MODULE TITLE	**Real Analysis**	**CREDIT VALUE**	**15**
MODULE CODE	**MTH2008**	**MODULE CONVENER**	**Dr Julian Newman (Coordinator)**

DURATION: TERM	**1**	**2**	**3**
DURATION: WEEKS	**11**	**0**	**0**

Number of Students Taking Module (anticipated)	**260**

DESCRIPTION - summary of the module content

Infinite processes appear naturally in many contexts, from science and engineering to economics. From solving the equation that finds the wave function of a quantum system in physics, processing sensor data in engineering, to calculating prices for options in economics, at the foundation of all of these are infinite processes and the pure mathematics developed to rigorously and correctly handle these processes. That field of pure mathematics is called analysis, and the central object of study in analysis is the limit which further extends to the notions of convergence, continuity, differentiation, and integrability.

In this module, you will be introduced to the pioneering work of Cauchy, Riemann and many other notable mathematicians. By building on material from the first year, we will carefully and rigorously develop notions first in the context of real variables. In particular, we will develop how to rigorously handle real-variable differentiation, Riemann integration, power series, and basic notions of point set topology.

The material in this module is a prerequisite for the study of Complex Analysis (MTH2009), Topology and Metric Spaces (MTH3040), Integral Equations (MTH3042), Fractal Geometry (MTHM004), Functional Analysis (MTHM001), and Advanced Probability (MTHM042). It is recommended for those studying Dynamical Systems and Chaos (MTHM018), and is the basis for applications in economics, science, and engineering.

Pre-requisite modules: MTH1001; MTH1002 (or equivalent)

AIMS - intentions of the module

Analysis is the theory that underpins all continuous mathematics. The objective of this module is to provide you with a logically based introduction to real analysis. The primary objective is to define all the basic concepts clearly and to develop them sufficiently to provide proofs of useful theorems. This enables you to see the reason for studying analysis, and develops the subject to a stage where you can use it in a wide range of applications.

INTENDED LEARNING OUTCOMES (ILOs) (see assessment section below for how ILOs will be assessed)

On successful completion of this module, ***you should be able to:***

Module Specific Skills and Knowledge:
1 state and prove key theorems in real analysis using a rigorous approach;
2 develop proofs related to topological concepts such as limits and connectedness;
3 understand the basis of integration of functions of a real variable.

Discipline Specific Skills and Knowledge:
4 apply fundamental mathematical concepts, manipulations and results in analysis;
5 formulate rigorous arguments as part of your mathematical development;

Personal and Key Transferable/ Employment Skills and Knowledge:
6 think analytically and use logical argument and deduction;
7 communicate your ideas effectively in writing and verbally;

8 manage your time and resources effectively.

SYLLABUS PLAN - summary of the structure and academic content of the module

- Topology on R; Bolzano-Weierstrass theorem

- Epsilon-delta function limits; continuity; differentiability in R

- Function classes: C^k, C^infinity etc; Lipschitz continuity
- Review of epsilon-N sequence limits, Cauchy sequences; series of real numbers, sequences and series of functions;

- Formal theory of Riemann integration; integrability of monotonic functions and continuous functions; problems interchanging limits in general
- Continuity and differentiability in R^n, inverse and implicit function theorems.

LEARNING AND TEACHING

LEARNING ACTIVITIES AND TEACHING METHODS (given in hours of study time)

Scheduled Learning & Teaching Activities	38.00	**Guided Independent Study**	112.00	**Placement / Study Abroad**	0.00

DETAILS OF LEARNING ACTIVITIES AND TEACHING METHODS

Category	Hours of study time	Description
Scheduled Learning and Teaching Activities	33	Lectures including example classes
Scheduled Learning and Teaching Activities	5	Tutorials
Guided Independent Study	112	Lecture and assessment preparation; wider reading

ASSESSMENT

FORMATIVE ASSESSMENT - for feedback and development purposes; does not count towards module grade

Form of Assessment	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method

Exercise sheets	5 x 10 hours	All	Discussion at tutorials; tutor feedback on submitted answers

SUMMATIVE ASSESSMENT (% of credit)

Coursework	10	**Written Exams**	90	**Practical Exams**	0

DETAILS OF SUMMATIVE ASSESSMENT

Form of Assessment	% of Credit	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method
Written Exam – closed book	90%	2 hours (January)	All	Written/verbal on request, SRS
Coursework exercises 1	5%	15 hours	All	Annotated script and written/verbal feedback
Coursework exercises 2	5%	15 hours	All	Annotated script and written/verbal feedback

DETAILS OF RE-ASSESSMENT (where required by referral or deferral)

Original Form of Assessment	Form of Re-assessment	ILOs Re-assessed	Time Scale for Re-reassessment
Written Exam *	Written Exam (2hr) (90%)	All	August Ref/Def Period
Coursework exercises 1 *	Coursework exercises 1 (5%)	All	August Ref/Def Period
Coursework exercises 2 *	Coursework exercises 2 (5%)	All	August Ref/Def Period

* Please refer to reassessment notes for details on deferral vs. referral reassessment

RE-ASSESSMENT NOTES

Deferrals: Reassessment will be by coursework and/or exam in the deferred element only. For deferred candidates, the module mark will be uncapped.
Referrals: Reassessment will be by a single written exam worth 100% of the module only. As it is a referral, the mark will be capped at 40%

RESOURCES

INDICATIVE LEARNING RESOURCES - The following list is offered as an indication of the type & level of information that you are expected to consult. Further guidance will be provided by the Module Convener

Web based and Electronic Resources:
ELE: http://vle.exeter.ac.uk

William F. Trench, Introduction to Real Analysis, freely downloadable here: https://digitalcommons.trinity.edu/mono/7/

Reading list for this module:

Type	Author	Title	Edition	Publisher	Year	ISBN	Search
Set	DuChateau, P.C.	Advanced Calculus		Harper Collins	1992	000-0-064-67139-9	[Library]
Set	McGregor, C., Nimmo, J. & Stothers, W.	Fundamentals of University Mathematics	2nd	Horwood, Chichester	2000	000-1-898-56310-1	[Library]
Set	Gaughan, E.	Introduction to Analysis	5th	Thompson	1998	000-0-534-35177-8	[Library]
Set	Burn, R.P.	Numbers and Functions: Steps to Analysis	Electronic	Cambridge University Press	2005	000-0-521-41086-X	[Library]
Set	Bryant, V.	Yet Another Introduction to Analysis		Cambridge University Press	1990	978-0521388351	[Library]
Set	Abbott, Stephen	Understanding Analysis	2nd	Springer, New York	2015		[Library]
Set	Krantz, Steven G.	Real Analysis and Foundations	4th	CRC Press, Boca Raton, FL	2017		[Library]
Set	Rudin, R.	Principles of Mathematical Analysis	3rd	McGraw-Hill Book Co.	1976		[Library]

CREDIT VALUE	15	**ECTS VALUE**	7.5
PRE-REQUISITE MODULES	MTH1001, MTH1002		
CO-REQUISITE MODULES			
NQF LEVEL (FHEQ)	5	**AVAILABLE AS DISTANCE LEARNING**	No
ORIGIN DATE	Wednesday 26 February 2020	**LAST REVISION DATE**	Wednesday 28 June 2023
KEY WORDS SEARCH	Analysis; supremum; infimum; series; functions; limits; continuity; differentiability; integrability;		