

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based on AICTE Flexible Curricula

CSE- Internet of Things and Cyber Security Including Block Chain Technology

IS- 701 Cloud Computing

- Explain the core concepts of the cloud computing paradigm
- Demonstrate knowledge of virtualization
- Explain the core issues of cloud computing such as security, privacy, and interoperability.
- Choose the appropriate technologies, algorithms, and approaches for the related issues.
- Identify problems, and explain, analyze, and evaluate various cloud computing solutions

Unit I: Introduction of Grid and Cloud computing, characteristics, components, business and IT perspective, cloud services requirements, cloud models, Security in public model, public versus private clouds, Cloud computing platforms: Amazon EC2, Platform as Service: Google App Engine, Microsoft Azure, Utility Computing, Elastic Computing.

Unit II: Cloud services- SAAS, PAAS, IAAS, cloud design and implementation using SOA, conceptual cloud model, cloud stack, computing on demand, Information life cycle management, cloud analytics, information security, virtual desktop infrastructure, storage cloud.

Unit III: Virtualization technology: Definition, benefits, sensor virtualization, HVM, study of hypervisor, logical partitioning- LPAR, Storage virtualization, SAN, NAS, cloud server virtualization, virtualized data center.

Unit IV: Cloud security fundamentals, Vulnerability assessment tool for cloud, Privacy and Security in cloud, Cloud computing security architecture: Architectural Considerations- General Issues, Trusted Cloud computing, Secure Execution Environments and Communications, Microarchitectures; Identity Management and Access control-Identity management, Access control, Autonomic Security, Cloud computing security challenges: Virtualization security management virtual threats, VM Security Recommendations, VM-Specific Security techniques, Secure Execution, Environments and Communications in cloud.

Unit V: SOA and cloud, SOA and IAAS, cloud infrastructure benchmarks, OLAP, business intelligence, e-Business, ISV, Cloud performance monitoring commands, issues in cloud computing. QOS issues in cloud, mobile cloud computing, Inter cloud issues, Sky computing, Cloud Computing Platform, Xen Cloud Platform, Eucalyptus, OpenNebula, Nimbus, TPlatform, Apache Virtual Computing Lab (VCL), Anomaly Elastic Computing Platform.

References:

1. Dr.Kumar Saurabh, “Cloud Computing”, Wiley India.
2. Ronald Krutz and Russell Dean Vines, “Cloud Security”, Wiley-India.
3. Judith Hurwitz, R.Bloor, M.Kanfman, F.Halper, “Computing for Dummies”, Wiley India Edition.
4. Anthony T.Velte Toby J.Velte, “Cloud Computing – A Practical Approach”, TMH.
5. Barrie Sosinsky, ‘Cloud Computing Bible’, Wiley India.

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Departmental Elective IS- 702(A) Machine Learning

COURSE OBJECTIVES: The objective of this course is to impart necessary knowledge of different machine learning techniques and develop programming skills required to build machine learning based applications.

COURSE OUTCOMES: After completing the course student should be able to:

1. Describe in-depth about theories, methods, and algorithms in machine learning.
2. Find and analyze the optimal hyper parameters of the machine learning algorithms.
3. Examine the nature of a problem at hand and determine whether machine learning can solve it efficiently.
4. Solve and implement real world problems using machine learning.

COURSE CONTENTS:

UNIT-I

Introduction to machine learning, Machine learning life cycle, Types of Machine Learning System (supervised and unsupervised learning, Batch and online learning, Instance-Based and Model based Learning), scope and limitations, Challenges of Machine learning, data visualization, hypothesis function and testing, data pre-processing, data augmentation, normalizing data sets, , Bias-Variance tradeoff, Relation between AI (Artificial Intelligence), ML (Machine Learning), DL (Deep Learning) and DS (Data Science).

UNIT-II

Clustering in Machine Learning: Types of Clustering Method: Partitioning Clustering, Distribution Model-Based Clustering, Hierarchical Clustering, Fuzzy Clustering. Birch Algorithm, CURE Algorithm. Gaussian Mixture Models and Expectation Maximization. Parameters estimations – MLE, MAP. Applications of Clustering.

