Brazosport College

Syllabus for INTC 2330 - Troubleshooting

Instructor: **Office:**
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I. COURSE DESCRIPTION:

INTC 2330 - Troubleshooting CIP 1504040011
A hands-on approach to the techniques of troubleshooting in a sophisticated instrumented environment. Laboratory exercises requiring students to troubleshoot upsets in actual chemical processes. **Credit Hours:** 3 (2 lecture, 2 lab)

A. **Prerequisite:** Grade of "C" or better in **INTC 1315**, **INTC2410**, and **INTC 1343**. **Required skill level:** College-level reading and writing. Math: College-level with corequisite (placement code 3).

II. COURSE OBJECTIVES

To understand process and equipment specific troubleshooting techniques. This will be accomplished by having process pilot plant training exercises that simulate common problems that include but are not limited to:

- Loss of instrument air
- Loss of electrical power
- Transmitter blocked in
- Plugged line
- Open control circuit
- Incorrect controller action
- Loss of controller output
- Open bypass valves
- Open thermocouple circuit

Equipment specific troubleshooting will consist of the following topics:

1. Review Management of Change issues and their relationship to manufacturer's model numbers and electrical area classification.

2. List types of test equipment used in troubleshooting pneumatic, electrical, and instrumented systems.

3. Review the proper use of electrical test equipment and its capabilities.CAT ratings on multimeters and fuse ratings in electrical circuits

4. Review Safety Instrumented Systems and control system operations with regards to interlocks, permissive and shutdowns. Overview the roles and responsibilities of Operations and I&E technicians when checking out and troubleshooting these systems.

5. Review the considerations and techniques that are involved with troubleshooting controls with electrical power removed.

6. Recognize the responsibility of the technician to ensure that the documentation used in troubleshooting is up to date and accurate. Overview the methods that various industrial facilities use in maintaining their engineering documentation.

7. Review the various engineering and manufacturer documentation used in checking out, maintaining, and troubleshooting the process control equipment technicians are responsible for.

8. Relate how the scientific method of observation, description, prediction, and control can be used when troubleshooting.
9. Review how analog and digital signals are transmitted using current, voltage, resistance, frequency, pulse, and pneumatic pressure.
10. Review proper testing procedures for conductor insulation, shielding and grounding and the effects of nonconformance.
11. Test requirements for checking fail safe alarm circuits.
12. Requirements for testing intrinsically safe instrument loops.
13. Consideration to be addressed when working with control systems that use voting configurations.
14. Proper use of HART communicators and associated DCS screens when working with smart transmitters and control valve positioners.
15. Calculate maximum allowable loop resistance and minimum voltage requirements of smart instrumentation.
16. Evaluate and interpret timing charts for sequential control systems.
17. Evaluate and troubleshoot using ladder logic, function block, structured text and Boolean logic.
18. Evaluate and troubleshoot pneumatic controller and transmitter installations
19. Evaluate and troubleshoot pneumatic control valves with legacy and smart positioners.
20. Evaluate and troubleshoot smart differential pressure transmitters used in measuring flow, level, and pressure applications.
21. Evaluate and troubleshoot smart level transmitters the employ radar and ultrasonic technology.
22. Evaluate and troubleshoot legacy and smart temperature transmitters using thermocouples and resistance temperature detectors.
23. Develop familiarity with thermal imagery test equipment and emissivity considerations.
24. Develop familiarity with proper operation and troubleshooting Coriolis flow meters.

