A. **Academic Division:** Business, Industry, and Technology

B. **Discipline:** Industrial Technology - Industrial Maintenance

C. **Course Number and Title:** EMMT2710 – Robot Control Systems

D. **Course Coordinator:** Randy Storms
   **Assistant Dean:** Daniel Wagner

**Instructor Information:**
- **Name:** Click here to enter text.
- **Office Location:** Click here to enter text.
- **Office Hours:** Click here to enter text.
- **Phone Number:** Click here to enter text.
- **E-Mail Address:** Click here to enter text.

E. **Credit Hours:** 3
   - Lecture: 2 hours
   - Laboratory: 2 hours

F. **Prerequisites:** EMMT2250 c, ELET2100

G. **Syllabus Effective Date:** Fall 2017

H. **Textbook(s) Title:** None

I. **Workbook(s) and/or Lab Manual:** None

J. **Course Description:** This course covers the systems and tools that determine and control the motion of robotic tooling a robotic workcell. Topics include: negative feedback, servo control, open and closed loop control, servomotors, stepper motors, path control, sensors, motion types, programming, maintenance, world-coordinates, work-coordinates, relative-coordinates, and fixed-coordinates.

K. **College-Wide Learning Outcomes**

<table>
<thead>
<tr>
<th>College-Wide Learning Outcome</th>
<th>Assessments - - How it is met &amp; When it is met</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication – Written</td>
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<td>Communication – Speech</td>
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<td>Intercultural Knowledge and Competence</td>
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<td>Critical Thinking</td>
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<td>Information Literacy</td>
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<td>Quantitative Literacy</td>
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</table>
## Course Outcomes and Assessment Methods:

Upon successful completion of this course, the student shall:

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Assessments – How it is met &amp; When it is met</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Describe basic feedback control loops that use transmitters, controllers, control valves and auxiliary devices and their function in industrial control.</td>
<td>Quizzes and labs during weeks 1-3, midterm and final exam.</td>
</tr>
<tr>
<td>2. Describe feedback control, open loop control, closed loop control using standard instrument symbols and terminology.</td>
<td>Quizzes and labs during weeks 1-3, midterm and final exam.</td>
</tr>
<tr>
<td>3. Describe control system operating parameters, safety requirements, documentation and permissions to prevent any problems in operation or safety while work is being performed.</td>
<td>Quizzes and labs during weeks 1-3, midterm and final exam.</td>
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<tr>
<td>4. Diagnose and repair manufacturing hardware or control loop malfunctions.</td>
<td>Quizzes and labs throughout the quarter, midterm and final exam.</td>
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<tr>
<td>5. Relate proper troubleshooting techniques and maintenance procedures to complete measurement and control loop problem solving to in-plant application.</td>
<td>Quizzes and labs during weeks 1-7, midterm and final exam.</td>
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<tr>
<td>6. Isolate and repair faults in an electronic process control loop and lists step to prevent the fault from recurring.</td>
<td>Quizzes and labs during weeks 1-7, midterm and final exam.</td>
</tr>
<tr>
<td>7. Classify as to the function and action of each following robotic elements: “manipulator” (arm, base, shoulder, elbow, wrist, upper arm, forearm, end effector, gripper and links); “actuator” (effector, hydraulic motor, cable drive, servovalve, stepper motor, stop, limit switch, interlock); “control system” (controller, open-loop control, closed-loop control, servo-controlled robot, continuous path control, point-to-point control, step point control, sequence control, trajectory control, pick and place control, computer numerical control, direct numerical control and hierarchical control); “sensor” (internal, external, force, contact, proximity, tactile, touch, vision, temperature, pressure, flow, weight and concentration)</td>
<td>Quizzes and labs during weeks 1-7, midterm and final exam.</td>
</tr>
<tr>
<td>8. Describe the general requirements for the installation of Distributed Systems including set-up and manipulation of controller data acquisition files.</td>
<td>Quizzes and labs during weeks 8-15, final exam.</td>
</tr>
<tr>
<td>9. Analyze the types of motions that are used for robotic programming (translational, rotational, continuous-path, point-to-point, world coordinates, work coordinates, relative coordinates and fixed coordinates).</td>
<td>Quizzes and labs during weeks 8-15, final exam.</td>
</tr>
</tbody>
</table>

