PH345-15 Computability Theory

23/24

Department
> Philosophy

Level
> Undergraduate Level 3

Module leader
> Walter Dean

Credit value
> 15

Module duration
> 10 weeks

Assessment
> 100% exam

Study location
> University of Warwick main campus, Coventry

Description

Introductory description

PH345-15 Computability Theory

Module aims

Computability theory is a subfield of contemporary logic which is also related to theoretical computer science and the foundations of mathematics. The goal of this module will be acquaint students with fundamental concepts and results in this field as illustrated by the following: models of computation (e.g. Turing machine, unlimited register machines, recursive functions), Church's Thesis, decidable versus undecidable problems, computable and computably enumerable sets, computational reductions (e.g. many-one and Turing reducibility), degree hierarchies, computational completeness, creative sets, Post's problem,

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

Week 1: Algorithms, and Unlimited Register Machines (URMs)
Week 2: Combining URMs, recursive functions
Week 3: Turing machines, Church's Thesis

Week 4: Enumerating machines, the s-m-n Theorem, universality
Week 5: Diagonalization, undecidable problems
Week 7: Recursive and recursively enumerable sets
Week 8: Reducibilities, degrees, completeness
Week 9: Completeness (cont.), the Recursion Theorem
Week 10: Complexity theory and the P versus NP problem

Learning outcomes

By the end of the module, students should be able to:

- state and understand basic definitions and results about machine models, computational problems, undecidability, degree notions, and completeness.
- follow and construct mathematical proofs involving computability theoretic notions and to explain their significance in regard to foundational issues like undecidability and Church's Thesis.

Indicative reading list

Computability: an introduction to recursive function theory by N. Cutland, Cambridge, 1980.
Computability theory by Barry Cooper, Chapman & Hall, 2000.
Introduction to the theory of computation by M. Sipser, Thomson, 2013.

Subject specific skills

students should have specific knowledge of the models of computation covered in the module, facility in constructing and manipulating their instances, and an ability to reason abstractly about their behaviour.

Transferable skills

apply and generalize from these notions in order to both concretely construct models of computation and to prove results about them.

Study

Study time

Type	Required
Lectures	9 sessions of 3 hours (18%)
Seminars	9 sessions of 1 hour (6%)
Private study	114 hours (76%)
Total	150 hours

Private study description

Private study and preparation for classes.

Costs

No further costs have been identified for this module.

Assessment

You do not need to pass all assessment components to pass the module.

Students can register for this module without taking any assessment.

Assessment group B

	Weighting	Study time
Take-home examination	100%	

Feedback on assessment

Discussion and feedback on unassessed exercises during seminar.

[Past exam papers for PH345](#)

Availability

Courses

This module is Core optional for:

- Year 3 of UMAA-GV19 Undergraduate Mathematics and Philosophy with Specialism in Logic and Foundations

This module is Optional for:

- UPHA-L1CA Undergraduate Economics, Psychology and Philosophy
  - Year 2 of L1CA Economics, Psychology and Philosophy
  - Year 2 of L1CC Economics, Psychology and Philosophy (Behavioural Economics Pathway)
  - Year 2 of L1CD Economics, Psychology and Philosophy (Economics with Philosophy Pathway)
  - Year 2 of L1CE Economics, Psychology and Philosophy (Philosophy and Psychology

