Subject code: 620-154

Subject name: Calculus 1

Credit points: 12.5

Coordinator: Karen Baker

Semesters of offer: 1, repeat 2

Prerequisites: Study score of ≥ 25 in VCE Mathematical Methods 3/4 or equivalent, or 620-173 Introduction to Mathematics.

Mode of delivery: Lectures and tutorials

Contact hours: 36 one-hour lectures (three per week), 12 one-hour tutorials (one per week)

Estimated total time commitment: 120 hours

Description: This subject extends students' knowledge of functions and calculus and introduces them to the topics of vectors and complex numbers. Students will be introduced to new functions such as the inverse trigonometric functions and learn how to extend the techniques of differentiation to these. Integration techniques will be applied to solving first order differential equations.
Differential calculus: graphs of functions of one variable, trigonometric functions and their inverses, derivatives of inverse trigonometric functions, implicit differentiation, related rates. Integral calculus: integration by trigonometric and algebraic substitutions and partial fractions with application to areas and volumes. Ordinary differential equations: slope fields, solution of simple first order differential equations arising from applications such as population modelling. Vectors: dot product, scalar and vector projections, plane curves specified by vector equations. Complex numbers: arithmetic of complex numbers, sketching regions in the complex plane, De Moivre's Theorem, roots of polynomials, the Fundamental Theorem of Algebra.

Assessment: Up to 25 pages of written assignments 10% (due during semester), a 45-minute written test 10% (held mid-semester), a 3-hour written examination 80% (in the examination period).

Prescribed texts: not decided

Notes: Students with a score of 27 or more in Specialist Mathematics 3/4 will normally not be permitted to enrol in this subject; such students should enrol in one of 620-155, 620-156 or 620-157.
Students may only gain credit for one of [07]620-151, 620-154, [07]620-161.
Students who have completed [07]620-121, [07]620-140 or [07]620-141 may not enrol in this subject for credit.

Subject objectives: Students completing this subject will:

- be able to graphically represent and analyse key features of power, circular, inverse circular and reciprocal functions and relations representing circles, simple ellipses and hyperbolas;
- be able to manipulate simple trigonometric identities and compound and double angle formulas for sine, cosine and tangent;
- understand the arithmetic and algebra of vectors in two and three dimensions, linear independence, scalar product and application to vector projections and resolutes, plane curves specified parametrically by a vector equation and determination of corresponding cartesian equations;
- extend differentiation techniques to implicit differentiation, derivatives of inverse circular functions, second and higher order derivatives and be able to apply these to curve sketching and related rates problems;
- be able to evaluate integrals using algebraic and trigonometric substitutions, and simple partial fractions;
- be able to apply integration techniques to the calculation of volumes of solids of revolution and the solution of simple ordinary differential equations;
- understand the extension of the real numbers to the set of complex numbers and their algebra and arithmetic, including cartesian representation and polar form.

Generic skills: In addition to learning specific skills that will assist students in their future careers in science, they will have the opportunity to develop generic skills that will assist them in any future career path. These include

- problem-solving skills: the ability to engage with unfamiliar problems and identify relevant solution strategies;
- analytical skills: the ability to construct and express logical arguments and to work in abstract or general terms to increase the clarity and efficiency of analysis;
- collaborative skills: the ability to work in a team;
- time management skills: the ability to meet regular deadlines while balancing competing commitments.

Lecture-by-lecture outline:

Functions

1. Sketch graphs of circles, ellipses, hyperbolae (conic sections).

2. Revision of trigonometric functions. Reciprocal circular functions.

3. Trigonometric formulae: identities, compound and double angle formulae.

---

4. Inverse circular functions and their graphs.

Vectors

5. Introduction to vectors, definitions. Addition, scalar multiplication.

6. Coordinates, position vectors. Length of vectors. Unit vectors.

---

7. Angle between vectors. Dot product.

8. Scalar and vector projections. Vector resolutes.

9. Equation of a straight line in vector, parametric and Cartesian form.

---

10. Parametric curves specified by vector equations.

Differential Calculus

11. Inverse trigonometric functions, derivatives, graphs

12. Implicit differentiation.

---

13. Related rates.

14. Second and higher order derivatives.

15. Graph sketching, including increasing/decreasing functions, concavity, points of inflection.

---

16. Graphs of rational functions, asymptotic behaviour

17. Applications of differentiation: max/min problems

18. GOOD FRIDAY/EASTER BREAK (nominal position)

Integral Calculus

19. Antidifferentiation of $\frac{1}{x}$. Integration by 'derivative present' substitution (i.e. $f(g(x))g'(x)$).

20. MID-SEMESTER TEST (nominal position)

21. Integration using trigonometric substitutions.

---

22. ANZAC DAY (nominal position)

23. Using trigonometric formulae in antidifferentiation.

24. Partial fractions and antidifferentiation.

---

25. Definite integrals and areas.

26. Volumes of solids of revolution using discs/washers.

Differential Equations

27. Slope fields.

---

28. Verification of solutions.

29. Solution of 'simple' separable ODEs.

30. Applications (simple modelling such as population models).

Complex Numbers

31. Cartesian representation. Argand diagrams. Complex conjugates.

32. Addition, subtraction, multiplication, division.

33. Modulus, argument, trigonometric polar form.

---

34. Sketching regions in the complex plane (lines, circles, etc.)

35. Complex exponential (definition). De Moivre's theorem.

36. Roots of polynomials. Fundamental Theorem of Algebra.

Notes: If Anzac Day does not fall on a lecture day a final revision lecture will be included.
