

# Tulsiramji Gaikwad-Patil College of Engineering & Technology, Nagpur

(An Autonomous Institution Affiliated to RTM Nagpur University, Nagpur)

## SCHEME OF INSTRUCTION & SYLLABI

**Programme: Computer Science and Engineering**

**Scheme of Instructions: Final Year B.Tech. in Computer Science and Engineering**

**Semester-VII**

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs/Wk	Credits	Exam Scheme				
									CT-1	CT-2	CA	ESE	TOTAL
1	PCC	BCS34701	Information and Cyber Security	3	-	-	3	3	15	15	10	60	100
2	PCC	BCS34702	Sustainable Development Goal	2	-	-	2	2	14	6	30	2	50
3	Project	BCS34703	Project	-	-	8	8	4	-	-	50	50	100
4	PEC	BCS34704-07	Program Elective - IV	4	-	-	4	4	15	15	10	60	100
5	PEC	BCS34708-11	Program Elective - V	4	-	-	4	4	15	15	10	60	100
6	MDM	BEC34811	Introduction to IOT	4	-	-	4	4	15	15	10	60	100
7	PCC	BCS34812	Information and Cyber Security Lab	-	-	2	2	1	-	-	25	25	50
<b>Total</b>				<b>17</b>		<b>10</b>	<b>27</b>	<b>22</b>	<b>74</b>	<b>66</b>	<b>145</b>	<b>317</b>	<b>600</b>

L-Lecture

CT1-ClassTest1

CT2-ClassTest2

SL-Self Learning

TA/CA-Teacher Assessment/Continuous Assessment




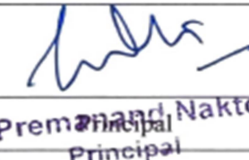
ESE-End Semester Examination (For Laboratory End Semester Performance)

P-Practical

NHL-Notional Hrs/Wk (Total Notional Hrs)

Course Category	BSC/ESC (Basic Science Course/Engineering Science Course.)	PCC (Programme Core courses)	PEC (Programme Elective courses)	OEC (Open Elective Course)	Multi-disciplinary courses	VSEC (Skill Course)	VEC (Value Education Courses)	Humanities Social Science & Management		Experiential Learning Courses	CC (Liberal Learning Courses)
								AEC (Ability Enhancement Course)	IKS (Indian Knowledge System)		
Credits		04	6	-	2	-	-			8	
Cumulative Sum	16/13	48	20	8	14	8	4		10	22	4

**PROGRESSIVE TOTAL CREDITS: 128+22=150**

 Chairperson HOD	 Director Academics / Vice-Principal Director Academics	 Director Administration	 Principal Dr. Premnand Naktode	June, 2026 Date of Release	1.00 Version	Applicable for AY 2026-27
Computer Science & Engineering Tulsiramji Gaikwad-Patil College Of Engineering		TGPCET, Nagpur				

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SCHEME OF INSTRUCTION & SYLLABI

Program: Computer Science & Engineering

List of Electives offered by  
Computer Science & Engineering

Course Code	Professional Elective- I	Course Code	Professional Elective- II
	Semester V		Semester VI
BCS33506	Artificial Intelligence	BCS33605	Neural Network and Fuzzy Logic
BCS33507	Principles of Distributed Systems	BCS33606	Cloud Computing
BCS33508	Design Patterns	BCS33607	Software Project Management
BCS33509	Introduction to Data Science	BCS33608	Data Visualization Techniques

Course Code	Professional Elective- III	Course Code	Professional Elective- IV
	Semester VI		Semester VII
BCS33609	TCP/IP	BCS34704	Natural Language Processing
BCS33610	Computer Graphics	BCS34705	Parallel and Distributed Database
BCS33611	Network Security	BCS34706	Software Testing and Quality Assurance
BCS33612	Blockchain and Distributed Ledger Technology	BCS34707	Big Data Analytics

Course Code	Professional Elective- V
	Semester VII
BCS34708	Deep Learning
BCS34709	DevOps
BCS34710	Full Stack Development
BCS34711	Predictive Analytics



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**Fourth Year (Semester-VII) B.Tech. (CSE)**

