Electives for Executive M.Tech Blockchain & Big Data

Sl. No.	Subject Code	Elective-I	L	T	P	C
1	EBB 6101	Web development for blockchain applications	3	0	0	3
2	EBB 6102	Blockchain components and architecture	3	0	0	3
3	EBB 6103	Data Engineering	3	0	0	3

Sl. No.	Subject Code	Elective-II	L	T	P	C
1	EBB 6201	Smart contracts and solidity programming	3	0	0	3
2	EBB 6202	Data Analytics	3	0	0	3
3	EBB 6203	Deep Learning	3	0	0	3

Sl. No.	Subject Code	Elective-III	L	T	P	C
1	EBB 6301	Cryptocurrency & cyber security	3	0	0	3
2	EBB 6302	Data virtualization & dashboards	3	0	0	3
3	EBB 6303	Blockchain policy – Legal, social and economic impact	3	0	0	3

Sl. No.	Subject Code	Elective-IV	L	T	P	C
1	EBB 6401	Blockchain Technologies: Platforms & Applications	3	0	0	3
2	EBB 6402	Security and privacy for big data	3	0	0	3
3	EBB 6403	Reinforcement Learning	3	0	0	3

Course Number	EBB 6101
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Web development for blockchain applications**
Learning Mode	Online
Learning Objectives	● Understand the basics of Blockchain Technology and its integration with Web Development. ● Gain hands-on experience in developing blockchain-based web applications using JavaScript and Python. ● Explore different server-side options and databases for building blockchain applications. ● Learn about web security, continuous integration, and deployment of blockchain applications on a production server.
Course Description	This course introduces the fundamentals of Blockchain Technology and its integration with web development, focusing on hands-on experience in building blockchain-based web applications using JavaScript and Python. Students will explore various server-side options, databases, web security, and learn continuous integration and deployment of blockchain applications on a production server.

Course Outline	**Module 1 : Introduction to Blockchain Web Development** ● Blockchain Technology and its integration with Web Development ● Technology stacks for blockchain-based web development ● HTML5 & CSS for blockchain-based web development ● Chrome DevTools for web development ● Functional programming paradigm for JavaScript inside a browser ● Python data types and basics ● Building client and server for blockchain applications ● Miner and wallet for blockchain applications ● Building a socket communication utility for blockchain applications ● Use of Low Code, No Code Tools in the development **Module 2 : JavaScript for Blockchain Web Development** ● JavaScript enabled blockchain applications ● Compiling new JavaScript to the old one with webpack ● Better CSS with webpack ● Code organization in a project ● Asynchronous JavaScript code for developing smart contracts ● APIs for blockchain solutions ● Building a simple blockchain application **Module 3: Server-side Development for Blockchain Applications** ● Overview of server-side options for blockchain applications ● Node.js environment for blockchain and its ecosystem ● JSON REST API for blockchain applications ● Using Postman to debug APIs ● Managing server-side application state for blockchain applications ● Web3.js for blockchain web applications ● Databases and SQL (SQLite, PostgreSQL) for blockchain applications ● Data normalization for blockchain applications ● User authorization and authentication for blockchain applications. ● Allowing users to interact with blockchain applications. **Module 4 : Web Security and Development Organization for Blockchain Applications** ● Web security basics for blockchain applications,Not trusting your clients for blockchain applications ● Why use HTTPS for blockchain applications,Integrating other software with the server for blockchain applications ● Developing frontend with React for blockchain applications

	● Concept of single-page applications for blockchain applications,Managing client-side application state (Redux) for blockchain applications,Overview of other client JS frameworks for blockchain applications ● Development organization for blockchain applications ● Using Git for blockchain application development ● Concept of continuous integration for blockchain application development ● Configuring a production web server with Ubuntu for blockchain applications

Learning Outcome	● Ability to build blockchain-based web applications using JavaScript and Python ● Understanding of server-side options and databases for building blockchain applications ● Proficiency in web security and deployment of blockchain applications on a production server ● Acquiring skills in using various web development tools and technologies for building blockchain applications.
Assessment Method	Quiz / Assignment / ESE

TEXTBOOKS:

- "Building Blockchain Projects: Building Decentralized Blockchain Applications with Ethereum and Solidity" by Narayan Prusty, published by Packt Publishing.
- "Blockchain Basics: A Non-Technical Introduction in 25 Steps" by Daniel Drescher, published by Apress.
- "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained" by Imran Bashir, published by Packt Publishing.

