**ELE829: System Models and Identification**

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<tr>
<th>Instructor(s)</th>
<th>Gocha Zywno [Coordinator]</th>
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<td></td>
<td>Office: ENG463</td>
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<td></td>
<td>Phone: (416) 979-5000 x 6105</td>
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<td></td>
<td>Email: <a href="mailto:gzywno@ryerson.ca">gzywno@ryerson.ca</a></td>
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<td>Office Hours: Tue 10 - 11 am, Wed 3 - 5 pm</td>
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**Calendar Description**


**Prerequisites**

ELE 639

**Antirequisites**

None

**Corerequisites**

None

**Compulsory Text(s):**

1. **ELE829: Course Notes**, M.S. Zywno, Copyright 1999-2019. The notes are available from the secure course website, (login at https://my.ryerson.ca) as PDF downloadable files.

**Reference Text(s):**

At the end of this course, the successful student will be able to:

1. Demonstrates competency in developing mathematical models for deterministic systems (dynamic processes) and for stochastic systems (noise). Uses relevant computer simulation software - MATLAB System Identification Toolbox. Identifies and carries out steps required in performing a successful model identification procedure. Evaluates the effect of uncertainty in model parameters. (2b)
2. Applies the tools for system identification to a real-time servomotor system, including obtaining experimental data. Selects appropriate analytical model for the real-time servomotor system, and verifies the model by comparing to experimental results. (3a)
3. Selects appropriate analytical model for the real-time servomotor system, and verifies the model by comparing to experimental results. Assesses accuracy of the results obtained from the real-time servomotor system, verifying experimental data and explaining sources of possible discrepancies (non-linearity). (3b)
4. Designs data collection experiments for diagnostics and identification of the model, selects appropriate model structure (BJ model) and noise filter function, and appropriate Least Squares Algorithm. (4b), (4a)
5. Evaluates the quality of the derived system and noise models by validating against a set criteria, then improves the design until the model is validated. (4c)
6. Demonstrates proficiency in the use of high-performance engineering modeling and analysis software, including System Identification Toolbox, in this course, and for subsequent engineering practice by completing and demonstrating to the professor the required simulation and analyses to perform system and noise model diagnostics, identification and verification. (5a)
7. Helps other team members, and accepts help, on technical and team issues. Demonstrates capacity for team leadership while respecting others roles. Evaluates team effectiveness and plans for improvements. (6b)
8. Produces a professionally prepared technical report using appropriate format, grammar, and citation styles, with figures and tables chosen to illustrate points made, with appropriate size, labels and references in the body of the report. Reports are graded on correctness, completeness, grammar, quality of graphics and layout. (7a)
9. Responds appropriately to verbal questions from instructors, formulating and expressing ideas, using appropriate technical terminology this is assessed through comprehensive lab interviews by instructors. (7b)
10. Demonstrates an understanding of project management principles, applying them both to the individual final project and to group tutorials. These include: negotiating the project scope, managing the deadlines, decomposing projects into key tasks and allocating responsibilities and resources according to deadlines. (11b)

NOTE: Numbers in parentheses refer to the graduate attributes required by the Canadian Engineering Accreditation Board (CEAB).

Course Organization
3.0 hours of lecture per week for 13 weeks
1.0 hours of lab/tutorial per week for 12 weeks

Course Evaluation
<table>
<thead>
<tr>
<th>Course Activities</th>
<th>15 %</th>
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<tbody>
<tr>
<td>Lab/Tutorial Project (Group) #1</td>
<td>9 %</td>
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<tr>
<td>Lab/Tutorial Project (Group) #2</td>
<td>9 %</td>
</tr>
<tr>
<td>Lab/Tutorial Project (Group) #3</td>
<td>9 %</td>
</tr>
<tr>
<td>Lab/Tutorial Project (Group) #4</td>
<td>13 %</td>
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<tr>
<td>Final Project Report (Individual)</td>
<td>45 %</td>
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<tr>
<td>TOTAL:</td>
<td>100 %</td>
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Note: In order for a student to pass a course with “Theory and Laboratory” components, in addition to earning a minimum overall course mark of 50%, the student must pass the Laboratory and Theory portions separately by achieving a minimum of 50% in the combined Laboratory components and 50% in the combined Theory components. Please refer to the "Course Evaluation" section for details on the Theory and Laboratory components.

