



Module Descriptor

Title	Asymptotic and Perturbation Methods		
Session	2025/26	Status	
Code	MATH09015	SCQF Level	9
Credit Points	20	ECTS (European Credit Transfer Scheme)	10
School	Computing, Engineering and Physical Sciences		
Module Co-ordinator	Ryan P. Meeten		
Summary of Module			
This module introduces analytic approximation techniques for problems that cannot be solved exactly. The module is well-suited for mathematically inclined advanced undergraduate students at Levels 9 or 10 who are studying mathematics, physics or engineering. Most problems in applied mathematics are not amenable to closed-form solutions. When faced with problems of this nature, one approach is to use numerical techniques. While numerical methods can provide approximate solutions, they often offer limited insight into the underlying structure of the solution and must be repeated when parameters change. Moreover, some problems are stiff or otherwise resistant to numerical treatment. An alternative and complementary approach is to use asymptotic analysis and perturbation theory techniques. These methods transform a "hard problem" into a sequence of "easier problems", producing approximations that reveal the essential features of the solution. Topics include the asymptotic expansion of integrals that commonly arise in applications, approximate solutions of algebraic and transcendental equations, regular and singular perturbation methods, local approximation and matching techniques, method of multiple scales, WKB, the acceleration of slowly convergent series, and methods for obtaining periodic solutions of nonlinear oscillatory solutions. At each stage, the theory will be developed through motivating examples drawn from applied mathematics, illustrating how asymptotic methods provide both practical approximations and qualitative insight. Use will be made of a computer algebra system (Maple or Maxima) to explore the techniques. At each stage, a motivating example will be considered and used to develop and understand the techniques. The Graduate Attributes relevant to this module are given below: • Academic: Critical thinker; Analytical; Inquiring; Knowledgeable; Problem-solver; Autonomous. • Personal: Motivated; Resilient • Professional: Ambitious; Driven.			

Module Delivery Method	On-Campus¹ ☒	Hybrid² ☐	Online³ ☐	Work -Based Learning⁴ ☐
Campuses for Module Delivery	☐ Ayr ☐ Dumfries	☐ Lanarkshire ☐ London ☒ Paisley	☐ Online / Distance Learning ☐ Other (specify)	
Terms for Module Delivery	Term 1 ☐	Term 2 ☒	Term 3 ☐	
Long-thin Delivery over more than one Term	Term 1 – Term 2 ☐	Term 2 – Term 3 ☐	Term 3 – Term 1 ☐	

Learning Outcomes	
L1	Understand and explain the need for asymptotic and numerical methods, including their advantages and limitations compared with numerical or exact analytical approaches.
L2	Construct and analyse regular perturbation expansions.
L3	Apply appropriate techniques to approximate the solutions to differential equations.
L4	Apply appropriate techniques to evaluate integrals asymptotically.
L5	Use a computer algebra system to implement and visualise the approximation methods.

Employability Skills and Personal Development Planning (PDP) Skills	
SCQF Headings	During completion of this module, there will be an opportunity to achieve core skills in:
Knowledge and Understanding (K and U)	SCQF 9 Approximating solutions of difficult problems that are not amenable to exact solution. Understanding which techniques are relevant for a given type of problem.
Practice: Applied Knowledge and Understanding	SCQF 9 Using a range of standard techniques to solve problems at an advanced level, sometimes in non-routine contexts. Carrying out defined investigative problems within a mathematically based subject.

¹ Where contact hours are synchronous/ live and take place fully on campus. Campus-based learning is focused on providing an interactive learning experience supported by a range of digitally-enabled asynchronous learning opportunities including learning materials, resources, and opportunities provided via the virtual learning environment. On-campus contact hours will be clearly articulated to students.

² The module includes a combination of synchronous/ live on-campus and online learning events. These will be supported by a range of digitally-enabled asynchronous learning opportunities including learning materials, resources, and opportunities provided via the virtual learning environment. On-campus and online contact hours will be clearly articulated to students.

³ Where all learning is solely delivered by web-based or internet-based technologies and the participants can engage in all learning activities through these means. All required contact hours will be clearly articulated to students.

⁴ Learning activities where the main location for the learning experience is in the workplace. All required contact hours, whether online or on campus, will be clearly articulated to students

Generic Cognitive skills	SCQF 9 Conceptualising and analysing problems informed by professional and research issues. Developing core mathematical skills, balancing intuition with rigour.
Communication, ICT and Numeracy Skills	SCQF 9 Using a computer algebra system to perform calculations related to asymptotic and perturbative analysis.
Autonomy, Accountability and Working with Others	SCQF 9 Exercising independence and initiative in carrying out a range of activities. Identifying learning needs through reflection based on self and tutor evaluation of work.