Pathway)
- ◦ Year 3 of L1CA Economics, Psychology and Philosophy
- ◦ Year 3 of L1CC Economics, Psychology and Philosophy (Behavioural Economics Pathway)
- ◦ Year 3 of L1CD Economics, Psychology and Philosophy (Economics with Philosophy Pathway)
- ◦ Year 3 of L1CE Economics, Psychology and Philosophy (Philosophy and Psychology Pathway)
- UPHA-L1CB Undergraduate Economics, Psychology and Philosophy (with Intercalated Year)
  - ◦ Year 4 of L1CG Economics, Psychology and Philosophy (Behavioural Economics Pathway) (with Intercalated Year)
  - ◦ Year 4 of L1CH Economics, Psychology and Philosophy (Economics with Philosophy Pathway) (with Intercalated Year)
  - ◦ Year 4 of L1CJ Economics, Psychology and Philosophy (Philosophy and Psychology Pathway) (with Intercalated Year)
  - ◦ Year 4 of L1CB Economics, Psychology and Philosophy (with Intercalated Year)
  - ◦ Year 4 of L1CB Economics, Psychology and Philosophy (with Intercalated Year)
- Year 2 of UMAA-GV19 Undergraduate Mathematics and Philosophy with Specialism in Logic and Foundations
- UPHA-V700 Undergraduate Philosophy
  - ◦ Year 2 of V700 Philosophy
  - ◦ Year 2 of V700 Philosophy
  - ◦ Year 3 of V700 Philosophy
  - ◦ Year 3 of V700 Philosophy
- Year 4 of UPHA-V701 Undergraduate Philosophy (wiith Intercalated year)
- Year 4 of UPHA-V702 Undergraduate Philosophy (with Work Placement)
- UPHA-VQ72 Undergraduate Philosophy and Literature
  - ◦ Year 2 of VQ72 Philosophy and Literature
  - ◦ Year 3 of VQ72 Philosophy and Literature
- UPHA-V7ML Undergraduate Philosophy, Politics and Economics
  - ◦ Year 2 of V7ML Philosophy, Politics and Economics (Tripartite)
  - ◦ Year 2 of V7ML Philosophy, Politics and Economics (Tripartite)
  - ◦ Year 2 of V7ML Philosophy, Politics and Economics (Tripartite)
  - ◦ Year 3 of V7ML Philosophy, Politics and Economics (Tripartite)
  - ◦ Year 3 of V7ML Philosophy, Politics and Economics (Tripartite)
  - ◦ Year 3 of V7ML Philosophy, Politics and Economics (Tripartite)
- UPHA-V7MW Undergraduate Politics, Philosophy and Law
  - ◦ Year 2 of V7MW Politics, Philosophy and Law
  - ◦ Year 2 of V7MW Politics, Philosophy and Law
  - ◦ Year 3 of V7MW Politics, Philosophy and Law
  - ◦ Year 3 of V7MW Politics, Philosophy and Law
- Year 4 of UPHA-V7MX Undergraduate Politics, Philosophy and Law (with Intercalated Year)

This module is Unusual option for:

- UPHA-L1CA Undergraduate Economics, Psychology and Philosophy

- Year 2 of L1CA Economics, Psychology and Philosophy
- Year 2 of L1CC Economics, Psychology and Philosophy (Behavioural Economics Pathway)
- Year 3 of L1CA Economics, Psychology and Philosophy
- UPHA-V7ML Undergraduate Philosophy, Politics and Economics
  - Year 2 of V7MR Philosophy, Politics and Economics (Bipartite with Economics Major)
  - Year 2 of V7MP Philosophy, Politics and Economics (Bipartite)
  - Year 2 of V7MP Philosophy, Politics and Economics (Bipartite)
  - Year 2 of V7ML Philosophy, Politics and Economics (Tripartite)
  - Year 2 of V7ML Philosophy, Politics and Economics (Tripartite)
  - Year 2 of V7ML Philosophy, Politics and Economics (Tripartite)
  - Year 3 of V7MR Philosophy, Politics and Economics (Bipartite with Economics Major)
  - Year 3 of V7MP Philosophy, Politics and Economics (Bipartite)
  - Year 3 of V7MP Philosophy, Politics and Economics (Bipartite)
- UPHA-V7MM Undergraduate Philosophy, Politics and Economics (with Intercalated year)
  - Year 4 of V7MS Philosophy, Politics and Economics (Bipartite with Economics Major) (with Intercalated Year)
  - Year 4 of V7MS Philosophy, Politics and Economics (Bipartite with Economics Major) (with Intercalated Year)
  - Year 4 of V7MQ Philosophy, Politics and Economics (Bipartite) with Intercalated Year
  - Year 4 of V7MM Philosophy, Politics and Economics (Tripartite) (with Intercalated year)
- UPHA-V7MW Undergraduate Politics, Philosophy and Law
  - Year 2 of V7MW Politics, Philosophy and Law
  - Year 2 of V7MW Politics, Philosophy and Law
  - Year 3 of V7MW Politics, Philosophy and Law
  - Year 3 of V7MW Politics, Philosophy and Law
- Year 4 of UPHA-V7MX Undergraduate Politics, Philosophy and Law (with Intercalated Year)

This module is Core option list A for:

- UMAA-GV17 Undergraduate Mathematics and Philosophy
  - Year 3 of GV17 Mathematics and Philosophy
  - Year 3 of GV17 Mathematics and Philosophy
  - Year 3 of GV17 Mathematics and Philosophy
- Year 3 of UMAA-GV19 Undergraduate Mathematics and Philosophy with Specialism in Logic and Foundations

This module is Core option list B for:

- UMAA-GV17 Undergraduate Mathematics and Philosophy
  - Year 2 of GV17 Mathematics and Philosophy
  - Year 2 of GV17 Mathematics and Philosophy
  - Year 2 of GV17 Mathematics and Philosophy
- UMAA-GV19 Undergraduate Mathematics and Philosophy with Specialism in Logic and Foundations
  - Year 2 of GV19 Mathematics and Philosophy with Specialism in Logic and Foundations
  - Year 4 of GV19 Mathematics and Philosophy with Specialism in Logic and Foundations

