STELLENBOSCH UNIVERSITY

FACULTY of ENGINEERING

NUMERICAL METHODS 262
STUDY GUIDE 2019

1. MODULE DETAILS

MODULE CODE **36323**	MODULE **NUMERICAL METHODS 262**				SU CREDITS **8**	
SEMESTER **2**	LECTURE LOAD PER WEEK : **2*l*, 0p, 1t, 0s week**		HOME DEPARTEMENT **Mathematical Sciences (Applied Mathematics)**			
LECTURERS **Prof N Hale** **Ms M Steyn**			OFFICE **A410** **A219**		PHONE **808-4944** **888-2634**	
CLASSIFICATION	Mathe-matics 60%	Basic science 0%	Engineer-ing scienc 0%	Design & Synthesis 0%	Computa-tion and IT 40%	Comple-mentary studies 0%
PREREQUISITE MODULES	PASS (P≥50) **None**		GENERAL (P≥40) **Eng. Mathematics 214**		SECONDARY **None**	
ASSESSMENT-DETAILS See Year Book Parts I and II	METHOD **Flexible Assessment**		SEMESTER MARK **Assignments: 10%**		FINAL MARK FORMULA **0.1 SM+0.4 A1+0.5A2**	

2. SPECIFIC OUTCOMES and ASSESSMENT CRITERIA

CAPACITIES (Objectives of the Module)
The student who has successfully completed this module can: • Solve nonlinear scalar equations with a variety of methods (bisection, Regula-Falsi, Newton, secant). Also nonlinear systems of equations with Newton's method. • Solve linear systems of equations numerically, as well as the matrix eigenvalue problem. • Interpolate data using polynomials and splines, as well as least squares data fitting. • Integrate functions numerically, with methods such as the Trapezium- and Simpson-rules and Gaussian quadrature. • Solve first order ordinary differential equations (ODEs) with the Euler- and Runge-Kutta methods. Also higher order ODEs and systems. • Solve simple partial differential equations (PDEs). • Use MATLAB® to handle the above and represent solutions graphically where appropriate.

<table>
<tr><th>ACTIVITY</th><th>ASSESSMENT CRITERIA</th><th>SCOPE</th></tr>
<tr><td>Use Matlab to:
(a) exectute vector- and matrix computations.
(b) plot 2D and 3D graphs.</td><td rowspan="4">The following steps appear to a lesser or greater extent in all problems and are judged according to the level of complexity of the problem and the correct execution according to:
(a) Interpretation of the problem as stated.
(b) Deciding what the appropriate method is and applying it correctly.
(c) Defining appropriate variables and setting up appropriate equations.
(d) Numerical solution with either hand calculation or Matlab.</td><td>Appendix of the text book</td></tr>
<tr><td>Write a Matlab program (M-file) to solve a given problem.</td><td>Appendix of the text book</td></tr>
<tr><td>Compute the roots of a given scalar function using one or more of these methods (hand calculation or Matlab):
(a) bisection
(b) Regula-Falsi
(c) Newton
(d) secant</td><td>Chapter 3 of the text book (3rd edition)
Ch 2 (2nd edition)</td></tr>
<tr><td>Derive the Newton formula for the computation of roots. Ditto for secant and Regula-Falsi.</td><td>Chapter 3 of the text book (3rd edition)
Ch 2 (2nd edition)</td></tr>
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ACTIVITY	ASSESSMENT CRITERIA	SCOPE
Solve a given nonlinear system of equations using Newton`s method.	The following steps appear to a lesser or greater extent in all problems and are judged according to the level of complexity of the problem and the correct execution according to: (a) Interpretation of the problem as stated. (b) Deciding what the appropriate method is and applying it correctly. (c) Defining appropriate variables and setting up appropriate equations. (d) Numerical solution with either hand calculation or Matlab.	Chapter 3 of the text book (3rd edition) Ch 2 (2nd edition)
Use Matlab to solve a given system of linear equations, also in sparse format.		Chapter 4 of the text book (3rd edition) Ch 3 (2nd edition)
Use the built-in functions in Matlab to compute the LU factorisation of a matrix, and also use it to solve Ax = b.		Chapter 4 of the text book (3rd edition) Ch 3 (2nd edition)
Compute vector norms, matrix norms and condition numbers. Use the condition number to quantify the sensitivity of solutions of Ax = b with respect to perturbations in the data.		Chapter 4 of the text book (3rd edition) Ch 3 (2nd edition)
Derive the normal equations for a least squares fit.		Chapter 6 of the text book (3rd edition) Ch 4 (2nd edition)
Fit a given function to a given set of points in Matlab.		Chapter 6 of the text book (3rd edition) Ch 4 (2nd edition)
Fit a spline function to a set of data points in Matlab.		Chapter 6 of the text book (3rd edition) Ch 4 (2nd edition)
Use the Lagrange formula to compute the polynomial that interpolates a given set of data points.		Chapter 6 of the text book (3rd edition) Ch 4 (2nd edition)
Use the Lagrange formula to derive three-point difference formulas for the first and second derivatives.		Chapter 8 of the text book (3rd edition) Ch 5 (2nd edition)
Derivation of the basic and composite trapezium rules for the approximation of definite integrals. Ditto for the Simpson rule. Derivation of the two-point and three-point Gauss rules.		Chapter 9 of the text book (3rd edition) Ch 6 (2nd edition)

ACTIVITY	ASSESSMENT CRITERIA	SCOPE
Compute a definite integral numerically with hand calculations and/or Matlab with (a) the trapezium rule, and (b) Simpson's rule.	The following steps appear to a lesser or greater extent in all problems and are judged according to the level of complexity of the problem and the correct execution according to: (a) Interpretation of the problem as stated. (b) Deciding what the appropriate method is and applying it correctly. (c) Defining appropriate variables and setting up appropriate equations. (d) Numerical solution with either hand calculation or Matlab.	Chapter 9 of the text book (3rd edition) Ch 6 (2nd edition)
Use Gauss quadrature to approximate a definite integral. Transform the interval to [-1,1] if necessary.		Chapter 9 of the text book (3rd edition) Ch 6 (2nd edition)
Use the Euler / Modified Euler method to solve numerically a DE (initial value problem). Also systems of DEs.		Chapter 10 of the text book (3rd edition) Ch 7 (2nd edition)
Write a higher order DE as a system of first-order Des and then solve with Euler's method.		Chapter 10 of the text book (3rd edition) Ch 7 (2nd edition)
Solve a given system of ODEs with the aid of a suitable Matlab function.		Chapter 10 of the text book (3rd edition) Ch 7 (2nd edition)
Use the method of finite differences to discretize a two-point boundary value problem on an interval.		Chapter 11 of the text book (3rd edition) Ch 8 (2nd edition)
Use the finite difference method to discretize the Laplace equation with prescribed boundary conditions.		Section 16.1 in Zill & Wright, Advanced Engineering Mathematics