25. Develop familiarity with troubleshooting procedures for Vortex flow meters.

26. Develop familiarity with advanced statistical process monitoring diagnostics for smart instrumentation.

27. Recognize and correct improper controller tuning parameters.

28. Evaluate and troubleshoot DCS I/O rack installations.

29. Review the principle of operation for Vibration Monitoring equipment using displacement sensors and accelerometers.

III. STUDENT LEARNING OUTCOMES

OUTCOME	METHOD OF ASSESSMENT
Demonstrate proficiency in the use of test equipment while troubleshooting instrumented systems.	Use test equipment properly.
Demonstrate comprehension and compliance with plant safety and management of change procedures.	Describe MOC & Safety
Demonstrate competence in troubleshooting specific pieces of instrumentation using the manufacturer's technical manuals.	Use tech manuals properly.
Demonstrate familiarity with typical plant engineering documentation.	Describe typical plant engineering material
Demonstrate successful troubleshooting of various faults and misapplications in instrumented systems.	Evaluate and correct typical faults and misapplications

IV. TEXTBOOK OR COURSE MATERIAL INFORMATION

A. Textbook

1. No textbook, materials provided by instructor.
2. Calculator TI-30XIIS (required)
3. Visorgogs Safety Glasses (required)

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. 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	• Discuss how this class will be split between system and equipment specific troubleshooting. • Discuss safety items in the lab. • Discuss video handbook on troubleshooting • Relate how the scientific method of observation, description, prediction and control can be used as an iterative process when troubleshooting. Review troubleshooting section on page 6 of the workbook. • Discuss how the divide and conquer method can be applied to finding faults in systems with examples such as segmenting a control loop or troubleshooting a shorted lighting system through successive approximation. • Discuss how component substitution is used in troubleshooting • Discuss the different approaches when troubleshooting intermittent faults as opposed to constant faults • Tour PET and PGU units. Compare and contrast the control systems employed. Review the safety requirements for working in these units • Review the P&ID's for the pilot plants and what will occur in exercise #1. • Review Controller action determination. • Show overheads of controllers with problems. • Do exercise- controllers with problems.
2	• List types of test equipment used in troubleshooting pneumatic, electrical, and instrumented systems briefly review the principle of operation and their use in troubleshooting for the following: • Multimeters, Fluke 87V, with hold and min / max functions. Volts, ohms, current, frequency, continuity, and diode test. Relative function for zeroing out lead resistance, etc. Low pass filtering. Fluke internal fuse check procedure on 80 series voltmeters. Pass out Fluke multimeter manuals. • Meggers and surge testers for testing wiring and motors • Clamp on current meters for AC and DC and how this helps in checking motor loads and instrument loops. • Discuss calibrators and communicators that allow accuracy checks for calibration and configuration. Review several calibrators from different manufacturers. • Tic Tracers and reflectometers for determining where breaks and shorts to ground are located for conductors and fiberoptics. • Noncontact voltage detectors that sense the proximity of voltage for safety and troubleshooting.

2 (cont.)	• Oscilloscopes for checking frequency. View Fluke 120 & 190 series scopemeter virtual demo videos (http://www.fluke.com/Fluke/usen/trtraining/training/smtraining/default.htm) • Dataloggers for troubleshooting digital communications • Phase meter/ motor rotation testers for determining proper phase sequence and new motor rotation. • Pneumatic test equipment such as the Meriam bubble tester and pressure testing procedures. • Review the proper use of electrical test equipment and personal protective equipment, flash suits, gloves, mats, approach distances • CAT ratings on multimeters and their proper use in an industrial setting, review Fluke CAT handout. • Review fuse ratings in electrical circuits. Overview Bussman Fuseology publication with regards to fast, slow, and dual element fuses, the use of rejection fuse clips and fuse coordination at industrial sites. • Review electrical area classification, enclosure ratings and temperature ratings (KW chapter 44) • Divide class up into 3 groups and proceed with exercise #1 and 2. Each group will discuss and list possible causes of each problem.
3	• Review Management of Change issues and their relationship to "replacement in kind". • Review Safety Instrumented Systems and control system operations with regards to interlocks, permissives and shutdowns. Overview the roles and responsibilities of Operations and I&E technicians when checking out and troubleshooting these systems. • Introduce considerations for testing intrinsically safe instrument loops and loopsheet requirements. • Discuss the test requirements for checking fail safe alarm circuits with regards to opens and shorts to ground. • Discuss fire protection circuits that employ a terminal resistor and multiple detectors that shunt the signal line to alarm. • Continue with the lab groups that were formed up in the previous class only shift them to their second of three units. Students should discuss and list possible causes.
4	• Recognize the responsibility of the technician to ensure that the documentation used in troubleshooting is up to date and accurate. Relate how various process problems have been generated by using inaccurate information (Union Carbide towers). • Overview the methods that various industrial facilities use in maintaining their engineering documentation. Redlines, rev #'s, drawing notes, equip. workorder comments, online drawings and file folders. • Discuss the possible paths that should be taken when nonconformances in engineering documentation are encountered (Individual, supervisory, engineering/ MOC).

