Description: Iterative techniques for solving non-linear equations with one variable; techniques for solving sets of linear algebraic equations using direct and iterative methods; Iterative methods for solving sets of non-linear algebraic equations; LU factorization and application of LU matrices; eigenvalues, eigenvectors and modal transformations, solving sets of first- and second-order differential equations; optimization techniques, numerical solutions of partial differential equations

Prerequisites:

Corequisites: None

Instructor: Nurul Chowdhury
Associate Professor, Department of Electrical and Computer Engineering
Office: 3B44
Phone: (306) 966-5396
Email: nurul.chowdhury@usask.ca

Lectures: Tuesday, Thursday, 11:30 am – 12:50 pm, Room Geol 265

Tutorials: None

Laboratory: None

Website: http://www.engr.usask.ca/classes/EE/840/

Course Reference Numbers (CRNs): 81067

Textbook: None

Office Hours:

Reading List:

“Numerical Analysis”, by Richard L. Burden and J. Douglas Faires
Brooks/Cole Publishing Company

“Differential Equations and Linear Algebra”, by Stephen W. Goode
Prentice Hall

“Advanced Engineering Mathematics”, by Peter V. O’Neil
Wadsworth Publishing Company
Assessment:

The methods of assessment and their respective weightings are given below:

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignments</td>
<td>20%</td>
</tr>
<tr>
<td>Midterm</td>
<td>20%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>60%</td>
</tr>
</tbody>
</table>

Final Grades:

The final grades will be consistent with the “literal descriptors” specified in the university’s grading system.


The distribution of final grades in the class may be adjusted to conform with Departmental grading standards.

For information regarding appeals of final grades or other academic matters, please consult the University Council document on academic appeals.

[http://www.usask.ca/university_secretary/honesty/StudentAcademicAppeals.pdf](http://www.usask.ca/university_secretary/honesty/StudentAcademicAppeals.pdf)

Course Content:

<table>
<thead>
<tr>
<th>Week</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Iterative techniques for solving non-linear equations with one variable; bisection method, method of false position, fixed-point iteration, Newton’s technique, Secant’s method.</td>
</tr>
<tr>
<td>2</td>
<td>Review of matrices, matrix operations, matrix inversions, properties of determinants.</td>
</tr>
</tbody>
</table>
3 Techniques for solving sets of linear algebraic equations using direct and iterative methods; Gauss elimination, Gauss-Jordan elimination, Cramer’s Rule, Gauss-Seidel iterative techniques.

4 Techniques for solving sets of non-linear algebraic equations using iterative methods; Jacobi iterative techniques, Gauss-Seidel iterative techniques, Newton’s iterative technique.

5 State-space models, Transfer Function matrices and stability, Eigenvalues, eigenvectors, modal transformations.

6 Application of diagonalization and axes transformation, solving sets of first- and second-order differential equations using eigenvalues and eigenvectors.

7 Elementary matrices, LU factorization, application of LU matrices, application of elementary matrices, Ill-conditioned matrices.

8 Optimization; convex sets, Mean Value theorem, sufficient conditions for an optimum point, global maximum (minimum).

9 constrained and unconstrained optimization, multivariate grid search, univariate search method.

10 Optimization continued- Lagrange techniques, relaxation technique, method of steepest ascent (descent).

11 Numerical techniques for solving initial value problems; Euler’s method, Taylor’s method, Runge-Kutta method.

12 Partial differential equations, types, analytical solutions.

13 Numerical solutions for heat equations and wave equations.

Assignments: Up to 5 assignments

Tutorials: Details

Quizzes: Details
Exams: Details

Important Dates:

<table>
<thead>
<tr>
<th>Date</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Midterm Exam Period</td>
</tr>
</tbody>
</table>

Student Conduct: Ethical behaviour is an important part of engineering practice. Each professional engineering association has a Code of Ethics, which its members are expected to follow. Since students are in the process of becoming Professional Engineers, it is expected that students will conduct themselves in an ethical manner.

The APEGs (Association of Professional Engineers and Geoscientists of Saskatchewan) Code of Ethics states that engineers shall “conduct themselves with fairness, courtesy and good faith towards clients, colleagues, employees and others; give credit where it is due and accept, as well as give, honest and fair professional criticism” (Section 20(e), The Engineering and Geoscience Professions Regulatory Bylaws, 1997).

