ACADEMIC AFFAIRS OFFICE
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

No. Acd./391/IAPC-105 Dated: June 14, 2021

Head, CAIDS

The IAPC in its 105th meeting held on 09.06.2021 vide Item No. 105.2.4 considered and approved the following proposals:

1. Syllabi of Programme Elective Courses (PECs)

   (a) AID-559: Stochastic Processes and their Applications **(Appendix-A)** (for M.Tech. in Artificial Intelligence)

   (b) AID-575: Blockchain Technology **(Appendix-B)** (for M.Tech. in Data Science)

2. To introduce new PEC i.e., AID-583: Data-Driven Analytics for Smart Transportation Systems for M.Tech. in AI & DS. **(Appendix-C)**

Reeti

Assistant Registrar (Curriculum)

Encl: as above

Copy to (through e mail):-

1. All faculty
2. Head of all Departments/ Centres
3. Dean, Academic Affairs
4. Associate Dean of Academic Affairs (Curriculum)
5. Channel I/ Acad portal/ Academic webpage of iitr.ac.in

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Centre for Artificial Intelligence and Data Science

1. **Subject Code:** AID-559 **Course Title**: Stochastic Processes and their Applications
2. **Contact Hours:** **L:** 3 **T:** 1 **P:** 0
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-50 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Both **7. Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** To introduce concepts stochastic processes and their applications.
10. **Details of the Course**

S.No.	Contents	Contact hours
1.	**Review of Probability:** Probability measure, Borel-Cantelli lemma, multivariate random variable, Doob-Dynkin lemma, expectation, joint distribution and joint density functions, conditional expectation and its properties, conditional distribution and conditional density functions, independence of random variables, Markov inequality, Chebyshev inequality, convergence of random variables, law of large numbers, related applications and simulations.	7
2.	**Discrete time Markov chain:** Definition and construction, transition probability matrix, higher order transition probabilities, Chapman-Kolmogorov equation, dissection principle, classification of states, periodicity, solidarity properties, canonical decomposition, absorption probabilities, invariant measure and stationary distribution, limit distributions, renewal process, branching process, related applications and simulations.	11
3.	**Continuous time Markov chain:** Definition and construction, examples (pure birth process, birth-death process, uniformizable chain, etc.), stability and explosions, Markov property, dissection, backward and forward equations, generator, Chapman-Kolmogorov equation, stationary and limiting distributions, invariant measure, Laplace transform method, generating function technique, Point process, Poisson process, compound Poisson process, renewal process, Branching process, related applications and simulations.	11
4	**Brownian Motion:** Definition and construction (via random walk and Brownian bridge approximations), sample path properties, Brownian motion with drift, Ornstein-Uhlenbeck process, related applications and simulations.	6
5	**Martingales:** Filtration, stopping time, discrete time martingales with examples, optional stopping theorem, Doob's up-crossing inequality, Doob's convergence theorem, Doob's decomposition theorem, continuous time martingales with examples, related applications and simulations.	7
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors/Book/Publisher	Year of Publication/ Reprint
1.	Zdzislaw Brzezniak and Tomasz Zastawniak, Basic stochastic processes, Springer-Verlag London	2005/7th
2.	Sindney Resnick, Adventures in stochastic processes, Birkhäuser Boston	2005/4th
3.	Paul Glasserman, Monte Carlo Methods in Financial Engineering, Springer	2003/1st
4.	Peter W. Glynn and Søren Asmussen, Stochastic Simulation: Algorithms and Analysis, Springer	2007/1st

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NAME OF DEPARTMENT/CENTRE: Centre for Artificial Intelligence and Data Science

1. **Subject Code:** AID-575 **Course Title**: Blockchain Technology
2. **Contact Hours:** **L:** 3 **T:** 1 **P:** 0
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-50 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Both **7. Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** To provide knowledge about cryptographic and cybersecurity concepts of blockchain technology with some applications.
10. **Details of the Course**

S.No.	Contents	Contact hours
1.	**Basics of Blockchain:** Distributed Database, Two General Problem, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete	5
2.	**Crypto Primitives:** Hash functions, security aspects of hash function, Collison resistant hash, digital signatures, public key cryptography, verifiable random functions, NIST standards	8
3.	**Blockchain Theory:** Advantage over conventional distributed database, Blockchain Network, Mining Mechanism, Distributed Consensus, Merkle Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork, Private and Public blockchain.	8
3.	**Distributed Consensus:** Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Difficulty Level, Sybil Attack, Energy utilization and alternate	6
4.	**Cryptocurrency and regulations:** Distributed Ledger, Bitcoin protocols - Mining strategy and rewards, Ethereum - Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Namecoin, IBM hyper ledger, Stakeholders, Roots of Bitcoin, Legal Aspects - Cryptocurrency Exchange, Black Market and Global Economy	10
5.	**Blockchain Applications:** Good blockchain examples and how to identify potential use-cases, Design Thinking, Internet of Things, Medical Record Management System, Domain Name Service	5
Total		**42**