UNIT-III Classification algorithm: - Logistic Regression, Decision Tree Classification, Neural Network, K-Nearest Neighbors (K-NN), Support Vector Machine, Naive Bayes (Gaussian, Multinomial, Bernoulli). Performance Measures: Confusion Matrix, Classification Accuracy, Classification Report: Precisions, Recall, F1 score and Support.

UNIT-IV Ensemble Learning and Random Forest: Introduction to Ensemble Learning, Basic Ensemble Techniques (Max Voting, Averaging, Weighted Average), Voting Classifiers, Bagging and Pasting, Out-of-Bag Evaluation, Random Patches and Random Subspaces, Random Forests (Extra-Trees, Feature Importance), Boosting (AdaBoost, Gradient Boosting), Stacking.

UNIT-V Dimensionality Reduction: The Curse of Dimensionality, Main Approaches for Dimensionality Reduction (Projection, Manifold Learning) PCA: Preserving the Variance, Principal Components, Projecting Down to d Dimensions, Explained Variance Ratio, Choosing the Right Number of Dimensions, PCA for Compression, Randomized PCA,

Incremental PCA. Kernel PCA: Selecting a Kernel and Tuning Hyper parameters. Learning Theory: PAC and VC model.

REFERENCE BOOKS:

1. Tom M. Mitchell, "Machine Learning", McGraw Hill Education, First edition, 2017.
2. Aurelien Geon, "Hands-On Machine Learning with Scikit-Learn and Tensorflow: Concepts, Tools, and Techniques to Build Intelligent Systems", Shroff/O'Reilly; First edition (2017).
3. Andreas Muller, "Introduction to Machine Learning with Python: A Guide for Data Scientists", Shroff/O'Reilly; First edition (2016).
4. Leonard Kaufman and P. J. Rousseau. Finding groups in data: An introduction to cluster analysis, Wiley, 2005
5. Nello Cristianini and John Shawe-Taylor, An Introduction to Support Vector Machines, Cambridge University Press, 2000.

PRACTICAL: Different problems to be framed to enable students to understand the concept learnt and get hands-on on various tools and software related to the subject. Such assignments are to be framed for ten to twelve lab sessions

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Open Elective IS 702 (B) Compiler Design

UnitI: Introduction to compiling & Lexical Analysis Introduction of Compiler, Major data Structure in compiler, types of Compiler, Front-end and Back-end of compiler, Compiler structure: analysis-synthesis model of compilation, various phases of a compiler, Lexical analysis: Input buffering, Specification & Recognition of Tokens, Design of a Lexical Analyzer Generator, LEX.

UnitII: Syntax Analysis & Syntax Directed Translation Syntax analysis: CFGs, Top down parsing, Brute force approach, recursive descent parsing, transformation on the grammars, predictive parsing, bottom up parsing, operator precedence parsing, LR parsers (SLR, LALR, LR), Parser generation. Syntax directed definitions: Construction of Syntax trees, Bottom up evaluation of S-attributed definition, L-attribute definition, Top down translation, Bottom Up evaluation of inherited attributes Recursive Evaluation, Analysis of Syntax directed definition.

UnitIII: Type Checking & Run Time Environment: Type checking: type system, specification of simple type checker, equivalence of expression, types, type conversion, overloading of functions and operations, polymorphic functions. Run time Environment: storage organization, Storage allocation strategies, parameter passing, dynamic storage allocation, Symbol table, Error Detection & Recovery, Ad-Hoc and Systematic Methods.

Unit IV: Code Generation: Intermediate code generation: Declarations, Assignment statements, Boolean expressions, Case statements, Back patching, Procedure calls Code Generation: Issues in the design of code generator, Basic block and flow graphs, Register allocation and assignment, DAG representation of basic blocks, peephole optimization, generating code from DAG.