4 (cont.)	• 7 Review the various engineering and manufacturer documentation used in checking out, maintaining, and troubleshooting the process control equipment that technicians are responsible for. • Review Electrical schematics, wiring diagrams, lighting, and power distribution, MCC one lines and elevations. • Review Instrumentation loopsheets, P&ID's, ladder logic, function block diagrams, Boolean logic diagrams, structured text, sequential timing charts. • Manufacturer's maintenance manuals, troubleshooting maps and tables, call centers, FAQs, and white papers. • Continue with the lab groups that were formed up in the previous class only shift them to their second of three units. Students should discuss and list possible causes.
5	• Review how analog and digital signals are transmitted using current, voltage, resistance, frequency, pulse, and pneumatic pressure. • Work troubleshooting examples with regard to voltage divider networks (three resistors in series middle one's voltage changes. What are the potential causes for this?) • Discuss blown fuse indicator lamps, the necessity to pull both fuse and lamp when depowering. • What instances will not allow the lamp to indicate a blown fuse. • Checking fuses with a voltmeter (parallel and downstream to ground). • The principle involved when uncored solenoid coils blow fuses. Mushrooming of cores through repetition. • Grounded and ungrounded control power transformers and their implications for troubleshooting. • Discuss the use of Tatle Tales, min/max and hold multimeter functions, PLC HMI contact histograms when checking for intermittent faults. • Review proper testing procedures for megging conductor insulation, shielding and grounding for single and multiconductors. • Review temperature compensated megohmmeter readings and potential index readings for electric motors and their interpretation. • Continue with the lab groups that were formed up in the previous class only shift them to their third of three units. Students should discuss and list possible causes.
6	• Discuss the possible causes for problems listed in the three lab exercises with the entire class. • Field questions and review specifics at the units. • Review equipment specific material that will be covered on test #1.
7	• Administer Test #1(One-hour duration). • Overview the startup procedures for units HS 204. Have each group take one of these units and start it up. • Once up, two faults will be placed in the unit and troubleshot. • Conduct orderly shutdown procedure listed in the workbook, on each unit.

8	• Review basic motor control operation including magnetic and thermal magnetic circuit breakers, fused disconnects, contactors, overload relays both solid state and thermo mechanical. • Review operation and troubleshooting three wire start stop controls and multiple start stop stations. • Review considerations and techniques used when troubleshooting controls with electrical power removed. • Discuss Kirk key interlock systems for electrical power enclosure safety. • Test requirements for checking fail safe alarm circuits. Open, short, ground. • Review operation of legacy alarm panels (KW). • Have lab groups alternate to another pilot unit and start it up. • Once up, two faults will be placed in the unit and troubleshot.
9	• Review of PLC operations with regard to program execution and resultant outputs. Watch and discuss Ron Beaufort review of PLC operations (11 units, 2 hours) http://www.youtube.com/watch?v=zlsJxSK8tPE • Considerations to be addressed when working with control systems that use voting configurations and when forcing input contacts on PLC's. • Evaluate and troubleshoot DCS I/O rack installations. Review power, addressing and communication cabling for remote and local I/O racks. To include impedance matching terminating resistors, RC snubber circuits and MOV surge suppressors for inductive output loads, bleed off resistors for leakage current of solid state switches, capacitive coupling between AC inputs with multiconductor cables, sink and source terminology for I/O circuits • Overview the PGU and PET unit P&ID's and walk through the units to provide familiarity with them. Cover the motor control centers, marshaling cabinet, DeltaV controls and boiler control panel.
10	• Proper use of HART communicators and associated DCS screens when working with smart transmitters and control valve positioners. • Present the PowerPoint on Fisher DVC 6000, Emerson Global Users exchange Oct 3-7, 2005 (105 slides). • Review Rosemount technical note, 00840-1000-4801 Rev AA, on Advanced HART Diagnostics with a Field Communicator. Discuss statistical process monitoring and power advisory diagnostic. • Calculate maximum allowable loop resistance and minimum voltage requirements for various smart instruments (3051, 3144p and DVC positioner). • What voltages are required for operation and for HART communication? • Review handout of Action Pak field configurable isolator, AP4380-2000, and its use in split range Smart valve positioner configurations. Discuss its intrinsically safe applications also. • Break the class up into small groups, go out into the PET and PGU units