**Course Code:BCS34701 (Information and Cyber Security)**

Teaching Scheme		Examination Scheme	
Lectures	3 Hrs/week	CT-1	15 Marks
Tutorial	-	CT-2	15 Marks
Total Credit	3	CA	10 Marks
		ESE	60 Marks
		<b>Total</b>	<b>100 Marks</b>
		<b>Duration of ESE: 03Hrs 00Min.</b>	

**Course Objective:**

1	To understand the fundamentals, legal and ethical aspects, and management standards of information security.
2	To learn symmetric and asymmetric cryptographic techniques, key management, and encryption practices used in industry.
3	To explore authentication methods, hashing, digital signatures, and identity management systems.
4	To implement and analyse network, transport-layer, and perimeter security mechanisms with practical tools.
5	To study and apply web, email, and e-commerce security techniques aligned with modern cyber practices.

**Course Contents**

<b>Unit I</b>	<b>Foundations of Information Security:</b> Need of information security, legal/ethical issues, attributes of security, OSI security architecture, attacks, services, and mechanisms, Security policy, standards, lifecycle, classical cryptography. Industry Standards: ISO/IEC 27001, NIST Cybersecurity Framework, GDPR compliance. Tools: Wireshark (traffic analysis), Nmap (vulnerability scanning). Case Study: Security governance implementation in IT firms (e.g., IBM, Infosys).
<b>Unit II</b>	<b>Cryptography and Key Management</b> DES, AES, IDEA, RC5, RSA, ECC, Diffie Hellman, cryptography principles. Introduction to Tools: OpenSSL, CrypTool, VeraCrypt, encryption/decryption. Modern Cryptography: Quantum-resistant algorithms (post-quantum cryptography overview). Cloud Security: Encryption in cloud storage (AWS KMS / Azure Key Vault). Case Study: Data encryption strategy in banking systems or cloud infrastructure.
<b>Unit III</b>	<b>Authentication, Hashing, and Digital Signatures:</b> MD5, SHA, HMAC, DSA, PKI, Kerberos, X.509 certificates. Introduction to Tools: Hashcat (password cracking demo), OpenSSL (digital certificate creation). Applications: Identity and Access Management (IAM) using Okta/Azure AD. Modern Authentication: OAuth 2.0, JWT (JSON Web Tokens), Multi-factor Authentication (MFA). Case Study: Authentication architecture in Google Workspace / AWS Cloud.
<b>Unit IV</b>	<b>Network, Transport &amp; Perimeter Security:</b> IPSec, TLS/SSL, Firewalls, IDS/IPS. Security tools overview: pfSense (Firewall), Snort/Suricata (IDS/IPS), Wireshark (Packet Analysis). DevSecOps: Secure CI/CD pipelines with Jenkins & SonarQube. Cloud Security: Security Groups & VPC Firewall rules (AWS/Azure). Case Study: Incident detection using SIEM tools (Splunk, QRadar).

<b>Unit V</b>	<b>Web, Email, and E-Commerce Security:</b> Web & email security, PGP, S/MIME, SET, smart cards. Introduction to security tools: Burp Suite (web vulnerability scanning), OWASP ZAP, Metasploit (ethical testing). Industry Standards: OWASP Top 10 vulnerabilities, PCI-DSS for payment security. Modern Topics: API Security, Zero Trust Architecture, Cloud Web App Firewalls (AWS WAF). Case Study: Cyber fraud detection in e-commerce systems (e.g., Amazon Pay, Razorpay).
<b>Text Books</b>	
T1	William Stallings "Cryptography and network security, 8th Edition principles and practices", Pearson.
T2	Robert Bragge, Mark Rhodes, Keith Straggberg "Network Security, The Complete Reference", Tata McGraw Hill Publication
<b>Reference Books</b>	
R1	Bernard Menezes, —Network Security and Cryptography, Cengage Learning.
R2	Nina Godbole, Information System Security, Wiley India Pvt., ISBN978-81-265-1692-6.
R3	Charlie Kaufman, Radia Perlman and mike speciner, "Network security, private communication in a public world"
<b>Useful Links</b>	
1	<a href="https://www.infosecinstitute.com/resources/network-security-101/a-deep-dive-into-network-security-protocols-safeguarding-digital-infrastructure-2024/">https://www.infosecinstitute.com/resources/network-security-101/a-deep-dive-into-network-security-protocols-safeguarding-digital-infrastructure-2024/</a>
2	"The Web Application Hacker's Handbook" — for understanding underlying attack techniques (injection, XSS, auth flaws, etc.)
3	"Exploring network security: Firewalls, IDS, IPS and VPNs" — blog post summarizing perimeter security components & tools.
4	<a href="https://docs.aws.amazon.com/vpc/latest/userguide/vpc-security-groups.html">https://docs.aws.amazon.com/vpc/latest/userguide/vpc-security-groups.html</a>
5	<a href="https://nptel.ac.in/courses/106/105/106105031/">https://nptel.ac.in/courses/106/105/106105031/</a>
6	<a href="https://nptel.ac.in/courses/106/106/106106129/">https://nptel.ac.in/courses/106/106/106106129/</a>
7	National Institute of Standards and Technology (NIST) Special Publication — An Introduction to Information Security (PDF) — <a href="https://doi.org/10.6028/NIST.SP.800-12r1">https://doi.org/10.6028/NIST.SP.800-12r1</a> NIST Publications
8	E-Commerce Security & Controls (PDF excerpt) — <a href="https://cdn.taxmann.com/BookshopFiles/bookfiles/9789357788458_sampleNew7b891b192827.pdf">https://cdn.taxmann.com/BookshopFiles/bookfiles/9789357788458_sampleNew7b891b192827.pdf</a> cdn.taxmann.com
9	Principles of Information Security by Whitman & Mattord — details & edition info — <a href="https://www.cengage.co.in/book-list/print/principles-of-information-security-with-mindtap-7e-ac">https://www.cengage.co.in/book-list/print/principles-of-information-security-with-mindtap-7e-ac</a>