Course Number	EBB 6102
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Blockchain components & architecture**
Learning Mode	Online
Learning Objectives	● To provide an in-depth understanding of the key concepts and components of blockchain technology. ● To explore the different types of blockchain architectures and design considerations, including security and consensus protocols. ● To examine the use of blockchain in various sectors, such as financial software and systems, government, and trade supply chains. ● To provide students with the knowledge and skills to develop secure cryptographic protocols on blockchain and analyze existing blockchain ecosystems.
Course Description	This course offers an in-depth understanding of blockchain architectures, and design considerations, including security and consensus protocols. Students will explore blockchain applications in various sectors and develop skills to create secure cryptographic protocols and analyze existing blockchain ecosystems.
Course Outline	**Module 1: Blockchain Fundamentals** ● Basic crypto primitives: hash, signature, hashchain to blockchain ● Basic consensus mechanisms ● Blockchain architecture and design considerations ● Requirements for consensus protocols. ● Scalability aspects of blockchain consensus protocols. **Module 2: Consensus Mechanism** ● Proof of Work (PoW) consensus mechanism ● Alternative consensus mechanisms: Proof of Stake (PoS), Delegated Proof of Stake (DPoS), Byzantine Fault Tolerance (BFT), and more ● Decomposing the consensus process ● Consensus protocols for permissioned blockchains. **Module 3: Permissioned Blockchains and Applications** ● Design goals for permissioned blockchains ● Introduction to Hyperledger Fabric ● Hyperledger Fabric components ● Chaincode design and implementation ● Beyond chaincode: Fabric SDK and front end, Hyperledger Composer tool ● Settlements, KYC, and capital markets on blockchain ● Blockchain in insurance. **Module 4: Blockchain for Supply Chain and Government**

	● Use case: Blockchain in trade supply chain ● Provenance of goods and visibility on blockchain ● Trade supply chain finance on blockchain ● Invoice management and discounting on blockchain ● Digital identity and records on blockchain. ● Record keeping between government entities on blockchain ● Public distribution system and social welfare systems on blockchain. **Module 5: Blockchain Cryptography, Privacy, and Security** ● Overview of blockchain cryptography and security ● Privacy on blockchain ● Recent works on scalability ● Secured multi-party computation on blockchain ● Blockchain for science: making better use of the data-mining network. Case studies: comparing ecosystems - Bitcoin, Hyperledger, Ethereum, and more.
Learning Outcome	● Students will be able to explain the core concepts and components of blockchain technology. ● Students will be able to design and implement basic blockchain architectures and understand the security and consensus mechanisms required for their development. ● Students will be able to analyze the use of blockchain in various sectors and identify opportunities for its implementation. ● Students will be able to develop secure cryptographic protocols on blockchain and compare and contrast different blockchain ecosystems, such as Bitcoin, Hyperledger, and Ethereum.
Assessment Method	Quiz / Assignment / ESE

TEXTBOOKS:

- "Blockchain Basics: A Non-Technical Introduction in 25 Steps" by Daniel Drescher, Apress.
- "Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World" by Don Tapscott and Alex Tapscott, Portfolio.
- "The Basics of Bitcoins and Blockchains" by Antony Lewis, O'Reilly Media.

Course Number	EBB 6103
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Data Engineering**
Learning Mode	Online
Learning Objectives	• To understand data engineering principles and practices, including data modeling, database design, and data warehousing. • To develop skills in building efficient and scalable data pipelines for data processing and storage. • To learn how to manage and optimize data systems for performance and reliability. • To gain practical experience with data engineering tools and technologies, including SQL, ETL, and data warehousing.
Course Description	This course covers data engineering concepts and principles, focusing on designing and implementing efficient, scalable data pipelines for processing and storage.
Course Outline	**Module 1: Introduction to Data Engineering** • Overview of Data Engineering • Key Concepts in Data Modeling • Relational Database Design Principles • Data Warehousing Concepts **Module 2: Data Processing and Storage** • Data Pipelines and ETL (Extract, Transform, Load) • Distributed Systems and Parallel Computing • Data Storage Technologies, including NoSQL databases • Data Quality and Validation **Module 3: Managing and Optimizing Data Systems** • Performance Tuning and Optimization • Data Security and Privacy • Scalability and Availability • Disaster Recovery and Backup **Module 4: Data Engineering Tools and Technologies** • SQL and Relational Database Management Systems • Big Data Frameworks, including Hadoop and Spark • Cloud-Based Data Warehousing, including Amazon Redshift and Google BigQuery • Data Visualization and Reporting Tools

