Academic Year	2018-2019	**Semester**	2
Course Coordinator	A/P TEH CEE ING		
Course Code	CV2019		
Course Title	Matrix Algebra and Computational Methods		
Pre-requisites	NIL		
No of AUs	3		
Contact Hours	Total: 39 Hours (Lecture: 26 hours; Tutorial: 13 hours)		
Proposal Date	11 Dec 2018		

Course Aims

This course aims to:

i) Provide you with the knowledge of the fundamental principles of linear algebra and basic matrix operations;

ii) Equip you with the ability to apply computational methods to obtain solutions to problems involving: roots of equation; interpolations; differentiation and integration; simple ordinary differential equation and partial differential equations.

Course Learning Outcomes (Course LO)

By the end of this course, you should be able to:

1. Solve linear system of equations using Gauss elimination method.
2. Identify solution types of Ax = b using concept of rank.
3. Apply Gauss-Jordan elimination method and Adjoint method to calculate matrix inverse.
4. Solve linear system of equations using matrix inverse and Cramer's rule.
5. Formulate simple engineering problems as eigenvalue problems.
6. Solve eigenvalue problem.
7. Apply computational methods to find the approximate roots of equations and estimate the error associated with the solutions.
8. Obtain an interpolating polynomial of the required order for a given discrete set of data pairs; and be able to assess the accuracy of the interpolated values.
9. Perform numerical differentiations and integrations and able to distinguish the order of accuracy associated with such methods.
10. Use the appropriate numerical method to find the solution of an initial value problems involving a first order and second order Ordinary Differential Equation (ODE).
11. Apply the Finite Difference Method to solve simple second order Partial Differential Equation (PDE).

Course Content

S/N	Topic	Lecture Hrs	Tutorial Hrs
1	Introduction to matrix algebra, linear system of equations, Gauss elimination and solution types for **Ax=b**	2	1
2	Pivoting, Linear independence, Rank of matrix, Rank and solution type	2	1

3	Matrix inverse, Gauss-Jordan elimination, Determinant of matrix	2	1
4	Cramer's rule, Inverse by formula, Matrix norm and Matrix conditioning	2	1
5	Eigenvalues and Eigenvectors I, Eigenvalues and Eigenvectors II	2	1
6	Eigenvalues and Eigenvectors III, Further Examples	2	1
7	Revision – Matrix Algebra.	1	
7	Introduction to Mathematical Modelling and Numerical Methods; types of error.	1	
8	Roots of equations: Bisection and False Position Method. Newton-Raphson's Method, Secant & Modified Secant Method; error estimate.	2	1
9	Interpolation: Newton and Lagrange Polynomials; error estimate	2	1
10	Numerical Integration:Trapezoidal rule, Simpson's Rules.	2	1
11	Numerical Differentiation: forward-, centred- and backward finite divided differences.	2	1
12	Numerical Methods for solving ordinary differential equation – Euler's, Mid-point, Heun's and Runge-Kutta Methods	2	1
13	Numerical Method for solving linear Partial Differential Equations.	2	1
	Total:	26	13

Components	**Course LO tested**	**Related programme SLO or graduate attributes**	**weighting**	**Team/ Individual**	**Assessment rubrics**
1. Final Examination	All	EAB SLOs (a), (b)	60%	Individual	
2. Continuous Assessment 1 : Quiz 1	1, 2, 3, 4	EAB SLOs (a), (b)	20%	Individual	
3. Continuous Assessment 2 : Quiz 2	7, 8, 9	EAB SLOs (a), (b)	20%	Individual	
Total			100%		

*CEE SLOs = Student Learning Outcome For Civil Engineering Progamme (Per BEng Civil Engineering Accreditation)

Related Programme LO or Graduate Attributes

a. **Engineering knowledge:** Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems;

b. **Problem Analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences;

c. **Design/development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

d. **Investigation:** Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. **The engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for the sustainable development.

h. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.

j. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k. **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l. **Life-long Learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Formative feedback

1. Feedback will be through the dissemination of the student's performance in quizzes as well as review of the quiz questions in class.
2. We encourage you to initiate an Individual consultation sessions on your particular learning needs.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Lectures	Weekly lectures to provide you with the specific knowledge and techniques to achieve the learning outcome stated above.
Tutorials	Weekly tutorials to enable you to apply the knowledge to solve structured problems. We encourage you to explore alternative approaches and techniques.

Textbooks/References:

1. Howard Anton and Chris Rorres, "Elementary Linear Algebra with Applications, 9th Edition", 9th Edition, John Wiley & Sons, 2005.
2. Chapra, S. C. and Canale R. P. "Numerical Methods for Engineers", 5th Edition, McGraw-Hill, 2006.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.

Course Policies and Student Responsibilities

The standing university policy governing student responsibilities shall apply.
No special policy for this course.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion, and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors AY2017/18

Instructor	Office Location	Phone	Email
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Planned Weekly Schedule

Week	Topics	Course LO	Activities
1	Introduction to matrix algebra, linear system of equations, Gauss elimination and solution types for **Ax=b**	1	Lectures & Tutorial
2	Pivoting, Linear independence, Rank of matrix, Rank and solution type	2	Lectures & Tutorial
3	Matrix inverse, Gauss-Jordan elimination, Determinant of matrix	3	Lectures & Tutorial
4	Cramer's rule, Inverse by formula, Matrix norm and Matrix conditioning	3	Lectures & Tutorial
5	Eigenvalues and Eigenvectors I, Eigenvalues and Eigenvectors II	4, 5	Lectures & Tutorial
6	Eigenvalues and Eigenvectors III, Further Examples	5	Lectures & Tutorial
7	Revision – Matrix Algebra.		
7	Overview of mathematical modelling and numerical methods.	6	Lectures & Tutorial
8	Roots of equations: Bisection and False Position Method. Newton-Raphson's Method, Secant & Modified Secant Method; error estimate.	7	Lectures & Tutorial
9	Interpolation: Newton and Lagrange Polynomials; error estimate	8	Lectures & Tutorial
10	Numerical Integration: Trapezoidal rule, Simpson's Rules	9	Lectures & Tutorial
11	Numerical Differentiation: forward-, centred- and backward finite divided differences.	9	Lectures & Tutorial
12	Numerical Methods for solving ordinary differential equation – Euler's, Mid-point, Heun's and Runge-Kutta Methods	10	Lectures & Tutorial
13	Numerical Method for solving linear Partial Differential Equations.	11	Lectures & Tutorial