Sr. no.	Course Outcomes	CL	Class Session
1	<b>Explain</b> the principles, legal aspects, and architecture of information security and prepare a basic security policy aligned with industry standards.	2	9
2	<b>Implement</b> symmetric and asymmetric encryption techniques and demonstrate secure key management using standard tools.	2	9
3	<b>Apply</b> authentication and hashing techniques and configure digital signatures and identity management systems.	4	9
4	<b>Configure</b> and analyze firewalls, IDS/IPS, and secure communication protocols for enterprise networks.	4	9
5	<b>Evaluate</b> and implement web, email, and e-commerce security mechanisms using industry tools and frameworks.	4	9



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**Final Year (Semester- VII) B. Tech. Computer Science & Engineering**

**Course code : BCE34702 Course Name : Sustainable Development Goals**

Teaching Scheme		Examination Scheme	
Lectures	2 Hrs./week	CIE	20 Marks
Tutorial	-	ESE	30 Marks
Total Credit	2	Total	50 Marks
		Duration of ESE: 01 Hrs. 00 Min.	

**Course Objectives:**

1.	To develop a comprehensive understanding of the UN Sustainable Development Goals (SDGs) and their interconnections.
2.	To analyze the global challenges addressed by the SDGs and their impact on various sectors.
3.	To explore innovative solutions and best practices for implementing the SDGs.
4.	To evaluate the progress made towards achieving the SDGs at national and international levels.
5.	To foster a sense of global citizenship and social responsibility among students.

**Course Contents**

		Hours
<b>Unit I</b>	<b><u>Introduction to Sustainable Development Goals (SDGs):</u></b> Definition of Sustainability, Aspects of sustainability, historical perspective of sustainable development, Climate Change Conferences and Summits, the Brundtland Commission Report, transition from Millennium Development Goals (MDGs) to SDGs, the role of UN and the need for SDGs and Adoption by the World, scope and inclusion of the 2030 Agenda for Sustainable Development.	(7)
<b>Unit II</b>	<b><u>Framework &amp; Structuring of the 17 SDGs:</u></b> SDG 1: No Poverty, SDG 2: Zero Hunger, SDG 3: Good Health and Well-being, SDG 4: Quality Education, SDG 5: Gender Equality, SDG 6: Clean Water and Sanitation, SDG 7: Affordable and Clean Energy, SDG 8: Decent Work and Economic Growth, SDG 9: Industry, Innovation and Infrastructure, SDG 10: Reduced Inequalities, SDG 11: Sustainable Cities and Communities, SDG 12: Responsible Consumption and Production, SDG 13: Climate Action, SDG 14: Life below Water, SDG 15: Life on Land, SDG 16: Peace, Justice and Strong Institutions, SDG 17: Partnerships for the Goal	(7)
<b>Unit III</b>	<b><u>SDGs Implementation and Future Perspectives:</u></b> Interconnections between the SDGs, the role of technology and innovation in SDG implementation, financing the SDGs, measuring SDG progress, future challenges and opportunities, Climate change and its impact on sustainable development, Case studies of successful SDG implementation – India, World	(7)