Learning Outcome	● Demonstrate an understanding of data engineering concepts and principles. ● Design and implement efficient and scalable data pipelines for data processing and storage. ● Manage and optimize data systems for performance and reliability. ● Apply data engineering tools and technologies to real-world data problems.
Assessment Method	Quiz / Assignment / ESE

TEXTBOOKS:

- Designing Data-Intensive Applications by Martin Kleppmann (O'Reilly Media)
- Data Warehousing in the Age of Big Data by Krish Krishnan (Morgan Kaufmann)
- The Data Warehouse Toolkit by Ralph Kimball and Margy Ross (Wiley)

Course Number	EBB 6201
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Smart contracts and solidity programming**
Learning Mode	Online
Learning Objectives	● To provide an introduction to the concept of smart contracts and their applications. ● To familiarize students with the Solidity programming language and its constructs. ● To enable students to design, implement, and deploy smart contracts on the Ethereum blockchain. ● To teach students best practices for secure smart contract development and auditing.
Course Description	This course teaches the purpose and potential of smart contracts across various industries, focusing on writing and deploying them in Solidity on the Ethereum blockchain.
Course Outline	**Module 1: Introduction to Smart Contracts and Solidity** ● Definition and brief history of smart contracts,Applications of smart contracts ● Introduction to the Ethereum blockchain ● Solidity programming language and its syntax ● Structure of a smart contract,Global variables in Solidity. **Module 2: Ethereum Development** ● Life cycle of a Solidity contract,Interfaces and inheritance in Solidity,External function calls. ● Fallback functions,Payable functions and transactions,Revert, assert, and require statements. ● Decentralized Autonomous Organizations (DAOs). ● Introduction to MakerDAO. **Module 3: Advanced Solidity Development** ● Token-based membership,Share-based membership,Automated immutable systems. ● Pure functions and view functions,Ethereum Virtual Machine (EVM). ● Bytecode interpretation. ● Ethereum mining reward scheme,Gas pricing. **Module 4: Security and Auditing of Smart Contracts** ● Security issues in smart contracts,Common attacks on smart contracts,Error handling in smart contracts. ● Best practices for secure smart contract development,Modifiers. ● Mutex pattern and balance limit pattern,Smart contract security tools, including Smart Inspect, GasTap, Smart Check, and Solgraph.

	● Advanced research topics in smart contracts.
Learning Outcome	● Students will be able to understand the purpose and potential of smart contracts in various industries. ● Students will be able to write smart contracts in Solidity and deploy them on the Ethereum blockchain. ● Students will be able to design and implement secure smart contracts, and avoid common security issues. ● Students will be able to apply best practices for auditing and testing smart contracts.
Assessment Method	Quiz / Assignment / ESE

TEXTBOOKS:

- "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained" by Imran Bashir. Packt Publishing, 2018.
- "Building Ethereum Dapps: Decentralized Applications on the Ethereum Blockchain" by Roberto Infante. Apress, 2018.
- "Solidity Programming Essentials: A Beginner's Guide to Build Smart Contracts for Ethereum and Blockchain" by Ritesh Modi. Packt Publishing, 2018.