This module is Core option list C for:

- Year 4 of UMAA-GV19 Undergraduate Mathematics and Philosophy with Specialism in Logic and Foundations

This module is Core option list F for:

- UMAA-GV18 Undergraduate Mathematics and Philosophy with Intercalated Year
  - Year 4 of GV18 Mathematics and Philosophy with Intercalated Year
  - Year 4 of GV18 Mathematics and Philosophy with Intercalated Year

This module is Option list A for:

- UPHA-VL78 BA in Philosophy with Psychology
  - Year 2 of VL78 Philosophy with Psychology
  - Year 3 of VL78 Philosophy with Psychology
- UMAA-GV17 Undergraduate Mathematics and Philosophy
  - Year 3 of GV17 Mathematics and Philosophy
  - Year 3 of GV17 Mathematics and Philosophy
  - Year 3 of GV17 Mathematics and Philosophy
- UMAA-GV19 Undergraduate Mathematics and Philosophy with Specialism in Logic and Foundations
  - Year 3 of GV19 Mathematics and Philosophy with Specialism in Logic and Foundations
  - Year 4 of GV19 Mathematics and Philosophy with Specialism in Logic and Foundations

This module is Option list B for:

- Year 1 of TMAA-G1PE Master of Advanced Study in Mathematical Sciences
- UMAA-GV17 Undergraduate Mathematics and Philosophy
  - Year 2 of GV17 Mathematics and Philosophy
  - Year 2 of GV17 Mathematics and Philosophy
  - Year 2 of GV17 Mathematics and Philosophy
- UMAA-GV18 Undergraduate Mathematics and Philosophy with Intercalated Year
  - Year 2 of GV18 Mathematics and Philosophy with Intercalated Year
  - Year 2 of GV18 Mathematics and Philosophy with Intercalated Year
- UPHA-VQ72 Undergraduate Philosophy and Literature
  - Year 2 of VQ72 Philosophy and Literature
  - Year 3 of VQ72 Philosophy and Literature
- Year 2 of UPHA-VQ52 Undergraduate Philosophy, Literature and Classics
- UPHA-V7ML Undergraduate Philosophy, Politics and Economics
  - Year 2 of V7MP Philosophy, Politics and Economics (Bipartite)
  - Year 2 of V7MP Philosophy, Politics and Economics (Bipartite)

This module is Option list C for:

- UPHA-V7ML Undergraduate Philosophy, Politics and Economics
  - Year 3 of V7MP Philosophy, Politics and Economics (Bipartite)
  - Year 3 of V7MP Philosophy, Politics and Economics (Bipartite)
  - Year 3 of V7ML Philosophy, Politics and Economics (Tripartite)

- Year 3 of V7ML Philosophy, Politics and Economics (Tripartite)
  - Year 3 of V7ML Philosophy, Politics and Economics (Tripartite)
- UPHA-V7MM Undergraduate Philosophy, Politics and Economics (with Intercalated year)
  - Year 4 of V7MS Philosophy, Politics and Economics (Bipartite with Economics Major) (with Intercalated Year)
  - Year 4 of V7MS Philosophy, Politics and Economics (Bipartite with Economics Major) (with Intercalated Year)
  - Year 4 of V7MQ Philosophy, Politics and Economics (Bipartite) with Intercalated Year
  - Year 4 of V7MM Philosophy, Politics and Economics (Tripartite) (with Intercalated year)

This module is Option list D for:

- UHIA-V1V5 Undergraduate History and Philosophy
  - Year 2 of V1V5 History and Philosophy
  - Year 3 of V1V5 History and Philosophy
- Year 4 of UHIA-V1V8 Undergraduate History and Philosophy (with Year Abroad and a term in Venice)
- Year 4 of UHIA-V1V6 Undergraduate History and Philosophy (with Year Abroad)
- UHIA-V1V7 Undergraduate History and Philosophy (with a term in Venice)
  - Year 2 of V1V7 History and Philosophy (with a term in Venice)
  - Year 3 of V1V7 History and Philosophy (with a term in Venice)
- UPHA-V7ML Undergraduate Philosophy, Politics and Economics
  - Year 2 of V7MR Philosophy, Politics and Economics (Bipartite with Economics Major)
  - Year 3 of V7MR Philosophy, Politics and Economics (Bipartite with Economics Major)

This module is Option list E for:

- UPHA-V7MW Undergraduate Politics, Philosophy and Law
  - Year 2 of V7MW Politics, Philosophy and Law
  - Year 2 of V7MW Politics, Philosophy and Law