSE REQUIREMENTS AND GRADING POLICY  
TESTING MAKE-UP POLICY****A. Grading:**

Lecture / laboratory participation	20%
Three Unit examinations	40%
Final examination	40%

Grades are assigned as follows:

Grade	Final Average
A	90-100
B	80-89
C	70-79
D	60-69
F	Below 60

## **IX. STUDENT RESPONSIBILITIES**

Students are expected to fully participate in this course. The following criteria are intended to assist you in being successful in this course:

1. Understand the syllabus requirements
2. Use appropriate time management skills
3. Communicate with the instructor
4. Complete course work on time, and
5. Utilize online components (such as Desire2Learn) as required.

### **a. Class attendance**

Much of the learning occurs in the classroom setting and cannot be made up by reading the textbook. Therefore, class participation is essential to your learning, and attendance is taken.

### **b. Homework**

As a standing homework assignment, students should review and read the scheduled sections of the textbook before coming to class, and prepare questions for class discussion. Students should again review the scheduled section following the class (review forward, read, review back)

### **c. Class participation**

Participation grade is based on the quality (not frequency) of your contributions to laboratory and class activities. Those receiving high grades in class participation will be those who:

- Are prepared for class
- Arrive for class on time
- Have excellent attendance
- Make comments and ask questions that significantly contribute to the learning environment of the class

## **X. TITLE IX STATEMENT**

Brazosport College faculty and staff are committed to supporting students and upholding the College District's non-discrimination policy. Under Title IX and Brazosport College's policy FFDA (Local), discrimination based on sex, gender, sexual orientation, gender identity, and gender expression is prohibited. If you experience an incident of discrimination, we encourage you to report it. While you may talk to a faculty or staff member at BC, please understand that they are "Responsible Employees" and must report what you tell them to college officials.



You can also contact the Title IX Coordinators directly by using the contact information below. Additional information is found on the Sexual Misconduct webpage at [www.brazosport.edu/sexualmisconduct](http://www.brazosport.edu/sexualmisconduct).

Kelli Forde Spiers, Director, Student Life and Title IX Coordinator  
Office J-117D; 979-230-3355; [kelli.fordespiers@brazosport.edu](mailto:kelli.fordespiers@brazosport.edu)

Victoria Young, HR Coordinator and Deputy Title IX Coordinator  
Office C-114; 979-230-3303; [victoria.young@brazosport.edu](mailto:victoria.young@brazosport.edu)

## **XI. OTHER STUDENT SERVICES INFORMATION**

Information about the Library is available at <http://brazosport.edu/students/for-students/places-services/library/about-the-library/> or by calling 979-230-3310.

For assistance with online courses, an open computer lab, online and make-up testing, audio/visual services, and study skills, visit Learning Services next to the Library, call 979-230-3253, or visit <http://brazosport.edu/students/for-students/places-services/learning-services/>

For drop-in math tutoring, the writing center, supplemental instruction and other tutoring including e-tutoring, visit the Student Success Center, call 979-230-3527, or visit <http://brazosport.edu/students/for-students/student-success-center/>

To contact the Physical Sciences and Process Technology Department call 979-230-3618.

The Student Services provides assistance in the following:

Counseling and Advising	979-230-3040
Financial Aid	979-230-3294
Student Activities	979-230-3355

To reach the Information Technology Department for computer, email, or other technical assistance call the Helpdesk at 979-230-3266.



Get the information you need – when you need it. Click <http://geni.us/BRAZO> to install **BC Connect** on your mobile device to receive reminders, explore careers, map your educational plan, be in the know about events, find out about scholarships, achieve your goals and much more.