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भारतीय प्रौद्योगिकी संस्थान कानपुर
INDIAN INSTITUTE OF TECHNOLOGY KANPUR
P.O.: IIT Kanpur, 208 016, Uttar Pradesh, India
ACADEMIC SECTION : UNDERGRADUATE OFFICE

Prof. Sagar Chakraborty
Chairperson, SUGC

No. A(U)/New _Course/2025/UG/13/986
October 17, 2025

OFFICE MEMORANDUM

The SUGC, in its meeting 2025-26/2nd, approved the proposal of the Humanities and Social Sciences (HSS) and Mathematics and Statistics (MATH) departments to offer a new course as detailed below:

Sl. No.	Course No.	Course Credits	Course Title	Course Type
1.	MTH315	3-0-0-0 [9]	Arithmetic on quadratic fields	REGULAR
2.	PHI454	3-0-0-0 [9]	Formal Epistemology	REGULAR

The copy of the course proposals is enclosed for reference.

Sagar Chakraborty

Copy to:

1. Dean, Academic Affairs
2. Associate Dean, Academic Affairs
3. All SUGC members
4. Heads of All Departments
5. OARS Section

New Course Proposal: IIT Kanpur

- Course Title: Arithmetic on quadratic fields
- Department: Department of Mathematics and Statistics
- Course Number: MTH3XX (UG level) MTH315
- Proposing Instructor: Somnath Jha
- Other interested faculty members:
- Units: 3-0-0-0 [9 credits]
- Course Description:

This is an introductory number theory course with a focus on quadratic fields. The main goal is to study the prime ideals and the units in the ring of integers of quadratic fields. In particular, we will explore the relation of the ideal class group of imaginary quadratic fields with the binary quadratic forms and also with the (Dedekind) Zeta function via the class number formula. We will also study quadratic reciprocity, and the Brahmagupta-Pell's equation. The course will be largely self contained and necessary tools from algebra and analysis will be developed along the way in the course.

- Course content and lecture plan:
  - Abelian groups, subgroups and quotient groups, Lagrange's theorem, structure of finite abelian groups. [4 lectures]
  - Commutative Rings, ideals, quotient rings, Prime ideals and maximal ideals, Polynomial rings, fields, field extensions. [4 lectures]
  - the groups Z/nZ and (Z/nZ)*, Euler's theorem and Wilson Theorem, Chinese Remainder Theorem [3 lectures]
  - Frobenius map on finite fields, Classification of finite fields, the structure of the multiplicative subgroup of a finite field [3 lectures]
  - Law of quadratic reciprocity, Quadratic fields, roots of unity, containment of quadratic fields inside cyclotomic fields [3 lectures]
  - Unique Factorisation Domain (UFD), Principal ideal domain (PID), Euclidean Domain (ED), Ring of integers of quadratic fields, various examples. [4 lectures]
  - Binary quadratic forms [3 lectures]
  - ideal class groups of imaginary quadratic fields, relation with binary quadratic forms [4 lectures]
  - Units in the ring of integers of real quadratic fields, Brahmagupta-Pell's equation, continued fractions [3 lectures]
  - Riemann Zeta function, basic properties [3 lectures]
  - class number formula for imaginary quadratic fields [5 lectures]

- Departments to which the proposed course will be of interest: MATHS, CSE, PHY.
- Prerequisites: MTH111M, MTH113M
- References:
  - A Classical Introduction to Modern Number Theory, K. Ireland, M. Rosen, Springer GTM.
  - An introduction to the Theory of Numbers, I. Niven, H. S. Zuckerman, H. L. Montgomery, Wiley.
  - Abstract Algebra, D. S. Dummit, R. M. Foote, Wiley.
  - Number Fields, D. Marcus, Universitext, Springer-Verlag.
  - Principles of mathematical analysis, W. Rudin, McGraw Hill.
  - Primes of the form $x^2 + ny^2$, 2nd ed., D. A. Cox, Pure and Applied Mathematics (Hoboken), John Wiley & Sons, Inc.
  - A course in Arithmetic, J. P. Serre, GTM 07, Springer-Verlag.
  - Algebraic Number Theory , J. Neukirch, Grundlehren der Mathematischen Wissenschaften 322, Springer- Verlag.
  - Problems in Algebraic Number Theory, E. Jody and M. Ram Murty,, GTM 190, Springer-Verlag.
  - Complex Analysis, E. Stein and R. Shakarchi, Princeton University Press.

Dated: ____22 Sep 2025_____. Proposing Instructor: Somnath Jha

Dated: _____ DUGC Convener:_____

Dated:_____ Chairman, SUGC:_____

The course is approved / not approved

Indian Institute of Technology Kanpur
Department of Humanities and Social Sciences
Proposal for a New Course

Course No: PHI4**

Course Title: Formal Epistemology

Per Week Lectures:(L) 3

Tutorial: 0

Laboratory:(P) 0

Additional Hours[0-2]:

Credits (3*L+2*T+P+A): 3-0-0-0

Duration of Course: Full Semester

Proposing Department/IDP : Department of Humanities and Social Sciences

Other Departments/IDPs which may be interested in the proposed course: Cognitive Science. Computer Science, Economics, Mathematics

Other faculty members interested in teaching the proposed course:-

Proposing Instructor(s): A. V. Ravishankar Sarma

Course Description:
Formal epistemology is a branch of analytic philosophy that investigates knowledge and reasoning using formal tools from mathematics (probability) and logic. In this course, we will investigate knowledge and reasoning using mathematical and logical techniques such as probability theory and modal logic. The main stream epistemology is the subject matter of formal epistemology. In general, epistemology is organised around two main objectives. One in defining and securing knowledge while combating scepticism and the other in modelling the dynamics of epistemological and doxastic states (beliefs). Although mainstream epistemology has mostly concentrated on the former, formal approaches have largely focused on the latter.