## Topical Timeline (Subject to Change):

1. **SINGLE LOOP FEEDBACK CONTROL**
   a. The basic feedback control loops that use transmitters, controllers, control valves and auxiliary devices and their function in industrial control.
   b. Feedback control, open loop control, closed loop control using standard instrument symbols and terminology. (ISA-S51.1)
2. **CONTROL SYSTEMS TROUBLESHOOTING PRINCIPLES - ELECTRONIC**
   a. The principles and concepts of electronic instruments, process system and control-loop troubleshooting.
b. manufacturing hardware or control loop malfunctions. Determine the problem area.

c. Repair of individual instrument or control loop malfunction. (IEEE: STD 518)

3. ISOLATING PROBLEMS - TROUBLESHOOTING ELECTRONIC CONTROL LOOPS
   a. Proper troubleshooting techniques and maintenance procedures to complete measurement and control loops in in-plant situations.
   b. The procedure for isolating problems in an electronic process control loop;
      1) make sure there is a problem,
      2) describe and locate the problem,
      3) repair the malfunction,
      4) make sure the loop is functioning properly
      5) take steps
      6) to minimize reoccurrence of the problem. (ISA-S26, S12.4, S12.10, S12.11, S12.12; IEEE: STD 336, 446)

4. COMPUTER CONTROL SYSTEMS - GENERAL
   a. The characteristics and major components of computer control systems (processor, process interface, operator interface, process control software, algorithms and peripheral equipment). (IEEE: STD 162)

5. STRUCTURE ELEMENTS OF AN INDUSTRIAL ROBOT
   a. The elements of a robot "control system" (controller, open-loop control, closed-loop control, servo-controlled robot, continuous path control, point-to-point control, step point control, sequence control, trajectory control, pick and place control, computer numerical control, direct numerical control and hierarchical control)
   b. The elements of a robot "sensors" (internal, external, force, contact, proximity, tactile, touch, vision, temperature, pressure, flow, weight and concentration). (EIA: RS-281-B; IEEE: STD 796, 802.2)

6. SERVOMECHANISMS
   a. Uses
      1) Position Control
      2) Speed Control
      3) Other
   b. Servos for Rotary control
   c. Servos for Linear control
   d. The Servomotor
   e. Devices without feedback
   f. RC Servos

N. Course Assignments:
   1. Homework: Selected problems and questions from weekly reading assignments must be completed.
   2. Labs: Various self-paced and computer monitored labs administered in the IST lab.
   3. Quizzes: Quizzes will be administered online via LMS.
   4. Midterm: The midterm exam will be administered during week 8.
   5. Final: There will be a comprehensive final at the end of the semester.

O. Recommended Grading Scale:

<table>
<thead>
<tr>
<th>NUMERIC</th>
<th>GRADE</th>
<th>POINTS</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>93–100</td>
<td>A</td>
<td>4.00</td>
<td>Superior</td>
</tr>
<tr>
<td>90–92</td>
<td>A-</td>
<td>3.67</td>
<td>Superior</td>
</tr>
<tr>
<td>87–89</td>
<td>B+</td>
<td>3.33</td>
<td>Above Average</td>
</tr>
<tr>
<td>83–86</td>
<td>B</td>
<td>3.00</td>
<td>Above Average</td>
</tr>
<tr>
<td>80–82</td>
<td>B-</td>
<td>2.67</td>
<td>Above Average</td>
</tr>
<tr>
<td>77–79</td>
<td>C+</td>
<td>2.33</td>
<td>Average</td>
</tr>
<tr>
<td>73–76</td>
<td>C</td>
<td>2.00</td>
<td>Average</td>
</tr>
<tr>
<td>70–72</td>
<td>C-</td>
<td>1.67</td>
<td>Below Average</td>
</tr>
</tbody>
</table>

Updated: 2/14/2017
<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D+</td>
<td>1.33</td>
</tr>
<tr>
<td>D</td>
<td>1.00</td>
</tr>
<tr>
<td>D-</td>
<td>0.67</td>
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<tr>
<td>F</td>
<td>0.00</td>
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P. **Grading and Testing Guidelines:**

Click here to enter text.

Q. **Examination Policy:**

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R. **Class Attendance and Homework Make-Up Policy:**

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S. **Classroom Expectations:**

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T. **College Procedures/Policies:**

**Attendance Requirements:** All students are required to attend all scheduled classes and examinations. Each faculty member has the right to establish regulations regarding attendance that he/she considers necessary for successful study.

Students who do not attend classes may be administratively withdrawn from those classes. However, failure to attend classes does not constitute withdrawal, and students are expected to process a formal withdrawal through the Student Records Office in Kee Hall.