**Text Books**

1	Hazra, Somnath., Bhukta, Anindya (2020) Sustainable Development Goals An Indian Perspective, Springer International Publishing, Switzerland
2	Ziai, Aram (2016) Development Discourse and Global History from colonialism to the sustainable development goals. Routledge, London & New York

### Reference Books

1	Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G., Fuller, G., Woelm, F. 2020. The Sustainable Development Goals and COVID-19. Sustainable Development Report 2020. Cambridge: Cambridge University Press.
2	OECD (2019), Sustainable Results in Development: Using the SDGs for Shared Results and Impact, OECD Publishing, Paris, <a href="https://doi.org/10.1787/368cf8b4-en">https://doi.org/10.1787/368cf8b4-en</a> .

### Useful Links

1. <https://nptel.ac.in/courses/109106200>
2. <https://www.un.org/sustainabledevelopment/>

<b>BSH423</b>	<b>Course Outcomes</b>	<b>CL</b>
<b>CO 1</b>	To explore the historical origins and evolution of the UN-SDGs.	2
<b>CO 2</b>	To analyze the 17 SDGs and their interlinkages.	2
<b>CO 3</b>	To analyze the role of technology and innovation in achieving the SDGs along with future challenges and opportunities.	2





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**Fourth Year (Semester-VII) B.Tech. (CSE)**

**Course Code:BCS34704 (Natural Language Processing)**

Teaching Scheme		Examination Scheme	
Lectures	4Hrs/week	CT-1	15 Marks
Tutorial	-	CT-2	15 Marks
Total Credit	4	CA	10 Marks
		ESE	60 Marks
		<b>Total</b>	<b>100 Marks</b>
		<b>Duration of ESE: 03Hrs 00Min.</b>	

**Course Objective:**

1	To understand the fundamental concepts and techniques of Natural Language Processing.
2	To learn various NLP tasks, including text processing, information retrieval, and language modeling.
3	To gain practical experience in implementing NLP algorithms and applications.
4	To explore the applications of NLP in various domains.
5	To explore advanced NLP applications, considering ethical implications and emerging trends.

**Course Contents**

<b>Unit I</b>	Introduction to Natural Language Processing: Introduction to NLP: Concepts, applications, and challenges. Levels of Language Analysis: Phonology, Morphology, Syntax, Semantics, Pragmatics. Text Preprocessing: Tokenization, stemming, lemmatization, Stop word removal, noise removal, normalization, Regular expressions for text processing. Text Representation: Bag-of-Words (BoW), Word2Vec, GloVe, FastText, contextual embeddings (BERT embeddings)
<b>Unit II</b>	Linguistic Essentials and Syntax Analysis: Morphology: Inflectional and derivational morphology. Parts of Speech (POS) tagging: Rule-based, statistical, and transformationbased tagging, BERT-based POS tagging. Context-Free Grammars (CFGs) and parsing. Dependency Parsing: Concepts and algorithms. Chunking and Named Entity Recognition (NER)
<b>Unit III</b>	Semantic Analysis and Information Retrieval: Word Sense Disambiguation (WSD): Approaches and algorithms. Semantic roles and semantic networks. Information Retrieval (IR): Vector space model, relevance ranking, Evaluation metrics for IR.
<b>Unit IV</b>	Language Modeling and Text Classification: N-gram language models: Unigram, bigram, trigram. Smoothing techniques: Add-one, Good-Turing. Text classification: Naive Bayes, Support Vector Machines (SVM). Evaluation metrics for classification. Introduction to Recurrent neural network for text processing, LSTM.
<b>Unit V</b>	Advanced NLP Applications and Trends: Sentiment analysis: Techniques and applications, Machine Translation: Basic concepts and approaches. Neural MT, Text summarization: Extraction and abstraction methods. Dialogue systems: Basic concepts and applications. Introduction to transformer networks. Ethical Considerations in NLP.

**Text Books**

T1	Daniel Jurafsky and James H. Martin, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition," Pearson
T2	Natural Language Processing" by James Allen.