Some intriguing topics in mainstream epistemology are handled using formal models based on probability theory and modal logic. These issues include the distinction between internalism and externalism, the problem of justification, induction, and social epistemology. The course is divided into two parts. The first part is concerned with modelling beliefs with probabilities, and the second with analysing knowledge and belief using epistemic logic. Though it has enjoyed a

resurgence in interest and use over the past two decades, formal epistemology nevertheless has several significant limitations despite its mathematical elegance. This course will additionally illustrate some of the limitations of formal epistemology.

Objective(s): The primary objective of the course is to emphasise logic and probability theory in addressing standard epistemological problems. This course will provide students with a foundational understanding of formal epistemology's motivation, methods, and relationship to traditional epistemology in order to prepare them for the intriguing world of formal epistemology.

Contents: Mainstream vs Formal Epistemology, belief and probability, belief and acceptance, pillars of Bayesisnism, justification and probability, three approaches for justification: Foundationalism, coherentism, infinitism, knowledge, certainty and skepticism, Logics of knowledge and belief, Logical omniscience, common knowledge, basics of interactivist epistemology, limitations of formal epistemology.

Table: lecture wise breakup:

S. No	Broad Title	Topics	Lectures
1	Mainstream vs Formal Epistemology	Introduction and motivation, formal tools: probability and logic, foundations of formal epistemology	3
2	Belief and Probability:	graded and categorical beliefs, conditional probability and conditional beliefs, degree of belief raising theory of confirmation	6
3	Belief and acceptance	The threshold theory, Lottery Paradox, actual and ideal agents	3
4	Pillars of Bayesianism	Probabilism, Conditionalization, arguments for Conditionalization, objective vs subjective Bayesians	6
5	Justification and Probability	Justification and Probability & Three approaches: Foundationalism, Coherentism, Infinitism, Objections	4
6	Knowledge and probability	Knowledge, certainty, skepticism, rejection of knowledge requires certainty.	6

S. No	Broad Title	Topics	Lectures
7	Logic of Knowledge and beliefs	Basic concepts of epistemic logic: syntax and semantics, Common knowledge, awareness, problem of logical omniscience and distinction between explicit vs implicit beliefs.	6
8	Interactive Epistemology	Agency and interaction,strategies in the interaction, rationality constraints, David Lewis theory of elusive knowledge and convention	6

Short summary for including in the Courses of Study Booklet:

Formal epistemology is a young and vibrant field of research in Analytic philosophy. It mainly addresses problems of mainstream epistemology with the use of logic, probability theory, and other formal logic tools. The field covers concepts like knowledge, belief, certainty, rationality, reasoning, decision, justification, learning, agent interaction, and information processing.

Recommended books:

1. Bradley, D. (2015). A critical introduction to formal epistemology. Bloomsbury Publishing.'

2. Fagin, R., Halpern, J. Y., Moses, Y., Vardi, M. (2004). Reasoning about knowledge. MIT press.

3. Titelbaum 2021, Fundamentals of Bayesian Epistemology, Oxford University Press

Reference Books:

1. Arló-Costa, H., Hendricks, V. F., Van Benthem, J., Boensvang, H., Rendsvig, R. K. (2016). Readings in formal epistemology. Springer International Publishing Switzerland.

2. Glymour, C. Thinking Things Through. Cambridge, MA: MIT Press, 1992.
Hendricks, V. F. Mainstream and Formal Epistemology. New York: Cambridge University Press, 2006.

3. Williamson, T. Knowledge and Its Limits. Oxford: Oxford University Press, 2010.

4. Hintikka, J. (1962): Knowledge and Belief: An Introduction to the Logic of the Two Notions. Cornell: Cornell University Press.

5. Adams, E. W. (1998). A Primer of Probability Logic, CSLI Publication.

6. Stalnaker, R. (2006). On logics of knowledge and belief. Philosophical Studies: An International Journal for Philosophy in the Analytic Tradition, 128(1), 169-199.

7. S. O., Hendricks, V. F., Kjeldahl, E. M. (2018). Introduction to formal philosophy. Springer International Publishing AG, part of Springer Nature.

8. Bovens, L., Hartmann, S. (2004). Bayesian epistemology. OUP Oxford.

9. Lewis, D. (2008). Convention: A philosophical study. John Wiley Sons.

10 Halpern, J. Y. (2017). Reasoning about uncertainty. MIT press.

Any other remarks: --

Dated: 26-02-2025 **Proposer**: A. V. Ravishankar Sarma

Dated: 03-03-2025..... **DUGC/DPGC Convener:** .....

The course is approved / not approved

Chairman, SUGC/SPGC

Indian Institute of Technology Kanpur
Department of Humanities and Social Sciences
Proposal for a New Course

PHI 454

Course No: PHI4**

Course Title: Formal Epistemology

Per Week Lectures:(L) 3

Tutorial: 0

Laboratory:(P) 0

Additional Hours[0-2]:

Credits (3*L+2*T+P+A): 3-0-0-0

Duration of Course: Full Semester

Proposing Department/IDP : Department of Humanities and Social Sciences

Other Departments/IDPs which may be interested in the proposed course: Cognitive Science. Computer Science, Economics, Mathematics

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Any other remarks: --

Dated: 26-02-2025 **Proposer**: A. V. Ravishankar Sarma

Dated: 03-03-2025 **DUGC/DPGC Convener:** Sudeepa Mathur

The course is approved / ~~not approved~~

Chairman, SUGC/~~SPGC~~