Course Number	EBB 6202
Course Credit (L-T-P-C)	L-T-P-C: 3-0-0-3
Course Title	**Data Analytics**
Learning Mode	Online
Learning Objective	In this subject, the students will be trained with the knowledge of various computational techniques required for multi-dimensional data analysis such that they are able to apply these techniques in practice through programming, modeling etc.
Course Description	Modern day data is vast and diverse owing to their different acquisition systems and medium. This course aims to give an in-depth view to different data generation/acquisition mechanisms over diverse domains and the challenges incurred. It will discuss the role of computational data analysis techniques to understand and mathematically model data formation process. It will also teach them about the various data processing techniques required to manipulate and operate data to suit various objectives.
Course Outline	**Module1:** Understanding multi-dimensional data formation from physical acquisition devices with example cases in Remote Sensing, Geoscience, Medical sciences. Drawbacks and challenges in data acquisition, Necessity for computational modelling and analysis of data. **Module 2:** Mathematical models for data formation and analysis, Probability models, Linear inverse optimization models, L1-L2 Regularizers, Minimizers, Cascade Modelling, Multiscale Modelling, Machine Learning models. **Module 3:** Data Interpretation: Handling missing/corrupted data, Handling outliers, Imputation techniques, Interpolation techniques, Curve based approximation, non-convex optimization, sparse regularizers, Non-convex minimizers, Machine learning based. **Module 4:** Data compression: Necessity, Applications, Lossless compression techniques, Lossy compression techniques, JPEG compression, Machine learning based. **Module 5:** Statistical Models, Data preprocessing techniques in Machine learning, Signal processing techniques for multi dimensional data, Application in various domains.

Learning Outcome	After completion of course, students will be able to ● Understand data formation/generation process and the role of computational techniques in analyzing those data. ● Apply the Mathematical principles behind computational techniques for data analysis. ● Understand the utilities of statistical models and ML models in data analysis.
Assessment Method	Quiz / Assignment / ESE

Suggested Readings:

1. Signal Processing: A Mathematical Approach, Charles L. Byrne, Second Edition, Chapman & Hall, 2014.
2. Digital Functions and Data Reconstruction: Digital-Discrete Methods, Li M Chen, Springer, 2013.
3. Machine Learning with Neural Networks: An Introduction for Scientists and Engineers, Bernhard Mehlig, Cambridge University Press, 2021
4. Signal Processing and Machine Learning with Applications, Michael M. Richter, Sheuli Paul, Veton Këpuska, Marius Silaghi, Springer Cham, 2022
5. Data Compression: The Complete Reference, David Solomon, 4th Edition, Springer, 2007

Course Number	EBB 6203
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Deep Learning**
Learning Mode	Online
Learning Objectives	This course aims to provide an introductory overview of deep learning and its application varied domains. The course will provide basic understanding of neural networks, mathematical description of it and finally applications of it in multiple domains. A few open source tools will be demonstrated during the course to provide hands-on experience.
Course Description	This course provides an introduction to big data problems and linear algebra, covering essential machine learning techniques like linear regression and classification. It delves into neural networks, gradient-based learning, regularization methods, optimization strategies, and advanced topics such as CNNs, RNNs, and deep reinforcement learning.
Course Outline	● Introduction: Introduction to bigdata problem, overview of linear algebra ● Feature engineering: Basics of machine learning (linear regression, classification) ● Neural network: Deep feed forward network, cost function, activation functions, overfitting, underfitting, Universal approximation theorem ● Gradient based learning: DG, SGD, Backpropagation ● Regularization: L2, L1, L\infinity, drop-out, early stopping, data augmentation, etc. ● Optimization: Multivariable taylor series, momentum, adaptive learning rate, ADAM, Nesternov, AdaGrad, etc. ● CNN: CNN and its application in computer vision ● RNN: RNN, LSTM, GRU and their applications in NLP ● Advanced topics: Autoencoder, Transformer, Deep reinforcement learning
Learning Outcome	● Basic understanding of deep learning and neural networks. ● Problem modeling skill ● Usage of different open source tools / libraries. ● Analysis of large volume of data
Assessment Method	Quiz / Assignment / ESE

Textbooks:

- Ian Goodfellow, Yoshua Bengio and Aaron Courville, “Deep Learning”, Book in preparation for MIT Press, 2016.

Reference books:

- Jerome H. Friedman, Robert Tibshirani, and Trevor Hastie, “The elements of statistical learning”, Springer Series in Statistics, 2009.
- Charu C Aggarwal, “Neural Networks and Deep Learning”, Springer.
- Aston Zhang, Zachary C. Lipton, Mu Li, Alexander J. Smola, "Dive into Deep Learning"
- Iddo Drori, "The Science of Deep Learning", Cambridge University Press
- Simon O. Haykin, "Neural Networks and Learning Machines", Pearson Education India
- Richard S. Sutton, Andrew G. Barto, "Reinforcement Learning: An Introduction", MIT Press
- Christopher M. Bishop, Hugh Bishop, "Deep Learning: Foundations and Concepts", Springer, 2022.
- Simon J. D. Prince, "Understanding Deep Learning", MIT Press 2023.