**Reference Books**

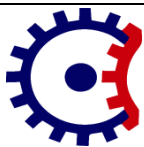
R1	Steven Bird, Ewan Klein, and Edward Loper, "Natural Language Processing with Python," O'Reilly Media
R2	The Oxford Handbook of Computational Linguistics" edited by Ruslan Mitkov.

## Useful Links

1 [https://onlinecourses.nptel.ac.in/noc23\\_cs45/preview](https://onlinecourses.nptel.ac.in/noc23_cs45/preview)

<b>BCS34704</b>	<b>Course Outcomes</b>	<b>CL</b>	<b>Class Session</b>
BCS34704.1	<b>Classify</b> the ability to preprocess text data using NLP techniques.	2	9
BCS34704.2	<b>Demonstrate</b> syntactic parsing methods, including context-free grammars and dependency parsing.	3	9
BCS34704.3	<b>Analyze</b> semantic structures and apply information retrieval techniques to extract meaningful insights from text.	4	9
BCS34704.4	Interpret language models and perform text classification using algorithms in NLP.	3	9
BCS34704.5	Evaluate real-world applications of Natural Language Processing	5	9





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**Fourth Year (Semester-VII) B.Tech. (CSE)**

**Course Code: BCS34705 (Parallel and Distributed Database)**

Teaching Scheme		Examination Scheme	
Lectures	4Hrs/week	CT-1	15 Marks
Tutorial	-	CT-2	15 Marks
Total Credit	4	CA	10 Marks
		ESE	60 Marks
		<b>Total</b>	<b>100 Marks</b>
		<b>Duration of ESE: 03Hrs 00Min.</b>	

**Course Objective:**

1	To enrich the previous knowledge of database systems and expose the need for distributed database technology to confront the deficiencies of the centralized database systems.
2	To introduce basic principles and implementation techniques of distributed database systems
3	To equip with principles and knowledge of parallel and object-oriented databases
4	To understand distributed DBMS architecture and design; query processing and optimization
5	To realize the importance of distributed transaction management and reliability; parallel and object database management systems

**Course Contents**

<b>Unit I</b>	<b>Introduction:</b> Distributed Data Processing, Distributed Database System, Promises of DDBSs, Problem areas. Distributed DBMS Architecture: Architectural Models for Distributed DBMS, DDMBS Architecture. Distributed Database Design: Alternative Design Strategies, Distribution Design issues, Fragmentation, Allocation.
<b>Unit II</b>	<b>Query processing and decomposition:</b> Query processing objectives, characterization of query processors, layers of query processing, query decomposition, localization of distributed data. Distributed query Optimization: Query optimization, centralized query optimization, distributed query optimization algorithms.
<b>Unit III</b>	<b>Transaction Management:</b> Definition, properties of transaction, types of transactions, distributed concurrency control: serializability, concurrency control mechanisms & algorithms, time - stamped & optimistic concurrency control Algorithms, deadlock Management.
<b>Unit IV</b>	<b>Distributed DBMS Reliability:</b> Reliability concepts and measures, fault-tolerance in distributed systems, failures in Distributed DBMS, local & distributed reliability protocols, site failures and network partitioning. Parallel Database Systems: Parallel database system architectures, parallel data placement, parallel query processing, load balancing, database clusters.
<b>Unit V</b>	<b>Distributed object Database Management Systems:</b> Fundamental object concepts and models, object distributed design, architectural issues, object management, distributed object storage, object query Processing. Object Oriented Data Model: Inheritance, object identity, persistent programming languages, persistence of objects, comparison OODBMS and ORDBMS

**Text Books**

T1	M. Tamer OZSU and Patuck Valduriez: Principles of Distributed Database Systems, Pearson Edn. Asia, 2001.
T2	Stefano Ceri and Giuseppe Pelagatti: Distributed Databases, McGraw Hill.