Unit V: Code Optimization: Introduction to Code optimization: sources of optimization of basic blocks, loops in flow graphs, dead code elimination, loop optimization, Introduction to global data flow analysis, Code Improving transformations, Data flow analysis of structure flow graph Symbolic debugging of optimized code.

References:

1. A. V. Aho, R. Sethi, and J. D. Ullman. Compilers: Principles, Techniques and Tools , Pearson Education
2. Raghavan, Compiler Design, TMH Pub.
3. Louden. Compiler Construction: Principles and Practice, Cengage Learning
4. A. C. Holub. Compiler Design in C , Prentice-Hall Inc., 1993.
5. Mak, writing compiler & Interpreters, Willey Pub.

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Open Elective IS 702 (C) Malware Analysis and Reverse Engineering

Unit I: Fundamentals of Malware Analysis (MA), Reverse Engineering Malware (REM) Methodology, Brief Overview of Malware analysis lab setup and configuration, Introduction to key MA tools and techniques, Behavioral Analysis vs. Code Analysis, Resources for Reverse-Engineering Malware (REM)

Unit II: Malware taxonomy and characteristics, Understanding Malware Threats, Malware indicators, Malware Classification, Examining ClamAV Signatures, Creating Custom ClamAV Databases, Using YARA to Detect Malware Capabilities. Malware Labs, Creating a Controlled and Isolated Laboratory, Introduction to MA Sandboxes.

Unit III: Malware Lab Integrity, Routing TCP/IP Connections, Capturing and Analyzing Network Traffic, Internet simulation using INetSim, Using Deep Freeze to Preserve Physical Systems, Using FOG for Cloning and Imaging Disks, Using MySQL Database to Automate FOG Tasks. Malware Analysis Tools, Introduction to Python, Introduction to x86 Intel assembly language, Scanners: Virus Total, Jotti, and NoVirusThanks. Analyzers: ThreatExpert, CWSandbox, Anubis, Joebox, Dynamic Analysis Tools: Process Monitor, Regshot, HandleDiff, Analysis Automation Tools:

Unit IV: Malware Forensics, Using TSK for Network and Host Discoveries, Using Microsoft Offline API to Registry Discoveries, Identifying Packers using PEiD, Registry Forensics with RegRipper Plug-ins, Case Studies. Malware and Kernel Debugging, Opening and Attaching to Processes, Configuration of JIT Debugger for Shellcode Analysis, Controlling Program Execution, Setting and Catching Breakpoints, Debugging with Python Scripts and PyCommands, DLL Export Enumeration, Execution, and Debugging, Debugging a VMware Workstation Guest (on Windows), Debugging a Parallels Guest (on Mac OS X), Introduction to WinDbg Commands and Controls,

Unit V: Memory Forensics and Volatility, Memory Dumping with MoonSols Windows Memory Toolkit, Accessing VM Memory Files, Overview of Volatility, Investigating Processes in Memory Dumps, Code Injection and Extraction. Researching and Mapping SourceDomains/IPs, Using WHOIS to Research Domains, DNS Hostname Resolution. Reverse IP Search, Creating Static Maps, Creating Interactive Maps

Reference:

1. Malware Analyst's Cookbook and DVD: Tools and Techniques for Fighting Malicious Code, First Edition (2010):Michael Ligh, Steven Adair, Blake Hartstein, and Matthew Richard. ISBN-10: 0470613033, ISBN-13: 978- 0470613030. Wiley Publications
2. Malware: Fighting Malicious Code: Ed Skoudis and Lenny Zeltser (2003). ISBN-10: 0131014056, ISBN-13: 978-0131014053. Prentice Hall Publications.
3. Malware Forensics: Investigating and Analyzing Malicious Code: Cameron H. Malin, Eoghan Casey, and JamesM. Aquilina (2008). ISBN-10: 159749268X, ISBN-13: 978- 1597492683. Syngress Publications.