Course Number	EBB 6301
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Cryptocurrency and cyber security**
Learning Mode	Online
Learning Objectives	● To understand the fundamentals of network and symmetric ciphers. ● To apply asymmetric ciphers and data integrity algorithms. ● To explore the basics of cryptocurrencies and use Ethereum programming
Course Description	This course provides a comprehensive overview of cryptocurrency and cybersecurity, focusing on the technologies, threats, and best practices associated with digital currencies.
Course Outline	**Module 1: Introduction to Cybersecurity and Cryptography** ● Need for cybersecurity,Concept of cyberspace,Cyber crimes and cyber-attacks. ● Fundamental security principles,Key security triad,Key components of cybersecurity network architecture,Basic security management and policies. ● Cryptography,Private key cryptography,Classical encryption techniques,Substitution techniques Transposition techniques,Rotor machines,Steganography. ● Data Encryption Standard,Advanced Encryption Standard, Multiple Encryption and Triple DES. **Module 2: Asymmetric Cryptography and Hash Functions** ● Public-key cryptography,RSA algorithm,Diffie-Hellman key exchange,Elgamal cryptographic system. ● Elliptic curve arithmetic,Elliptic curve cryptography,MD5 message digest algorithm. ● Secure hash algorithm (SHA),Digital signatures. ● Authentication protocols, Digital signature standards (DSS). **Module 3: Blockchain Security and Privacy Issues** ● Transaction security,Client security and privacy,Pseudo-anonymity vs anonymity. ● Zcash and 2k-SNARKS for anonymity preservation. ● Network layer attacks. ● Security and privacy issues with scalability solutions,Balance privacy. ● Wormhole attack. **Module 4: Cybersecurity Infrastructure using Blockchain** ● Blockchain-based PKI

	● 2-Factor authentication using blockchain ● Blockchain-based DNS ● Identity management ● Blockchain-based DDoS protection Module 5: Security Aspects of Blockchain Applications ● Blockchain for cybersecurity and privacy in IoT. ● Payment system applications.
Learning Outcome	● Recall the network security fundamentals. ● Employ various symmetric ciphers. ● Apply asymmetric ciphers and data integrity algorithms. ● Explore the basics of cryptocurrencies. ● Use Ethereum programming
Assessment Method	Quiz / Assignment / ESE

TEXT BOOKS

- William Stallings, "Cryptography and Network security Principles and Practices", Pearson/PHI,2017.
- Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press, July, 2016.

- William Stallings, Network Security Essentials (Applications and Standards), Pearson Education, India,2017
- Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization and Smart
- Contracts Explained", Second Edition, Packt Publishing, 2018.

Course Number	EBB 6302
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Data Virtualization and Dashboards**
Learning Mode	Online
Learning Objectives	1. To introduce students to the concept of data virtualization and its applications in the field of big data and blockchain. 2. To provide students with hands-on experience using popular data virtualization tools to create a unified view of data from multiple sources and running queries on the views in optimized manner. 3. To teach students how to design effective dashboards that provide meaningful insights into complex data sets and allows intelligent analytics o data. 4. To explore advanced topics in data virtualization and dashboards, such as real-time data integration, self-service analytics, and integration with big data platforms and blockchain.
Course Description	This course introduces data virtualization concepts and applications in big data and blockchain, offering hands-on experience with popular tools for unified data views and optimized querying. Students will learn to design effective dashboards for intelligent analytics and explore advanced topics, including real-time integration, self-service analytics, and integration with big data platforms and blockchain.
Course Outline	**Module 1: Introduction to Data Virtualization** ● Overview of data virtualization and its benefits, Data Silos, Data Partitioning, performance parameters of data virtualization. ● Understanding data integration and how it differs from data virtualization, Centralized vs Peer-2-peer Data Integration, ETL, Mediation and Federated Databases. ● Data Transformation, Master Data and Metadata Management in Data Virtualization. ● Use cases for data virtualization. ● Challenges and limitations of data virtualization. ● Introduction to popular data virtualization tools and their architectures. **Module 2: Data Virtualization in Action** ● Building a virtual data layer with a popular data virtualization tool such as Denodo and TIBCO, Redhat JBOSS.