**Reference Books**

R1	Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom: “Database Systems: The Complete Book”, Second Edition, Pearson International Edition.
R2	Raghu Ramakrishnan and Johannes Gehrke, <i>Database Management Systems</i> , McGraw Hill Education.
<b>Useful Links</b>	
1	<a href="#">NPTEL – Distributed Database Management Systems</a>

BCS34705	Course Outcomes	CL	Class Session
BCS34705.1	<b>Understand</b> concepts and architecture of Distributed Database Systems.	2	9
BCS34705.2	<b>Apply</b> database design concepts such as fragmentation and allocation.	3	9
BCS34705.3	<b>Analyze</b> query processing and optimization techniques.	4	9
BCS34705.4	<b>Evaluate</b> transaction management, concurrency control, and reliability mechanisms.	5	9
BCS34705.5	<b>Design</b> distributed and parallel database systems using object-oriented concepts.	6	9





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**Fourth Year (Semester-VII) B.Tech. (CSE)**

**Course Code:BCS34706 (Software Testing and Quality Assurance)**

Teaching Scheme		Examination Scheme	
Lectures	4Hrs/week	CT-1	15 Marks
Tutorial	-	CT-2	15 Marks
Total Credit	4	CA	10 Marks
		ESE	60 Marks
		<b>Total</b>	<b>100 Marks</b>
		<b>Duration of ESE: 03Hrs 00Min.</b>	

**Course Objective:**

1	To introduce students to the basic concepts Software Testing.
2	To introduce a student to Testing Methodologies.
3	To introduce tools for testing and use it.
4	To introduce concept of Quality Assurance, Quality Factors
5	To introduce Quality management of software and Quality improvements.

**Course Contents**

<b>Unit I</b>	<b>PRELIMINARIES OF SOFTWARE TESTING;</b> Overview of testing- Need for software testing – Testing principles – STLC models-Testing in STLC models: Unit Testing, Integration Testing, System Testing, Acceptance Testing. Testing of software attributes: Smoke test, functional testing, usability testing, security, compliance testing.
<b>Unit II</b>	<b>TESTING METHODOLOGIES</b> Test Design techniques: Black Box testing- White Box testing –Software testing strategies-Unit testing- Integration Testing-validation testing – System testing-test planning.
<b>Unit III</b>	<b>TOOLS FOR TESTING</b> Test tool classification- Tools for management and control- Tools for specification- Tools for static and dynamic testing- Tools for non- functional tests. Manual testing versus automated testing- automated testing tools
<b>Unit IV</b>	<b>OVERVIEW OF QUALITY ASSURANCE</b> Definition of software quality and quality assurance- Quality assurance versus Quality control- Quality factors- Quality components – Quality plans- Software quality metrics Costs of software quality- Quality Management Framework
<b>Unit V</b>	<b>QUALITY MANAGEMENT</b> Requirements for SQA- Software QA versus Traditional QA- Defect prevention and process improvement- Software inspection- Comparison of Quality Assurance techniques and activities- Quality improvement methods- Management and its role in SQA - Quality management in IT

**Text Books**

T1	Andreas Spillner, Tilo Linz , Hans Schaefer “Software Testing Foundations - A Study Guide for the Certified Tester Exam” , Foundation Level ISTQB compliant, 4th Edition, Santa Barbara, CA :Rocky Nook, Inc, 2014
T2	Anne Mette Jonassen Hass, “Guide to Advanced Software Testing”, Artech House Publishers, 2008.

**Reference Books**

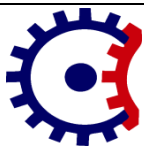
R1	G. Gordon Schulmeyer, “Handbook of Software Quality Assurance”, Fourth Edition, Artech House Publishers, 2007
R2	Daniel Galin, “Software Quality Assurance: From Theory To Implementation”, Pearson Education, 2008

## Useful Links

1	<a href="https://coastaltech.com/systems/">https://coastaltech.com/systems/</a>
2	<a href="http://www.javatpoint.com/software-testing-tutorial">http://www.javatpoint.com/software-testing-tutorial</a>

BCS34707	Course Outcomes	CL	Class Session
BCS34707.1	<b>Describe</b> the criteria for test cases, test metrics and measurements	2	9
BCS34707.2	<b>Design</b> the test cases for different applications.	2	9
BCS34707.3	<b>Apply</b> the appropriate test management and test automation techniques	3	9
BCS34707.4	<b>Analyze</b> different approaches to quality assurance	4	9
BCS34707.5	<b>Summarize</b> the quality management techniques based on commercial standards	5	9





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**Fourth Year (Semester-VII) B.Tech. (CSE)**