**Student engagement requirements:**

Student engagement is based on the “active pursuit” of learning which can be measured by class attendance, class participation (in class or online), taking required quizzes/examinations, and submission of work assignments or papers. Student engagement consists of a student attending at least 60% of the class sessions (there should be attendance throughout the term) and/or completing 75% of the assignments listed on the syllabus at the midpoint in the term. Exceptions can be made when there is on-going communication between the student and faculty member. The communication must be documented and the faculty member and student must be in agreement regarding the exception. Students not meeting the expectation will be administratively withdrawn from class. If a student believes he/she was administratively withdrawn in error, he/she may file an appeal. Being administratively withdrawn may have program and financial aid implications.

**Academic Misconduct** is any activity that tends to compromise the academic integrity of the college, or subvert the educational process. Examples of academic misconduct include, but are not limited to:

1. **Violation of course or program rules** as contained in the course syllabus or other information provided to the student; violation of program requirements as established by departments and made available to students.

2. **Plagiarism** including, but not limited to, submitting, without appropriate acknowledgment, any written, visual or oral material that has been copied in whole or in part from the work of others (whether such source is published or not) even if the material is completely paraphrased in one’s own words. This includes another individual’s academic composition, compilation, or other product, or a commercially
prepared paper. Plagiarism also includes submitting work in which portions were substantially produced by someone acting as a tutor or editor.

Such practices constitute plagiarism regardless of motive. Those who deny deceitful intent, claim not to have known that the act constituted plagiarism, or maintain that what they did was inadvertent are nevertheless subject to penalties when plagiarism has been confirmed.

3. Cheating and dishonest practices in connection with examinations, papers and projects, including but not limited to using unauthorized notes, study aids or information on an examination; obtaining help from another student during an examination; taking an exam or doing work for another student; providing one’s own work for another student to copy and submit as his/her own; or allowing another student to do one’s work and then submitting the work as one’s own. Also included would be altering a graded work after it has been returned, then submitting the work for re-grading; or submitting identical or similar papers for credit in more than one course without prior permission from the course instructors.

4. Fabrication including but not limited to falsifying or inventing any information, data or citation; presenting data that were not gathered in accordance with defined appropriate guidelines, and failing to include an accurate account of the method by which data were collected.

5. Obtaining an Unfair Advantage including, but not limited to stealing, reproducing, circulating, or otherwise gaining access to examination materials prior to the time authorized by the instructor; unauthorized collaborating on an academic assignment; taking, hiding or altering resource material; or undertaking any activity with the purpose of creating or obtaining an unfair advantage over another student’s academic work.

6. Aiding and Abetting Academic Dishonesty including, but not limited to providing material, information or other assistance to another person with the knowledge that such aid could be used in any of the violations stated above, or providing false information in connection with any inquiry regarding academic integrity.

7. Alteration of Grades or Marks including but not limited to, action by the student in an effort to change the earned credit or grade.

In addition, cases of academic dishonesty may involve photocopied materials. Materials used may fall under the Copyright Act. Violations of said Act may subject the user and/or the College to sanctions.

Statement on Disabilities: Any student who requires reasonable accommodations related to a disability should inform the course instructor and the Coordinator of Specialized Services (Room 138 in Kee Hall; phone 419-755-4727).

Students who encounter difficulty in any of their courses are encouraged to visit the Tutoring Resource Center (Room 119 in Fallerius Technical Education Center) for tutoring assistance, and the Student Success Center (Room 136 in Kee Hall) for academic assistance, advising services, referrals for personal counseling and Learning Disability (LD) Testing.

Statement on Withdrawals: As a student, you are expected to attend class. If you are unable or choose not to attend class, or if for whatever reason you are unable to keep up with the requirements of a course, you need to officially drop the class at the Student Records Office. Refund dates and withdrawal dates will vary slightly from term to term. Contact the Student Records Office for applicable dates. Additionally these dates are posted on the academic calendar available on the college’s website, www.ncstatecollege.edu, under the Academics heading on the home page and are available at the Student Records Office in Kee Hall. Students should go to the Student Records Office (Room 142 in Kee Hall) to process their withdrawal from any class.
If you choose to walk away from your class without officially withdrawing from it, the faculty member teaching the class must grade your classroom performance on the material available to him or her. This normally results in an "F" grade. An "F" grade can lower your grade point average considerably depending on the total credits accumulated.