Appendix

Foundation Mathematics

Aim: To enable students to develop an adequate foundation upon which to build the additional mathematical skills required for successful actuarial practice.

1 FUNCTIONS AND SETS

1.1 Define a function and explain and apply functional concepts including: domain, codomain, image, limit, and inverse.
1.1 Determine asymptotes and turning points, and sketch a curve.
1.2 Explain basic set terminology and apply basic set concepts.
1.3 Define the supremum and infimum of a set of numbers.
1.4 Apply simple numerical techniques to calculate roots of equations and evaluate integrals.

2 DIFFERENTIATION

2.1 Define the derivative of a function as a limit and determine the derivative from first principles.
2.2 Apply the basic rules of differentiation (including the chain rule and implicit differentiation) to calculate first, higher-order, and partial derivatives.
2.3 State the derivatives for power, trigonometric, inverse trigonometric, exponential, logarithmic, hyperbolic, and inverse hyperbolic functions.
2.4 Determine the extreme points of a function of two variables, including using Lagrange multipliers for constrained problems.

3 INTEGRATION

3.1 Evaluate definite and indefinite integrals, using basic techniques including substitution and integration by parts.
3.2 Evaluate double and triple integrals and calculate areas and volumes of simple geometric shapes.
3.3 Interchange the order of integration of multiple integrals and change variables to evaluate multiple integrals.
3.4 Apply simple numerical integration techniques such as the trapezium rule and Simpson's rule.

4 SEQUENCES AND SERIES

4.1 State the Taylor and Maclaurin expansions for functions of one and two variables.
4.2 Define sequence and series and explain the concepts of boundedness, convergence, limit, and monotonicity.
4.3 Use the formulae for the sums of arithmetic and geometric progressions.
4.4 Use appropriate techniques to determine convergence or boundedness sequences and series in simple cases.

5 DIFFERENTIAL EQUATIONS

5.1 Solve first-order differential equations which are separable, linear or homogeneous.

5.2 Solve simple first-order differential equation models for various applications with given conditions and use the solution to find the values of any parameters involved.

6 REAL AND COMPLEX NUMBERS

6.1 Carry out arithmetic with complex numbers.

7 MATRICES AND SYSTEMS OF LINEAR EQUATIONS

7.1 Carry out simple operations with matrices (addition, scalar multiplication, matrix multiplication, transposition).

7.2 Calculate the determinant of a matrix and use Cramer's rule to solve a system of linear equations.

7.3 Use Gaussian elimination to find the rank of a matrix, to invert a matrix, and to solve systems of linear equations.

7.4 Compute the characteristic polynomial of a matrix and determine its eigenvalues and eigenvectors.

7.5 Determine whether a given matrix is diagonalizable and, if so, find a diagonalizing matrix.

8 VECTORS, VECTOR SPACES AND INNER PRODUCT SPACES

8.1 Carry out simple operations with vectors (addition, scalar product, vector product, scalar triple product).

8.2 Explain the concepts of vector space, inner product space, orthogonality.

9 PROBABILITY

9.1 Explain what is meant by a set function, a sample space for an experiment, and an event.

9.2 Define probability as a set function on a collection of events, stating basic axioms.

9.3 Derive basic properties satisfied by the probability of occurrence of an event, and calculate probabilities of events in simple situations.

9.4 Derive the addition rule for the probability of the union of two events, and use the rule to calculate probabilities.

9.5 Define the conditional probability of one event given the occurrence of another event, and calculate such probabilities.

9.6 Derive Bayes' Theorem for events, and use the result to calculate probabilities.

9.7 Define correlation and independence for two events, and calculate probabilities in situations involving independence.