	● Connecting to various data sources (relational databases, big data systems, cloud applications, web applications, etc.). ● Creating views and queries using the selected data virtualization tool, query optimization and caching in data virtualization. ● Handling complex data transformations with the selected tool. ● Managing metadata and security in a virtual environment. **Module 3: Data Visualization and Dashboards** ● Introduction to data visualization and dashboard design. ● Key principles of effective data visualization. ● Overview of popular dashboard tools (e.g. Tableau, Power BI, QlikView), Creating reports in Tableau and PowerBI. ● Best practices for designing interactive dashboards. ● Connecting virtual data sources to dashboards. **Module 4: Advanced Topics in Data Virtualization and Dashboards** ● Using data virtualization to support self-service analytics, Experimenting self-service analytics in Denodo and PowerBI. ● Real-time data integration and processing with data virtualization. ● Integrating data virtualization with big data platforms and blockchain. ● Best practices for performance tuning and optimization in data virtualization. ● Future trends in data virtualization and dashboard design.
Learning Outcome	1. Students will be able to describe the benefits and challenges of data virtualization and how it differs from traditional data integration approaches. 2. Students will be able to create a virtual data layer using a popular data virtualization tool and connect to various data sources, including relational databases, big data systems, and cloud applications. 3. Students will be able to design effective dashboards using popular dashboard tools and connect virtual data sources to create interactive visualizations.

	4. Students will be able to identify and apply advanced techniques in data virtualization and dashboard design, such as real-time data processing, self-service analytics, and integration with big data platforms and blockchain.
Assessment Method	Quiz / Assignment / ESE

Suggested Reading

1. Data Virtualization for Business Intelligence Systems: Revolutionizing Data Integration for Data Warehouses (Rick van der Lans)

2. Data Virtualization: Going Beyond Traditional Data Integration to Achieve Business Agility (Judith R. Davis, Robert Eve, and Ramesh Chakkoli)

3. Data Visualization: A Practical Introduction (Kieran Healy)

4. The Big Book of Dashboards: Visualizing Your Data Using Real-World Business Scenarios (Steve Wexler, Jeffrey Shaffer, and Andy Cotgreave)

Course Number	EBB 6303
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Blockchain Policy: Legal, Social And Economic Impact**
Learning Mode	Online
Learning Objectives	● Understand the importance and impact of blockchain policies, regulations, and guidelines. ● Analyze the different stakeholders and communities affected by blockchain policies and their implications. ● Develop skills for drafting and implementing blockchain policies to ensure sustainable infrastructure investment and international trade. ● Evaluate the potential unintended consequences of blockchain and apply effective strategies for mitigating them
Course Description	This course explores the importance of blockchain policies,regulations, and guidelines, and their impact on various stakeholders. Students will develop skills in drafting and implementing blockchain policies for sustainable infrastructure and international trade, while evaluating and mitigating potential unintended consequences.
Course Outline	**Module 1:Blockchain Policy and Guidelines** ● Introduction to blockchain policies and their importance,Guidelines for blockchain applications and infrastructures,International laws and regulations related to blockchain. ● Dialogue on distributed ledger technology (DLT),Policies for preventing money laundering and terrorism financing,FATF standards on virtual assets. ● Stable coins and their policy implications,Issues related to trust and framework,Challenges and business impact of blockchain. ● Resources for blockchain policies,Smart securities and derivatives. **Module 2: Impact of Blockchain on Different Stakeholders** Tokenization and securities for physical assets,Impact of blockchain on different stakeholders,Shareholder engagement and investor privacy. ● Blockchain industry bodies around the world,Corporate governance on the chain,Impact on specific communities. ● Problem of equality and blockchain. ● Role of blockchain in the ecosystem for persons with disabilities,Impact of blockchain on women,Tax administration to transparency,Tax treatment of digital financial assets.