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Departmental Elective IS- 702(D) Ethical Hacking and Penetration Testing

- This course teaches students the underlying principles and many of the techniques associated with the cybersecurity practice known as penetration testing or ethical hacking.
- Students will learn about the entire penetration testing process including planning, reconnaissance, scanning, exploitation, post-exploitation, and result reporting.
- The course will provide the fundamental information associated with each of the methods employed and insecurities identified. In all cases, remedial techniques will be explored.
- Students will develop an excellent understanding of current cybersecurity issues and ways that user, administrator, and programmer errors can lead to exploitable insecurities.

Unit I: Introduction: Introduction to Ethical Hacking and penetration testing, Software Installation, Pre-engagement, Scope of penetration testing, Ethical hacking requirements, Legal issues, Penetration test report structure and components

Unit II: Reconnaissance, DNS reconnaissance, Web reconnaissance, TCP Connections, UDP Connections, Scanning using Nmap, FTP, HTTP, telnet, SSL and TLS encryption, NetBIOS and NFS.

Unit III: Encryption essentials, Cryptography weaknesses, Windows passwords, Hashes, Rainbow tables, Linux Passwords, Hashes with salt, Pentesting Windows and Linux vulnerabilities

Unit IV: Metasploit exploitation framework, Use of netcat and pivoting, VOIP, Wireless networks and their encryption standards, Lock picking, Master Keys, and Oracle hacks, Databases, SQL, SQL Injection

Unit V: Browser Proxies and non-rendered content, Cross-site scripting, Cross-site request forgery, Web authentication, Session Management, Mobile device security issues.

Textbooks:

1. Hacking Exposed 7: Network Security Secrets and Solutions, Stuart McClure, Joel Scambray, George Kurtz, © 2012, McGraw Hill, ISBN 978-0-07-178028-5.
2. Beaver, Kevin. Hacking for dummies. 6th ed. John Wiley & Sons, 2018.

Web Resources:

1. Open Web Application Security (OWASP): <https://owasp.org/>
2. Certified Ethical Hacker(CEH) by EC-Council

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Departmental Elective IS- 703(A) Cyber Physical Systems

Unit I: Cyber Physical Systems in Real world, Basic Principle of Cyber Physical Systems, Industry 4.0, IIoT, Cyber Physical System Design and system requirements, Cyber Physical Systems Design Recommendations, CPS system requirements, Cyber Physical System Application, Case study of Cyber Physical Systems

Unit II: Cyber Physical System Platforms, Hardware platforms for Cyber Physical Systems (Sensors/Actuators, Microprocessor/Microcontrollers), Wireless Technologies for Cyber Physical Systems

Unit III: Cyber Physical System – Models and Dynamics Behaviours Continuous Dynamics, Discrete dynamics, Hybrid Systems, Concurrent Models of computation, Structure of Models, Synchronous Reactive models, Dataflow models of computation, Timed models of computation

Unit IV: Study of Embedded Systems vs Internet of Things vs Cyber Physical System Design of Embedded Systems (I/O Units, Multitasking and Scheduling), Internet of Things Architecture, CPS Architecture

Unit V: Security and Privacy in Cyber Physical Systems Security and Privacy Issues in CPSs, Local Network Security for CPSs, Internet-Wide Secure Communication, Security and Privacy for Cloud-Interconnected CPSs, Case Study: Cybersecurity in Digital Manufacturing/Industry 4.

Text Book(s)

- Principles of Cyber Physical Systems, Rajeev Alur, MIT Press, 2015
- E. A. Lee, Sanjit Seshia , "Introduction to Embedded Systems – A Cyber–Physical Systems Approach", Second Edition, MIT Press, 2017, ISBN: 978-0-262-53381-2
- Guido Dartmann, Houbing song, Anke schmeink, “Big data analytics for Cyber Physical System”, Elsevier, 2019
- Houbing song, Danda B Rawat, Sabina Jeschke, Christian Brecher, “Cyber Physical Systems Foundations, Principles and Applications”, Elsevier, 2017
- Chong Li, Meikang Qiu, “Reinforcement Learning for Cyber Physical Systems with Cyber Securities Case Studies”, CRC press, 2019
- Houbing Song, Glenn A.Fink, Sabina Jesche, “Security and Privacy in Cyber-Physical
- Systems: Foundations, Principles and Solutions”, IEEE Press.