Examinations
Course evaluation is ongoing and semester-long, and includes both group work (lab/tutorial reports) and individual effort (final project). All reports include simulations – Matlab codes are submitted and parsed for originality and efficacy. The course professor personally verifies all individual codes submitted with the final report. If the execution of the code does not support claims in the report, the project will automatically receive an automatic deduction in the grade.
# Other Evaluation Information

Course activities are part of the ongoing and semester-long evaluation: there are graded activities in every week of classes (on top of scheduled tutorial/lab reports).

The graded activities include both individual in-class assessments (pop quizzes), and homework assignments, including computer simulations on the application of theory learned, which are then demonstrated to the professor in class.

NOTE: The four lab/tutorial reports have different weights.

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<tr>
<th>Other Information</th>
<th>None</th>
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## Course Content

<table>
<thead>
<tr>
<th>Week</th>
<th>Hours</th>
<th>Chapters / Section</th>
<th>Topic, description</th>
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<tbody>
<tr>
<td>Week 2</td>
<td>3</td>
<td>Non-parametric frequency response models: SPA ETFE the effect of noise data filtering. Transfer function models conversions between continuous and discrete representations sampling sampling. Simple Box-Jenkins (BJ) model structure: OE Model (deterministic process white noise). (References: Course Notes Chapters 1 2 3)</td>
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<td>Week 3</td>
<td>3</td>
<td>Diagnostic tools in frequency domain - summary. Introduction to Tutorial # 2: Non-parametric models in time domain. Review - time domain response for conventional modeling (Step and Impulse response plots). Review – basic definitions of stochastic processes. (References: Course Notes Chapters 2 4)</td>
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<td>Week 4</td>
<td>3</td>
<td>Non-parametric models in time domain: impulse and step weights from de-convolution and from correlation analysis. The effect of noise on non-parametric models in time domain. Simple parametric non-robust discrete transfer function models from impulse weights. Hankel Test of system order. (References: Course Notes Chapters 2 4)</td>
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<td>Week 5</td>
<td>3</td>
<td>Diagnostic tools in time domain – summary. Review of matrix algebra. Introduction to Least Squares method. Robust parametric models. The effect of noise on conventional parametric models (non-robust and robust). (References: Course Notes Chapters 4 5)</td>
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<tr>
<td>Week</td>
<td>Lab</td>
<td>Description</td>
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| 2-3  | ENG413 | Tutorial #1: Diagnostic Tools in Frequency Domain and Simple Model Identification - OE Model (2 sessions):  
Part 1: Non-Parametric Models in Frequency Domain as Diagnostic Tools  
Part 2: Simple Model Identification using OE Model  
| 4-5  | ENG413 | Tutorial #2: Diagnostic Tools in Time Domain and Simple Model Identification - OE Model (2 sessions):  
Part 1: Non-Parametric Models in Time Domain as Diagnostic Tools  
Part 2: Simple Model Identification using OE Model  
| 6-7  | ENG413 | Tutorial #3: Stochastic Noise Models (2 sessions):  
Identify structure of four different noise models. |
Policies & Important Information:

1. Students are required to obtain and maintain a Ryerson e-mail account for timely communications between the instructor and the students;
2. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented;
3. Assignments, projects, reports and other deadline-bound course assessment components handed in past the due date will receive a mark of ZERO, unless otherwise stated. Marking information will be made available at the time when such course assessment components are announced.
4. Refer to our Departmental FAQ page for information on common questions and issues at the following link: https://www.ee.ryerson.ca/guides/Student.Academic.FAQ.html

Missed Classes and/or Evaluations

When possible, students are required to inform their instructors of any situation which arises during the semester which may have an adverse effect upon their academic performance, and must request any consideration and accommodation according to the relevant policies as far in advance as possible. Failure to do so may jeopardize any academic appeals.

