

Module code

SPM-3417

Type of module

Undergraduate: Mathematical Sciences – Elective

Advanced Probability



Modular credits

4

Total student
engagement

56 hours

Prerequisite

**SPM-2203
(Probability and
Statistics)**

Anti-requisite

None

Aims

To develop students' ability to analyse and apply measure-theoretic probability, convergence theory, and advanced probabilistic methods to construct rigorous mathematical arguments and solve advanced probability problems.

Module learning outcomes (MLO)

On successful completion of this module, a student will be expected to be able to:

MLO 1

Compute and apply moment generating functions and characteristic functions to derive moments and establish convergence in distribution.

MLO 2

Verify and distinguish different modes of convergence for sequences of random variables, including almost sure, in probability, in L_p , and in distribution.

MLO 3

Formulate and prove statements in measure theory and probability, using key results such as the monotone class theorem and Carathéodory extension theorem.

MLO 4

Apply and justify convergence theorems (Fatou's lemma, monotone convergence, dominated convergence) in the context of Lebesgue integration.

MLO 5

Synthesise concepts from probability and measure theory to evaluate and construct rigorous proofs of advanced probabilistic results.

Module contents

Transformations and characteristic functions:
Random variable transformations; characteristic and moment generating functions

Sequences of random variables:
Convergence modes (a.s., in probability, L_1 , L_2 , L_p , in distribution); Borel–Cantelli lemma; continuity theorem

Asymptotics of i.i.d. sequences:
Laws of large numbers (weak and strong); central limit theorem; law of iterated logarithm

Measure and probability: Fields, σ -fields, monotone class theorem; measures on σ -fields; Carathéodory extension; Borel sets; Lebesgue measure; measurable functions; abstract measure spaces

Lebesgue integration: Abstract integration with respect to Lebesgue measure; Riemann vs. Lebesgue integrability; Fatou's lemma, monotone convergence theorem, dominated convergence theorem

Assessment

60% **40%**

Examination

Coursework

Examination
60%

Class tests
40%

■ Examination — 60% ■ Class tests — 40%

Formative assessment

Weekly discussion and feedback

Summative assessment

COMPONENT		WEIGHTING
Examination		60%
Coursework		40%
Individual		40%
Class tests		40%

Graduate attributes and skills

Programme learning objectives (PLO) addressed

1	PLO 1 (Core Mathematical Knowledge)	2	PLO 2 (Analytical Problem-Solving)
3	PLO 3 (Computational and Digital Tools)	4	PLO 4 (Mathematical Communication)

Sustainability concept addressed

4	SDG 4 Quality Education
8	SDG 8 Decent Work and Economic Growth
9	SDG 9 Industry, Innovation and Infrastructure

Digital skills/software used (not limited to)

- Statistical and Programming software (R)
- Visual and computational tools

Micro-credentialling option

No

Stackable towards GenBESTARI Undergraduate Degree Programme or other relevant Lifelong Learning Programmes

No

Document details

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