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Departmental Elective IS- 703(B) Security and Privacy in IoT

- Describe the basics of securing Internet of Things.
- Explain architecture and threats in IoT.
- Analyze various privacy schemes related to IoT
- Describe the authentication mechanisms for IoT security and privacy.
- Explain security issues for various applications using case studies

Unit I: Introduction: Securing the Internet of Things Introduction – Security Requirements in IoT architectures – Security in Enabling Technologies – IoT Security Life Cycle – Cryptographic Fundamentals for IoT Security Engineering - Security Concerns in IoT Applications – Basic Security Practices.

Unit II: security architecture in the Internet of Things Introduction – Security Requirements in IoT – Insufficient Authentication/Authorization – Insecure Access Control – Threats to Access Control, Privacy, and Availability – Attacks Specific to IoT – Malware Propagation and Control in Internet of Things.

Unit III: Privacy preservation Privacy Preservation Data Dissemination - Privacy Preservation for IoT used in Smart Building – Exploiting Mobility Social Features for Location Privacy Enhancement in Internet of Vehicles – Lightweight and Robust Schemes for Privacy Protection in Key personal IOT Applications: Mobile WBSN and Participatory Sensing.

Unit IV: Trust, Authentication and Data Security: Trust and Trust Models for IoT – Emerging Architecture Model for IoT Security and Privacy – preventing Unauthorized Access to Sensor Data – Authentication in IoT – Computational Security for the IoT – Secure Path Generation Scheme for real-Time Green IoT – Security Protocols for IoT Access Networks

Unit V: Social Awareness and Case Studies User Centric Decentralized Governance Framework for Privacy and Trust in IoT – Policy Based Approach for Informed Consent in IoT - Security and Impact of the IoT on Mobile Networks – Security Concerns in Social IoT – Security for IoT Based Healthcare – Smart cities.

TEXT BOOKS:

1. Shancang Li, Li Da Xu, “Securing the Internet of Things,” Syngress (Elsevier) publication, 2017, ISBN: 978-0-12-804458-2.
2. Fei Hu, “Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations,” CRC Press (Taylor & Francis Group), 2016, ISBN: 978-1-4987-23190.
3. Arshdeep Bahga, Vijay Madiseti, “Internet of Things – A Hands-on approach,” VPT Publishers, 2014, ISBN: 978-0996025515.
4. Alasdair Gilchris, “IoT Security Issues,” Walter de Gruyter GmbH & Co, 2017.
5. Sridipta Misra, Muthucumaran Maheswaran, Salman Hashmi, “Security Challenges and Approaches in Internet of Things,” Springer, 2016.
6. Brian Russell, Drew Van Duren, “Practical Internet of Things Security,” Packet Publishing Ltd, 2016.

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Departmental Elective IS- 703(C) Industrial IoT

1. Understand the role of IIOT in manufacturing processes
2. Apply knowledge of IIoT design considerations and IIoT technologies to develop solutions for industries
3. Collect, communicate and leverage the IIoT data
4. Analyze the IIoT data by using various machine learning algorithms
5. Identify, formulate and solve engineering problems by using Industrial IoT.

