SUBJECT OUTLINE: ME212 NUMERICAL METHODS

Course(s)	Bachelor of Mechanical Engineering (NQF Level 8)
Subject Name	Numerical Methods
Subject Code	ME212
Duration	13 teaching weeks,1 examination week, 1 mid-semester week
Contact Hours	6 hours per week (3 Lect; 2 Tut; 1 Proj)
Credit Points	18
Delivery Mode	On campus
Prerequisites	EN112 and EN121
Co-requisites	EN212
Subject Coordinator	TBA

Synopsis

Numerical Methods enable students to understand and use various numerical techniques and algorithms important for solving engineering problems. The students will be able to get elementary knowledge on errors and types of errors. They will be able to understand, derive and apply various root finding techniques and algorithms to the equation of one variable. They will learn various interpolation techniques using polynomials and hence they will apply them to cubic splines. They will be able to understand numerical differentiation and integration. The students will then be exposed to numerical techniques to solve initial and boundary value ordinary differential equations. The will also be exposed to the algorithms of numerical algebra such as direct and iterative methods for solving linear systems. Finally they will be introduced to some advanced numerical concepts and algorithms such as eigenvalue problems and approximation theory.

Subject Topics

1. Errors
2. Solutions of equations in one variable
3. Interpolation and polynomial approximation
4. Numerical differentiation and integration
5. Initial value and boundary problems for ODE
6. Direct methods for solving linear systems
7. Iterative Techniques
8. Eigenvalue problems
9. Approximation Theory

Subject Learning Outcomes (SLOs)

On completion of this subject, students should be able to:

1. Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.

2. Apply numerical methods to obtain approximate solutions to mathematical problems.
3. Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
4. Analyze and evaluate the accuracy of common numerical methods applied to different mechanical design and applications.
5. Implement numerical methods in Matlab or another other related software. Write efficient, well-documented code and present numerical results in an informative way. Learn the basic terminologies and definitions used in the development of concepts, theorems and techniques.
6. Work together with effective communication, professionalism and ethical responsibility in laboratories.

Assessment Tasks and Weightings

To obtain a pass grade in this Subject at least 50% overall must be achieved, and at least 40% achieved in the final examination.

Students must also refer to the Subject Assessment Details.

Assessment 1 - Assignment: The assignments are intended to support students achieving the learning outcomes for the subject and will contribute 20% towards the final grade for the subject.

Assessment 2 – Class Test: The Test contributes 30% towards the final grade for the subject and evaluates progress towards achievement of learning outcomes.

Assessment 3 – Final Exam: The individual components of final examination enable final evaluation of achievement of learning outcomes and contribute 40% towards the final grade for the subject.

Assessment 4 – Lab/Project Report: A team based or individual component report outlining individual or team formation. Team based report outlining formation and member roles, project selection, team and member action plan and a schedule of future activities to achieve the outcome. The report contributes 10% towards the final grade for the subject.

It is important that all students familiarise themselves with the University of Technology Assessment Guidelines including those on plagiarism in the Academic Integrity Policy at:

http://asix.unitech.ac.pg/apps/pnguot/?q=unitech/policies

Subject Mapping

Subject Learning Outcomes (SLO) are mapped to each of the PNG National Qualifications Framework (NQF), Course Learning Outcomes (CLO), Unitech Graduate Attributes (GA), Assessment Tasks (AT) and Engineers Australia (EA) Stage 1 Competencies.

SLO	SLO to NQF	SLO to CLO	SLO to GA	SLO to AT	SLO to EA Stage 1 Competencies
1	8 - knowledge	1	1,3	1,2,3	1.1
2	8 - knowledge, skills	1, 2	1,2,3	1,2,3	1.1, 1.2, 1.3
3	8 - Applications, Knowledge and skills	5	2,6	1,2,3	2.1, 2.2
4	8 - Applications, Knowledge and skills	3, 4, 5, 6	2, 6	1,2,3	2.1, 2.2, 2.3
5	8 - Applications, Knowledge and skills	4, 5, 6	2, 6	4	1.5, 2.1, 2.2, 2.3
6	8 - Applications, Knowledge and skills	7,8	3, 5	4	3.1, 3.2, 3.4, 3.5, 3.6

Engineers Australia Stage 1 Competencies

1. KNOWLEDGE AND SKILL BASE	2.ENGINEERING APPLICATION ABILITY	3. PROFESSIONAL AND PERSONAL ATTRIBUTES
1.1 Comprehensive, theory-based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline.	2.1 Application of established engineering methods to complex engineering problem solving.	3.1 Ethical conduct and professional accountability.
1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline.	2.2 Fluent application of engineering techniques, tools and resources.	3.2 Effective oral and written communication in professional and lay domains.
1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline.	2.3 Application of systematic engineering synthesis and design processes.	3.3 Creative, innovative and pro-active demeanour.
1.4 Discernment of knowledge development and research directions within the engineering discipline.	2.4 Application of systematic approaches to the conduct and management of engineering projects.	3.4 Professional use and management of information.
1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline.		3.5 Orderly management of self, and professional conduct.
1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering		3.6 Effective team membership and team leadership.

practice in the specific discipline		

Graduate Statement

The mechanical engineering graduate will have the skills and ability to systematically apply the engineering knowledge in an ethical and morally responsible manner in providing practical and sustainable solutions to engineering problems while upholding a level of sensitivity to social, cultural, legal and environmental issues in society.