Prerequisites	Module Code MATH08008 MATH08002	Module Title Multivariable Calculus Differential Equations 1
	Other Or equivalent	
Co-requisites	Module Code	Module Title

Learning and Teaching	
In line with current learning and teaching principles, a 20-credit module includes 200 learning hours, normally including a minimum of 36 contact hours and maximum of 48 contact hours.	
Learning Activities During completion of this module, the learning activities undertaken to achieve the module learning outcomes are stated below:	Student Learning Hours (Note: Learning hours include both contact hours and hours spent on other learning activities)
Lecture / Core Content Delivery	24
Tutorial / Synchronous Support Activity	12
Laboratory / Practical Demonstration / Workshop	12
Independent Study	152
n/a	
n/a	
TOTAL	200

Indicative Resources
The following materials form essential underpinning for the module content and ultimately for the learning outcomes: “Advanced Mathematical Methods for Scientists and Engineers 1: Asymptotic Methods and Perturbation Theory”, Bender, C.M and Orszag, S.A., 1999, New York: Springer

(N.B. Although reading lists should include current publications, students are advised (particularly for material marked with an asterisk*) to wait until the start of session for confirmation of the most up-to-date material)

Attendance and Engagement Requirements

In line with the [Student Attendance and Engagement Procedure](#), Students are academically engaged if they are regularly attending and participating in timetabled on-campus and online teaching sessions, asynchronous online learning activities, course-related learning resources, and complete assessments and submit these on time.

For the purposes of this module, academic engagement equates to the following:

The School of Computing, Engineering and Physical Sciences considers attendance and engagement to mean a commitment to attending, and engaging in, timetabled sessions. You will scan your attendance via the scanners each time you are on-campus and you will log in to the VLE several times per week. Where you are unable to attend a timetabled learning session due to illness or other circumstance, you should notify that Programme Leader that you cannot attend. Across the School an 80% attendance threshold is set. If you fall below this, you will be referred to the Student Success Team to see how we can best support your studies.

Equality and Diversity

The University's Equality, Diversity and Human Rights Procedure can be accessed at the following link: [UWS Equality, Diversity and Human Rights Code](#).

Aligned with the University's commitment to equality and diversity, this module supports equality of opportunity for students from all backgrounds and learning needs. Using the VLE, material will be presented electronically in formats that allow flexible access and manipulation of content. This module complies with University regulations and guidance on inclusive learning and teaching practice. This module has lab-based teaching and as such you are advised to speak to the Module Co-ordinator to ensure that specialist assistive equipment, support provision and adjustment to assessment practice can be put in place, in accordance with the University's policies and regulations.

(N.B. Every effort will be made by the University to accommodate any equality and diversity issues brought to the attention of the School)

Supplemental Information

Divisional Programme Board	Engineering Physical Sciences
Overall Assessment Results	☐ Pass / Fail ☒ Graded
Module Eligible for Compensation	☒ Yes ☐ No If this module is eligible for compensation, there may be cases where compensation is not permitted due to programme accreditation requirements. Please check the associated programme specification for details.
School Assessment Board	Physical Sciences
Moderator	K. Nisbet
External Examiner	C. Guiver
Accreditation Details	
Module Appears in CPD catalogue	☐ Yes ☒ No

Changes / Version Number	1.00 New module
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Assessment (also refer to Assessment Outcomes Grids below)
Assessment 1
Class Test (Unseen, closed book) (70%)
Assessment 2
A series of coursework assignments (30%)
Assessment 3
(N.B. (i) Assessment Outcomes Grids for the module (one for each component) can be found below which clearly demonstrate how the learning outcomes of the module will be assessed. (ii) An indicative schedule listing approximate times within the academic calendar when assessment is likely to feature will be provided within the Student Module Handbook.)

Component 1							
Assessment Type	LO1	LO2	LO3	LO4	LO5	Weighting of Assessment Element (%)	Timetabled Contact Hours
Class Test (unseen, closed book)	☒	☒	☒	☒	☐	70	2

Component 2							
Assessment Type	LO1	LO2	LO3	LO4	LO5	Weighting of Assessment Element (%)	Timetabled Contact Hours
Coursework	☒	☒	☒	☒	☒	30	0

Component 3							
Assessment Type	LO1	LO2	LO3	LO4	LO5	Weighting of Assessment Element (%)	Timetabled Contact Hours
	☐	☐	☐	☐	☐		
Combined total for all components						100%	2 hours

Change Control

What	When	Who
Created module descriptor	October 2025	R. Meeten