	Module 3: Enabling Sustainable Infrastructure Investment Digital financial marketplaces and track and trace,Provenance to countering fraud. ● Agricultural supply chains and policy makers,Material supply chains. ● Facilitating international trade,Trade finance to customs. ● How government can support blockchain innovation,Blockchain adoption. **Module 4: Unintended Consequences and Technical Assistance** ● Blockchain and the environment,Steering blockchain through the energy transition. ● Reducing the cost of remittances with blockchain. ● Potential unintended consequences of blockchain. ● Addressing criminal activities, inequality, privacy, security, and data protection,Intellectual property regulations
Learning Outcome	● Develop a comprehensive understanding of blockchain policies, regulations, and guidelines. ● Assess the impact of blockchain policies on different stakeholders and communities. ● Draft and implement effective blockchain policies to enable sustainable infrastructure investment and international trade. ● Analyze and mitigate the potential unintended consequences of blockchain for successful policy implementation.
Assessment Method	Quiz / Assignment / ESE

TEXTBOOKS:

- "Blockchain and the Law: The Rule of Code" by Primavera De Filippi and Aaron Wright, published by Harvard University Press.
- “The Age of Cryptocurrency: How Bitcoin and Digital Money are Challenging the Global Economic Order" by Paul Vigna and Michael Casey (St. Martin's Press, 2015).
- "Blockchain Revolution: How the Technology Behind Bitcoin is Changing Money, Business, and the World" by Don Tapscott and Alex Tapscott (Portfolio, 2016).

Course Number	EBB 6401
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Blockchain Technologies: Platforms and Applications**
Learning Mode	Online
Learning Objectives	● Articulate blockchain platforms that show promise in solving complex business problems. ● Examine the life cycle of a chain code and its components. ● Implement various blockchain-based enterprise applications.
Course Description	This course explores various blockchain platforms and their business applications, focusing on developing and deploying smart contracts on Ethereum using Solidity.
Course Outline	**Module 1 - INTRODUCTION TO BLOCKCHAIN TECHNOLOGIES** ● Introduction to Blockchain Technologies ● Overview of Blockchain Platforms: Ethereum, Hyperledger Project, IBM Blockchain, Multichain, Hydrachain, Ripple, R3 Corda, BigChainDB, IPFS **Module 2 - ETHEREUM SMART CONTRACTS** ● Introduction to Smart Contracts ● Solidity Programming Language ● Contract Creation and Deployment ● Web3js and RPC Protocols ● Miners, Transactions, and Blocks in Ethereum ● Front-End Development with React and Web3 **Module 3 - HYPERLEDGER FABRIC** ● Introduction to Hyperledger Fabric ● Fabric Model ● Identity Management in Fabric: Membership Service Provider (MSP) ● Policies in Fabric ● Ledgers in Fabric: World State and Transaction Log ● Chaincode in Fabric: Writing and Deploying Smart Contracts ● Endorsement Peers and Endorsement Policies in Fabric Module 4 - ADVANCED TOPICS IN BLOCKCHAIN TECHNOLOGIES ● Ordering Nodes in Hyperledger Fabric: Solo Ordering Service, Kafka

	● Committing Peers and Anchor Peers in Hyperledger Fabric ● Private Data Sharing in Hyperledger Fabric: Sharing Private Data, Private Data Sharing Patterns ● Key-level Transaction Access Control and Endorsement in Hyperledger Fabric. ● Setting up a Production Network on Hyperledger Fabric.
Learning Outcome	● Demonstrate an understanding of various blockchain platforms and their potential use cases in business. ● Develop and deploy smart contracts on the Ethereum platform using Solidity programming language. ● Configure and deploy a production network on the Hyperledger Fabric platform.
Assessment Method	Quiz / Assignment / ESE

TEXT BOOKS

- Tom Serres, Bill Wagner and Bettina Warburg, Basics of Blockchain, 2019. ISBN 9781089919441.
- Gaur and Nitin, Hands-On Blockchain with Hyperledger: Building decentralized applications with Hyperledger Fabric, Packt Publishing Ltd, 2018. ISBN 978-17889945.