10 (cont.)	and check out several loops. Determine if and what problems may be encountered.
11	• Discuss ladder diagram, function block, structured text and sequential function chart (KW 38-11,12,13,14) • Evaluate and troubleshoot using electrical control schematics and interpret timing charts for sequential control systems as exemplified in the PGU boiler controls and burner management module. • Evaluate and troubleshoot pneumatic controller and transmitter installations. • Investigate the flapper nozzle relay system and common failures. • Test for tubing leaks and control valve with a Meriam bubble tester. • Resolve oscillating signals through the use of volume tanks. • Review link and lever calibrations with Foxboro 43ap controller. • Review alignment procedure for the Foxboro 43ap controller • Evaluate and troubleshoot pneumatic control valves with legacy and smart positioners. • Determine the correct operation of an automatic control valve with positioner by referencing its configuration with regards to bench set, feedback springs, cams, auxiliary switches, and solenoid valves. • Review Fisher 3610 positioner cam, spring, and connection point along with direct / reverse jumper so that proper operation can be determined. • Review Fisher 3582 linkage, cam type and quadrant position to determine correct operation of its control valve. • Discuss operation of air supply trip switches and reserve tanks for air failure valve positioning on piston operated valves. • Review Masoneilan Domotor air circuit schematics for proper operation and correct air failure positioning for direct and reverse positioners. • Review DVC, digital valve controller operation and troubleshooting checks. Perform DVC troubleshooting checks along with set up wizard and manual tuning functions. Check linkage alignment and position feedback values. • Break the class into several groups to investigate the PGU boiler controls, Foxboro 43AP controller alignment / calibration procedures and the Fisher DVC control valves in the PGU and porch area.
12	• Evaluate and troubleshoot smart differential pressure transmitters used in measuring flow, level, and pressure applications. • Review configuration settings, saturation, and alarm output values, linear vs. square root extraction transfer functions and loop test checks. • Review procedure for checking that the correct flow indication is presented in the control room. • Review level calibration calculations for standard and interface applications. • Review wet legs and purged leg applications and their considerations when troubleshooting. • Discuss procedure and equipment used for rodding out taps safely. • Review proper sequences for three and five valve transmitter manifolds.