Mechanical Engineering Course Learning Outcomes

The following table is included to demonstrate to mechanical engineering students that their Course Learning Outcomes address all EA Stage 1 Competencies.

The mapping matrix for all subject learning outcomes within the Course, against EA Stage 1 Competencies, provides more detailed information. That matrix is provided separately to students.

Course Learning Outcome	Engineers Australia Stage 1 Competencies
1. Possession of a deep understanding of the sciences, math, information systems and engineering fundamentals that underpin the mechanical engineering discipline.	1.1, 1.2
2. An in-depth understanding of the body of knowledge that forms the mechanical engineering discipline.	1.2, 1.3
3. Collection, synthesis and application of information within the mechanical and related engineering disciplines.	1.4, 1.5, 2.1, 2.3, 2.4, 3.4
4. Undertaking research, analysis & evaluation of ideas and concepts within mechanical engineering.	1.3, 1.4, 1.6, 2.1, 2.3, 2.4, 3.2, 3.4
5. Applying problem solving skills to complex mechanical engineering systems and processes.	1.1, 1.2, 1.3, 1.4, 1.5, 2.1, 2.2, 2.3
6. Undertake mechanical engineering design and manage engineering projects.	1.6, 2.2, 2.4, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6
7. Communication via multiple media to diverse audiences, undertaking team roles, teamwork and providing team leadership.	2.4, 3.2, 3.3, 3.4, 3.5, 3.6
8. Behaving in an ethical and professional manner and respecting others.	1.6, 2.4, 3.1, 3.4, 3.5, 3.6
9. Being cognisant of the importance of sustainability and the environmental impact of engineering.	1.5, 1.6, 3.1, 3.3, 3.4

Unitech Graduate Attribute

Attribute	Academic dimension	Personal Dimension	Transferable Dimension
1. Lifelong learner	Sustained intellectual curiosity and use of feedback to reflect on their own work.	Sets aspirational goals for personal improvement and career growth.	Takes responsibility for one's learning and development.
2. Critical thinker	Uses rules of inference to analyse complex issues and find solutions.	Calmly uses logic and critical thinking, and not emotion, in all situations.	Ability to find solutions to problems by using logical and imaginative thinking.
3. Effective communicator	Ability to discuss and debate issues articulately and confidently and convincingly.	Character of producing high quality written essays and oral presentations.	Ability to communicate and negotiate with others and to listen to them.
4. Cultural modernist	Familiarity with international standards and world cultures and human rights.	Tolerance of the religions and cultures of others.	Ability to work in a multicultural setting and comprehension and tolerance of religious and cultural differences.
5. Moral uprightness	Understand and act upon the ethical responsibilities of their actions.	Character of acting in a morally upright way in all situations.	Professional behaviour at all times.
6. Technologically savvy	Familiarity and use of technologies appropriately.	Keeping up to date with innovations.	Character of accepting new technology and quickly adapting to it.

Student Workload

The total workload for the subject for the 'average' student is a nominal 150 hours, based on a 15 week semester with 13 weeks of teaching as per the PNG National Qualification Framework.

Subject Textbook

Richard L. Burden and J. Douglas Faires, Numerical analysis, 9th Ed., Brooks/Cole Cengage Learning, Boston, 2010

References

Steven C. Chapra and Raymond P. Canale, Numerical methods for engineers, 6th Ed., McGraw-Hill Education, New York, 2009.

Readings

Recommended Books and Reference Material

F.B. Hilderbrand, Introduction to Numerical analysis, 2nd Ed., Dover Publications, 1987.

YouTube Clips

The following youtube clips should help augment your weekly lectures.

Solutions of equations in one variable at:

https://www.youtube.com/watch?v=glaCLvm9mxY

Interpolation and polynomial approximation at:

https://www.youtube.com/watch?v=74g5_3TC-tQ

Numerical differentiation and integration at:

https://www.youtube.com/watch?v=mpkfYmnCZJw

Relevant Unitech Policies

It is important that all students familiarise themselves with the PNGUOT Assessment Guidelines including those on plagiarism and other relevant policies. These policies are viewed by visiting the PNGUOT website:

http://asix.unitech.ac.pg/apps/pnguot/?q=unitech/policies