11. Suggested Books:

S.No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1.	Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press	2016
2.	Bettina Warburg, Bill Wanger, Tom Serres, "Basics of Blockchain " Independently published	2019
3.	Andreas M. Antonopoulos, "Mastering Bitcoin: unlocking digital cryptocurrencies", O'Reilly Media Inc.,	2014
4.	Wattenhofer, Roger, "Blockchain Science", Inverted Forest Publishing, 3rd Edition	2019

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NAME OF DEPARTMENT/CENTRE: Centre for Artificial Intelligence and Data Science

1. **Subject Code:** AID-583 **Course Title**: Data-driven Analytics for Smart Transportation Systems
2. **Contact Hours:** **L:** 3 **T:** 1 **P:** 0
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-50 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Both **7. Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** To familiarize with the applications of data science in traffic and transportation engineering and to demonstrate the applications of the data science in smart transportation planning

10. **Details of the Course:**

S.No.	Contents	Contact hours
1.	**Data Science in Transportation** Overview and Practical Applications; Transportation Data Sources; Data Collection; Data Preparation and Visualization.	4
2.	**Sensing and Data Mining for Smart Transportation Systems** Intelligent Transportation Systems, Incident Management Program, Efficient Emergency Vehicle Movement (Pre-Emption), Crash Detection, Reporting, and Clearance; Traffic Surveillance, Identification of Hotspots, Violation Detection; Road Network Asset Management, Inventory of Potholes, other Deficiencies; Adaptive Traffic Signal.	8
3.	**Data Analytics in Urban Transportation Planning** Basics of Urban Transportation Planning, Data Collection and Advanced Data Sources, Household Surveys, Demand Modeling using WiFi/ Bluetooth/ Call Data Record, Data Extraction and Analysis using APIs, Trip Distribution Modelling Approaches, Route Choice Models, Choice Set Generation Methods, Genetic Algorithms, Transportation Planning Example using Data-Driven Modeling and Simulation.	10
4.	**Urban Mass Transit System** Basics of Urban Mass Transit System, Static and Dynamic GTFS, Real-Time Transit, Travel Time Variability, Transit Reliability, Transit Planning using Smart-Card Data, Real-Time Accessibility Analysis.	6
5.	**Applications in Environmental Impact of Transport System** IOT based Air pollution, Real-Time Air Pollution Monitoring and Data Analysis, Placement of Mobile Sensors, Pollution Prediction using ML, Noise Data, Analysis of Key Parameters, Development of Policy Framework.	6
6.	**Crash Data Analytics** Crash Data, Data Preparation, Model Estimation, Real-Time Data-Driven Analysis; Emergency Vehicle Data, Crash Prone Stretches, Ambulance Deployment; Near-misses/Traffic Conflict Data, Surrogate Approach, Proactive Assessment and Safety Interventions.	8
	Total	**42**

11. Suggested books

S.No.	Name of Authors/Book/Publisher	Year of Publication/ Reprint
1.	Fumitaka Kurauchi, Jan-Dirk Schmöcker "Public transport planning with smart card data" CRC Press	2021
2.	Juan de Dios Ortúzar, Luis G. Willumsen "Modelling Transport", Wiley	2011
3.	Vukan R. Vuchic "Urban Transit: Operations, Planning, and Economics" Wiley	2005
4.	Constantinos Antoniou, Loukas Dimitriou, Francisco Pereira "Mobility Patterns, Big Data and Transport Analytics" Elsevier	2018
5.	Sara Moridpour, Alireza Toran Pour, Tayebeh Saghapour "Big Data Analytics in Traffic and Transportation Engineering: Emerging Research and Opportunities" IGI Global	2019
6.	Khaled R. Ahmed, Aboul-Ella Hassanien "Deep Learning and Big Data for Intelligent Transportation" Springer	2021
7.	Davy Janssens, Ansar-Ul-Haque Yasar and Luk Knapen "Data Science and Simulation in Transportation Research" IGI Global	2013