Unit I: Introduction to Industrial Internet of Things and Industry 4.0: Basics of Industry 4.0, Basics of Industrial Internet of Things (IIoT), Evolution of IIoT – understanding the IT & OT (Operational Technology) convergence, OT components like Industrial control systems, PLC, SCADA, and DCS, Industrial Edge, Open loop and closed loop controls, Components of IIOT, Role of IIOT in Manufacturing Processes, Challenges & Benefits in implementing IIOT, Adoption of IIoT, Market trends and opportunities in IIoT

Unit II: Technological Aspects of Industry 4.0 and IIoT: Industrial processes, Industrial sensing and actuation, Industrial networks, Machine-to-machine networks, Business Models and Reference Architecture of IIoT, IIoT design considerations, Key Technologies: Off-site Technologies, On-site Technologies

Unit III: Enabling Technologies of IIoT: IIoT Layers, Sensing, Processing, Communication and Networking in IIoT, Sensors, Actuators, Industrial Data Transmission, Industrial Data Acquisition

Unit IV: IIoT Analytics: Big Data Analytics and Software Defined Networks, Machine Learning and Data Science in Industries, Security and Fog computing in IIoT

Unit V: Applications of IIoT and Case Studies: Healthcare Applications in Industries, Inventory Management and Quality Control, Plant Safety and Security, Oil, chemical and pharmaceutical industry, Integration of products, processes, and people, Smart factories and cyber-physical systems, Case Studies, IIoT Application Development, Protocols used in building IIoT applications

References:

1. “Introduction to Industrial Internet of Things and Industry 4.0”, By Sudip Misra Chandana Roy, Anandarup Mukherjee, CRC Press, 2020
2. “Industrial Internet of Things for Developers”, Ryane Bohm, Wiley
3. “Handbook of Industry 4.0 and Smart Systems”, Diego Galar Pascual, Pasquale Daponte, UdayKumar, CRC Press, 2019

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Departmental Elective IS- 703(D) Data Engineering

UNIT – I

Data Driven Organizations & Elements of Data:

Data-driven decisions, data pipeline infrastructure for data-driven decisions, role of the data engineer in data-driven organizations, Modern data strategies, Introduction to elements of Data, the five Vs of data – volume, velocity, variety, veracity, and value, Variety – data types & data sources, Activities to improve veracity and value.

UNIT – II

Design Principles and Patterns for Data Pipelines

The evolution of data architectures, Modern data architecture on various cloud platforms, Modern data architecture pipeline - Ingestion and storage, Modern data architecture pipeline - Processing and Consumption, Streaming analytics pipeline

Securing and Scaling the Data Pipeline:

Cloud security, Security of analytics workloads, ML security, Scaling Data Pipeline, creating a scalable infrastructure, Creating scalable components.

UNIT – III

Ingesting and Preparing Data:

ETL and ELT comparison, Data wrangling, Data Discovery, Data structuring, Data Cleaning, Data enriching, Data validating, Data publishing

Ingesting by Batch or by Stream

Comparing batch and stream ingestion, Batch ingestion processing, Purpose-built data ingestion tools, Scaling considerations for batch processing, stream processing, Scaling considerations for stream processing, Ingesting IoT data by stream

UNIT – IV

Storing and Organizing Data

Storage in the modern data architecture, Data Lake storage, Data warehouse storage, Purpose-built databases, Storage in support of the pipeline, Securing storage.

Processing Big Data

Big data processing concepts, Apache Hadoop, Apache Spark, Amazon EMR

UNIT – V

Processing Data for ML & Automating the Pipeline:

ML Concepts, ML Lifecycle, Framing the ML problem to meet the business goal, Collecting data, Applying labels to training data with known targets, Pre-processing data, Feature engineering, Developing a model, Deploying a model, ML infrastructure on AWS, AWS SageMaker, Automating the Pipeline, Automating infrastructure deployment, CI/CD, Automating with Step Functions.

List of Experiments:

- 7 - 10 experiments to be framed as per the syllabus.

Recommended Books:

1. Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems, by Martin Kleppmann
2. T-SQL Querying (Developer Reference) by Itzik Ben-Gan
3. The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modelling by Margy Ross
4. Spark: The Definitive Guide: Big Data Processing Made Simple by Bill Chambers
5. Data Pipelines with Apache Airflow by Bas P. Harens
6. Streaming Systems: The What, Where, When, and How of Large-Scale Data Processing by Tyler Akidau
7. Kubernetes in Action by Marko Luksa