1. **Health certificates** - If a student misses the deadline for submitting an assignment, or the date of an exam or other evaluation component for health reasons, they should notify their instructor as soon as possible, and submit a Ryerson Student Health Certificate AND an Academic Consideration Request form within 3 working days of the missed date. Both documents are available at https://www.ryerson.ca/senate/forms/medical.pdf. If you are a full-time or part-time degree student, then you submit your forms to your own program department or school;
2. **Religious, Aboriginal and Spiritual observance** - If a student needs accommodation because of religious, Aboriginal or spiritual observance, they must submit a Request for Accommodation of Student Religious, Aboriginal and Spiritual Observance AND an Academic Consideration Request form within the first 2 weeks of the class or, for a final examination, within 2 weeks of the posting of the examination schedule. If the requested absence occurs within the first 2 weeks of classes, or the dates are not known well in advance as they are linked to other conditions, these forms should be submitted with as much lead time as possible in advance of the absence. Both documents are available at www.ryerson.ca/senate/forms/relobservforminstr.pdf. If you are a full-time or part-time degree student, then you submit the forms to your own program department or school;
3. **Academic Accommodation Support** - Before the first graded work is due, students registered with the Academic Accommodation Support office (AAS - www.ryerson.ca/studentlearningsupport/academic-accommodation-support) should provide their instructors with an Academic Accommodation letter that describes their academic accommodation plan.

Academic Integrity

Ryerson’s Policy 60 (the Academic Integrity policy) applies to all students at the University. Forms of academic misconduct include plagiarism, cheating, supplying false information to the University, and other acts. The most common form of academic misconduct is plagiarism - a serious academic offence, with potentially severe penalties and other consequences. It is expected, therefore, that all examinations and work submitted for evaluation and course credit will be the product of each student's individual effort (or an authorized group of students). Submitting the same work for credit to more than one course, without instructor approval, can also be considered a form of plagiarism.

Suspicions of academic misconduct may be referred to the Academic Integrity Office (AIO). Students who are found to have committed academic misconduct will have a Disciplinary Notation (DN) placed on their academic record (not on their transcript) and will normally be assigned one or more of the following penalties:

1. A grade reduction for the work, ranging up to an including a zero on the work (minimum penalty for graduate work is a zero on the work);
2. A grade reduction in the course greater than a zero on the final course grade. (Note that this penalty can only be applied to course components worth 10% or less, and any additional penalty cannot exceed 10% of the final course grade. Students must be given prior notice that such a penalty will be assigned (e.g. in the course outline or on the assignment handout);
3. An F in the course;
4. More serious penalties up to and including expulsion from the University.

The unauthorized use of intellectual property of others, including your professor, for distribution, sale, or profit is expressly prohibited, in accordance with Policy 60 (Sections 2.8 and 2.10). Intellectual property includes, but is not limited to:

1. Slides
2. Lecture notes
3. Presentation materials used in and outside of class
4. Lab manuals
5. Course packs
6. Exams

For more detailed information on these issues, please refer to the Academic Integrity policy (https://www.ryerson.ca/senate/policies/pol60.pdf) and to the Academic Integrity Office website (https://www.ryerson.ca/academicintegrity/).

Important Resources Available at Ryerson

1. The Library (https://library.ryerson.ca/) provides research workshops and individual assistance. Inquire at the Reference Desk on the second floor of the library, or go to library.ryerson.ca/guides/workshops
2. Student Learning Support (https://www.ryerson.ca/studentlearningsupport) offers group-based and individual help with writing, math, study skills and transition support, and other issues.