Course Number	EBB 6402
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Security And Privacy For Big Data Analytics**
Learning Mode	Online
Learning Objectives	● Understand the basic concepts of Cryptography. ● Learn methods and tools for securing big data and how to apply them in practice. ● Understand differential privacy and its impact on big data. ● Be familiar with the laws and regulations regarding data protection in big data environments.
Course Description	This course introduces basic cryptography concepts and practical methods for securing big data, including differential privacy.
Course Outline	**Module 1: Cryptography for Big Data Security** ● Introduction to cryptography and its relevance to big data,Symmetric and asymmetric encryption techniques ● Hash functions and message authentication codes (MACs) ● Public Key Infrastructure (PKI) and digital certificates ● Cryptographic protocols for secure communication in big data,Cryptographic tools and libraries for big data security. **Module 2: Security and Privacy in Big Data** ● Threat modeling and risk assessment for big data,Access control and authentication mechanisms for big data systems ● Data anonymization and privacy-preserving techniques for big data ● Network security and data protection in distributed big data systems ● Intrusion detection and prevention in big data environments,Best practices for securing big data and compliance with data protection laws. **Module 3: Big Data Modeling for Security Analysis** ● Data modeling and schema design for security analysis in big data,Machine learning and data mining techniques for security analysis in big data ● Visualization and analytics tools for security analysis in big data,Data fusion and correlation for security intelligence in big data ● Case studies of security analysis in big data environments ● Big data security testing and evaluation methodologies

Learning Outcome	● Understand the basic concepts of Cryptography. ● Develop skills and knowledge to apply different methods and tools to secure big data. ● Be able to analyze the impact of differential privacy and malware on big data. ● Understand the data protection laws and regulations for big data and apply them in practice.
Assessment Method	Quiz / Assignment / ESE

Textbooks:

1. Big Data , Storage sharing and security , Fei Hu, CRC press.
2. Privacy & Big data , by Mary E. Ludloff, Terence Craig. Released September 2011. Publisher(s): O'Reilly Media, Inc.

Course Number	EBB 6403
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Reinforcement Learning**
Learning Mode	Online
Learning Objectives	This course aims to help the students **(a)** Understand the foundational concepts and mathematical frameworks of reinforcement learning. **(b)** Gain proficiency in key reinforcement learning algorithms, including dynamic programming, Monte Carlo methods, and temporal-difference learning **(c)** Apply deep reinforcement learning techniques to solve complex problems using methods such as deep Q-networks and policy gradient algorithms. **(d)** Explore recent advancements and applications of reinforcement learning, including multi-agent systems and ethical considerations.
Course Description	This specialized course on reinforcement learning aims to give students a deep understanding of the algorithms and methodologies used to train agents to make decisions through trial and error. Students will learn to develop and implement reinforcement learning models by focusing on foundational theories and practical applications. Students will explore key concepts such as Markov decision processes, policy gradients, Q-learning, and deep reinforcement learning through a mix of theoretical lectures, coding exercises, and project-based learning. Upon completion, students will be equipped to design and apply reinforcement learning solutions to complex problems in fields such as robotics, game development, and autonomous systems, enhancing their expertise in this dynamic area of artificial intelligence.

Course Outline	Foundations: Basics of machine learning and reinforcement learning (RL) terminology. Probability Concepts: Axioms of probability, random variables, distributions, and correlation. Markov Decision Process: Introduction to MDPs, Markov property, and Bellman equations. State and Action Value Functions: Concepts of MDP, state, and action value functions. Tabular Methods and Q-networks: Dynamic programming, Monte Carlo, TD learning, and deep Q-networks. Policy Optimization: Policy-based methods, REINFORCE algorithm, and actor-critic methods. Recent Advances and Applications: Meta-learning, multi-agent RL, ethics in RL, and real-world applications.
Learning Outcome	1. Mastery of fundamental principles and mathematical frameworks of reinforcement learning. 2. Proficiency in implementing key reinforcement learning algorithms and techniques. 3. Ability to apply deep reinforcement learning methods to complex, real-world problems. 4. Understanding of recent advancements in reinforcement learning and their ethical implications.
Assessment Method	Quiz / Assignment / ESE

Suggested Reading

- Reinforcement Learning: An Introduction by Richard S. Sutton and Andrew G. Barto, The MIT Press (1 January 1998).
- Deep Reinforcement Learning Hands-On by Maxim Lapan, Packt Publishing Limited (21 June 2018).
- Algorithms for Reinforcement Learning by Csaba Szepesvari, Morgan and Claypool Publishers (2010)
- Deep Reinforcement Learning: Fundamentals, Research and Applications by Hao Dong, Springer Verlag (2020)