12 (cont.)	• Evaluate and troubleshoot smart level transmitters that employ radar and ultrasonic technology. • Review operation of the Rosemount 5300 and 5400 Radar level transmitters, contrast and compare. Check configuration, calibration and troubleshooting methods. • Review operation of the Rosemount 3102HA level transmitter. Check configuration & calibration parameters and review troubleshooting methods. • Break the class up into the same groups as last week and have them rotate between the respective areas of Boiler controls, Foxboro 43 AP, and DVC control valves in the PGU and porch area. • Cycle this rotation a third time to assure all students have had time on each of the three topics.
13	• Evaluate and troubleshoot legacy and smart temperature transmitters that use thermocouples and resistance temperature detectors. Rosemount 444 and 3144P, Moore Industries TDZ transmitters. • Review configuration, calibration and troubleshooting methods for the Rosemount 3144P transmitter. • Review the configuration of a Rosemount 3144p temperature transmitter with dual sensor and hot backup options. Review advanced diagnostics for thermocouple burnout prediction. • Develop familiarity with thermal imagery test equipment and emissivity corrections. Operate the Fluke TI-10 thermal imager and vary the emmisivity of a known object. View video tutorial on thermal imagers by Fluke (http://www.fluke.com/Fluke/usen/training/training/titraining/Thermal-Imaging-Online-Training.htm) • Discuss how thermal imagery is used in detecting hot spots in electrical and process equipment (motor control center scans)
14	• Develop familiarity with proper operation and troubleshooting of Coriolis flow meters. • Review Micromotion 1700 configuration / calibration parameters and recommended troubleshooting methods. Familiarize with pulse, frequency, and milliamp output options. Vary damping settings and check for plugged tubes. • Develop familiarity with troubleshooting procedures for Vortex flow meters. Review how viscosity variations affect performance • Review Foxboro 84 vortex meter configuration and calibration parameters and diagnostics. • Develop familiarity with troubleshooting procedures for Magnetic Flow meters. • Compare and contrast Rosemount 8732 and Foxboro 800ha magnetic flowmeters. Review diagnostics and troubleshoot fouled probes and empty pipe situations. • Review and develop familiarity with Rosemount literature and

14 (cont.)	functionality of advanced diagnostics for statistical process monitoring and power supply analysis. Lached / unlatched alerts and alarm configurations. • Review vibration monitoring equipment for rotating equipment using eddy current displacement probes and accelerometers. Review the eddy current principle of operation with Bentley Nevada Equipment • Alter settings for process controllers on Simtronics tuning modules. Recognize and correct improper controller tuning parameters. Use tuning maps that show excessive gain, reset and rate parameters (KW 37-7). • Entire class will use the simtronics simulators for tuning problem recognition and resolution.
15	• Review for the final exam. • Summate what lab experiences will be questioned. • Review which equipment specific topics students will be responsible for.
16	• Final exam (2 hours).

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

Office Hours:
For fulltime faculty, office hours may change from semester to semester. Current faculty office hours are included on the syllabus, see link: https://brazosport.edu/faculty-and-staff/resources/course-syllabi-instructor-information/

For an adjunct faculty, no office hours are required, and they are not assigned an office. To set up an appointment with an adjunct, contact the instructor as per the email address on the syllabus, see link: https://brazosport.edu/faculty-and-staff/resources/course-syllabi-instructor-information/

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. 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.

Alex Crouse, Director of Student Life and Title IX Coordinator
979-230-3355; alex.crouse@brazosport.edu

Mareille Rolon, HR Coordinator and Deputy Title IX Coordinator
979-230-3303; mareille.rolon@brazosport.edu

VII. 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.

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, and may, at a minimum, result in F, in this course. Sanctions may be imposed beyond your grade in this course by the Dean of Student Services. Please refer to the Brazosport College Student Guide for more information. This is available online at http://brazosport.edu/students/for-students/student-services/.

VIII. 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).

IX. COURSE REQUIREMENTS AND GRADING POLICY TESTING MAKE-UP POLICY

A. Grading

Major Exams	20%
Attendance, participation & lab exercises	50%
Final Exam	30%

Grades are assigned as follows:

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

F	Below 60

X. STUDENT CONDUCT STATEMENT

Students are expected to be aware of and follow the Brazosport College Student Code of Conduct. Students have violated the Code if they "fail to comply with any lawful directions, verbal or written, of any official at BC." Lawful directions include precautions and requirements taken to prevent the spread of COVID-19 at Brazosport College. Students who do not follow safety requirements, including the wearing of a mask, may be removed from class by their instructor and referred to the Dean of Student Services.

XI. CAMPUS CLOSURE STATEMENT

Brazosport College is committed to the health and safety of all students, staff, and faculty and adheres to all federal and state guidelines. The College intends to stay open for the duration of the semester and provide access to classes and support services on campus in the safest way possible. The College will also comply with lawful orders given by applicable authorities, including the Governor of Texas, up to and including campus closure. It is possible that on campus activities may be moved online and/or postpone if such orders are given.

XII. 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.

XIII. 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.