The first part of this statement discusses an engineer’s relationships with his or her colleagues. One of the ways in which engineering students can demonstrate courtesy to their colleagues is by helping to maintain an atmosphere that is conducive to learning, and minimizing disruptions in class. This includes arriving on time for lectures, turning cell phones and other electronic devices off during lectures, not leaving or entering the class at inopportune times, and refraining from talking to others while the instructor is talking. However, if you have questions at any time during lectures, please feel free to ask (chances are very good that someone else may have the same question as you do).

For more information, please consult the University Council Guidelines for Academic Conduct.

http://www.usask.ca/university_secretary/council/reports_forms/reports/guide_conduct.php

Academic Honesty: The latter part of the above statement from the APEGs Code of Ethics discusses giving credit where it is due. At the University, this is addressed by university policies on academic integrity and academic misconduct. In this class, students are expected to submit their own individual work for academic credit, properly cite the work of others, and to follow the rules for examinations. Academic misconduct, plagiarism, and cheating will not be tolerated. Copying of assignments and lab reports is considered academic misconduct. Students are responsible for understanding the university’s policies on academic integrity and academic misconduct. For more information, please consult the University Council Regulations on Student Academic Misconduct and the university’s examination regulations.

http://www.usask.ca/university_secretary/honesty/StudentAcademicMisconduct.pdf
http://www.usask.ca/university_secretary/council/academiccourses.php

Safety: The APEGs Code of Ethics also states that Professional Engineers shall “hold paramount the safety, health and welfare of the public and the protection of the environment and promote health and safety within the workplace” (Section 20(a), The Engineering and Geoscience Professions Regulatory Bylaws, 1997).

Safety is taken very seriously by the Department of Electrical and Computer Engineering. Students are expected to work in a safe manner, follow all safety instructions, and use any personal protective equipment provided. Students failing to observe the safety rules in any laboratory will be asked to leave.
Laboratory Learning
Outcomes:
Course Learning Outcomes: Upon completing this course students will be able to:

1. Solve non-linear equations
2. Solve systems of linear and non-linear equations
3. Analyze and interpret the dynamic behaviour of linear systems
4. Solve partial differential equations
5. Analyze, interpret and obtain optimum points with and without constraints

Attribute Mapping:

<table>
<thead>
<tr>
<th>Learning Outcome</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>A4</th>
<th>A5</th>
<th>A6</th>
<th>A7</th>
<th>A8</th>
<th>A9</th>
<th>A10</th>
<th>A11</th>
<th>A12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Attributes:*
A1 Knowledge base for engineering
A2 Problem analysis
A3 Investigation
A4 Design
A5 Use of engineering tools
A6 Individual and team work
A7 Communication skills
A8 Professionalism
A9 Impact of engineering on society and the environment
A10 Ethics and equity
A11 Economics and project management
A12 Life-long learning

*Levels of Performance:
1 - Knowledge of the skills/concepts/tools but not using them to solve problems.
2 - Using the skills/concepts/tools to solve directed problems. (*Directed* indicates that students are told what tools to use.)
3 - Selecting and using the skills/concepts/tools to solve non-directed, non-open-ended problems. (Students have a number of S/C/T to choose from and need to decide which to employ. Problems will have a definite solution.)
4 - Applying the appropriate skills/concepts/tools to solve open-ended problems. (Students have a number of S/C/T to choose from and need to decide which to employ. Problems will have multiple solution paths leading to possibly more than one acceptable solution.)

Accreditation Unit (AU) Mapping: (% of total class AU)

<table>
<thead>
<tr>
<th>Math</th>
<th>Natural Science</th>
<th>Complementary Studies</th>
<th>Engineering Science</th>
<th>Engineering Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Assessment Mapping:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weighting</th>
<th>Methods of Feedback***</th>
<th>Learning Outcomes Evaluated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment</td>
<td>20%</td>
<td>S</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Midterm</td>
<td>20%</td>
<td>S</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td>Final Examination</td>
<td>60%</td>
<td>S</td>
<td>1, 2, 3, 4, 5</td>
</tr>
</tbody>
</table>

***Methods of Feedback:
F – *formative* (written comments and/or oral discussions)
S – *summative* (number grades)