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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/11/975
October 9, 2025

OFFICE MEMORANDUM

The SUGC, in its meeting 2025-26/1st, approved the proposal of the Economics Sciences department to offer a new course as detailed below:

Sl. No.	Course No.	Curse Credits	Course Title	Course Type
1.	ECO528	3-0-0-0 [9]	Bayesian Methods in Finance	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

Indian Institute of Technology, Kanpur

Proposal for a New Course

1. **Course No**: ECO528

2. **Course Title**: Bayesian Methods in Finance

3. **Per Week Lectures**: 3 (L), Tutorial: 0 (T), Laboratory: 0 (P), Additional Hours[0-2]: 0 (A)

   Credits (3*L + 0*T + P + A): 9 credits **Duration of Course**: Full Semester

4. **Proposing Department/IDP**: Department of Economic Sciences

   Other Departments/IDPs which may be interested in the proposed course:

   Other faculty members interested in teaching the proposed course:

5. **Proposing Instructor(s):** Mohammad Arshad Rahman

Course Description: This course introduces students to the powerful and increasingly influential role of Bayesian methods in contemporary financial analysis and decision-making. Emphasizing both theoretical foundations and practical applications, the course provides students with essential tools to model uncertainty, update beliefs in light of new information, and make rigorous, data-informed financial decisions under uncertainty.

The curriculum begins with an overview of the Bayesian paradigm, establishing a foundational understanding through Bayesian linear regression. It then advances to computational methods, including classical simulation techniques and Bayesian numerical approaches such as Markov Chain Monte Carlo (MCMC) techniques. Building on this foundation, the course explores the application of Bayesian methods to financial modeling and parameter estimation using real-world financial data.

A central focus is the Bayesian approach to portfolio theory, including the integration of investor views via the Black-Litterman framework and the role of prior beliefs in asset pricing models. The course also addresses advanced topics such as market efficiency, return predictability, and the Bayesian estimation of ARCH-type volatility models commonly used in risk management and derivative pricing. Throughout the course, students will gain hands-on experience through programming assignments using financial data, preparing them for research or industry roles in asset management, risk analysis, and financial modeling.

Software: The course is computationally intensive and will require extensive coding to implement the Bayesian methods learnt in the class on real and simulated data. Students taking this course will be required to code either in MATLAB or R, but the use of built-in packages is typically discouraged.

A) Objectives: The objective of this course is to equip students with a rigorous understanding of Bayesian methods and their application to modern financial analysis and decision-making under uncertainty. By integrating theoretical concepts with practical implementation, the course trains students to model uncertainty, incorporate new information through Bayesian updating, and apply these techniques to problems in portfolio theory, asset pricing, and financial risk management. Emphasis is placed on computational proficiency, with students developing hands-on skills in coding Bayesian models from first principles using MATLAB or R, applied to both real and simulated financial data. The course prepares students for advanced research or professional roles in quantitative finance, asset management, and risk analysis.

B) Contents

S. No	Broad Title	Topics	No. of Lectures
1.	The Bayesian Paradigm	Frequentist probability, subjective probability. Bayes theorem, prior, likelihood, posterior. Beta-binomial model, Dirichlet-multinomial model.	2
2.	Bayesian Linear Regression	Normal linear regression model, proper and improper priors, conjugate priors, conditionally conjugate priors. Model comparison methods: marginal likelihood, Bayes factor, and Bayesian R-squared.	3
3.	Classical Simulation	Inverse CDF method, method of composition, accept-reject method, and importance sampling.	2
4.	Bayesian Numerical Computation	Gibbs sampling, Metropolis algorithm, Metropolis-Hastings algorithm. Numerical standard error and convergence. Linear regression model with conditionally conjugate priors.	3
5.	Bayesian Framework for Portfolio Allocation	Classical portfolio selection, Bayesian portfolio selection (mean and covariance with diffuse and proper priors with application), shrinkage estimators, unequal histories of returns.	5
6.	Prior Beliefs and Asset Pricing Models	Preliminaries, quantifying the belief about pricing model validity. Perturbed model: prior, likelihood function, posterior distribution, and predictive distribution and portfolio selection. Illustrations: asset pricing model, combining inference from the CAPM and the Fama and French three-factor model.	5
7.	The Black-Litterman Portfolio Selection Framework	Preliminaries, combining market equilibrium and investor views, the choice of parameters, the optimal portfolio allocation with illustration, incorporating trading strategies into the Black-Litterman model, active portfolio management and the Black-Litterman model.	5
8.	Market Efficiency and Return Predictability	Test of mean-variance efficiency, inefficiency measures in testing the CAPM, testing the arbitrage pricing theory (APT, posterior and predictive distributions, certainty equivalent returns), return predictability (posterior and predictive inference, solving the portfolio selection problem). Illustration: Predictability and the investment horizon.	5
9.	Volatility Models	GARCH Models of volatility, stochastic volatility (SV) models. Illustration: forecasting Value-at-Risk. An ARCH-type model or SV	5

		model? Where do Bayesian methods fit in?	
10.	Bayesian Estimation of ARCH-Type Volatility Models	Griddy Gibbs sampler, Bayesian estimation of the GARCH(1,1) model, Markov regime-switching GARCH models. Illustrations.	5
	Total Number of Lectures		**40**

C) Pre-requisites: Econometrics I (ECO251) and/or Econometrics II (ECO351) or courses at the same level are a prerequisite for this course.

D) Short summary for including in the Courses of Study Booklet: This course explores the growing role of Bayesian methods in financial analysis and decision-making, combining theoretical foundations with practical applications. Students will learn to model and manage uncertainty through Bayesian inference, with topics ranging from linear regression and simulation techniques to advanced computational tools such as MCMC. The course emphasizes applications in portfolio theory, including the Black-Litterman model, asset pricing, and volatility estimation. A strong computational component requires students to implement Bayesian models from scratch using MATLAB or R, working with real and simulated financial data. Through hands-on assignments and in-depth analysis, students will develop the skills needed for research or professional roles in quantitative finance, asset management, and risk management.

6. **Recommended books:**

Textbooks:

(1) Bayesian Methods in Finance (John Wiley & Sons, Inc, 2008) by Svetlozar T. Rachev, John S. J. Hsu, Biliana S. Bagasheva, and Frank J. Fabozzi.

Reference Books:

(1) Introduction to Bayesian Econometrics, Second Edition (Cambridge University Press, 2012) by Edward Greenberg.

(2) Bayesian Data Analysis, Third Edition (Chapman & Hall, 2013) by Andrew Gelman, John B. Carlin, Hal S. Stern, David B. Dunson, Aki Vehtari, and Donald B. Rubin.

7. **Any other remarks:** Not applicable.

Dated: 30th July, 2025 Proposer: Mohammad Arshad Rahman A. Rahman

Dated:_____ DUGC Convener: Adity Vikram

The course is approved / not approved

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Chairman, SUGC

Dated:_____