**Course Code:BCS34707 (Big Data Analytics)**

Teaching Scheme		Examination Scheme	
Lectures	4Hrs/week	CT-1	15 Marks
Tutorial	-	CT-2	15 Marks
Total Credit	4	CA	10 Marks
		ESE	60 Marks
		<b>Total</b>	<b>100 Marks</b>
		<b>Duration of ESE: 03Hrs 00Min.</b>	

**Course Objective:**

1	To understand Data Analytics Life Cycle and Business Challenges
2	To learn the core technologies used for big data storage and processing
3	To apply distributed computing frameworks like Apache Hadoop and Apache Spark to process large-scale data sets efficiently.
4	To explore big data technologies and tools.
5	To understand the ethical considerations and privacy issues involved in big data analytics

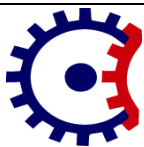
**Course Contents**

<b>Unit I</b>	<b>Introduction to Big Data Analysis</b> Definition of Big Data, Big data characteristics & considerations, Characteristics of Big data, Challenges and applications of Big Data, Enabling Technologies for Big Data, Big Data distribution packages.
<b>Unit II</b>	<b>Big Data Platforms</b> Overview of Apache Spark, HDFS, YARN, Map Reduce, MapReduce Programming Model with Spark, Cassandra, Cassandra Internals, HBase, HBase Internals. Hive (SQL): Introduction to Hive, Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, Hive QL, Tables, Spark: Introduction to data analytics with Spark, programming with RDDs, Working with key value pairs, Advanced spark programming. Hbase : HBasic, Concepts, Clients, Example, Hbase Versus RDBMS.
<b>Unit III</b>	<b>Big Data Applications</b> Overview of Big Data Machine Learning, Mahout, Big Data Machine Learning Algorithms in Mahout- K means, Naïve Bayes etc. Machine learning with Spark, Machine Learning Algorithms in Spark, Spark MLlib, Deep Learning for Big Data, Graph Processing: Pregel, Graph, Spark GraphX
<b>Unit IV</b>	<b>Data Analytics Lifecycle</b> Need of Data analytic lifecycle, Key roles for successful analytic projects, various phases of Data analytic lifecycle: Discovery, Data Preparation, Model Planning, Model Building, Communicating Results, Operationalization.
<b>Unit V</b>	<b>Database for the Modern Web</b> Introduction to mongoDB key features, Core server tools, MongoDB through the JavaScript' Shell, Creating and querying through Indexes, Document-oriented, principles of schema design, Constructing queries on databases, collections and documents, MongoDBquery language

<b>Text Books</b>	
T1	“Analytics in a Big Data World: The Essential Guide to Data Science and its Applications”, Bart Baesens, Wiley and SAS Business Series.
T2	“Big Data Principals and Paradiagram”, Rajkumar Buyya, Rodrigo N. Calheiros, Amir Vahid Dastjerdi, Morgan Kaufmann, Elsevier, ISBN: 978-0-12-805394-2
<b>Reference Books</b>	
R1	“BIG Data and Analytics”, Sima Acharya, Subhashini Chhellappan, Wiley publication, ISBN: 978-8126554782
R2	Data Mining: Concepts and Techniques Second Edition – Jiawei Han and Micheline Kamber – Morgan KaufMan Publisher
<b>Useful Links</b>	
1	<a href="https://www.coursera.org/specializations/big-data">https://www.coursera.org/specializations/big-data</a>
2	<a href="https://onlinecourses-archive.nptel.ac.in/">https://onlinecourses-archive.nptel.ac.in/</a>

<b>BCS34707</b>	<b>Course Outcomes</b>	<b>CL</b>	<b>Class Session</b>
<b>BCS34707.1</b>	<b>Understand</b> Data Analytics Lifecycle to address big data analytics projects	2	9
<b>BCS34707.2</b>	<b>Apply</b> appropriate analytic techniques and tools to analyze big data, create statistical models, and identify insights that can lead to actionable results	3	9
<b>BCS34707.3</b>	<b>Perform</b> business challenge as an analytics challenge	3	9
<b>BCS34707.4</b>	<b>Evaluate</b> the appropriate data visualizations to clearly communicate analytic insights to business sponsors and analytic audiences	4	9
<b>BCS34707.5</b>	<b>Analyze</b> how advanced analytics can be leveraged to create competitive advantage	4	9





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**Fourth Year (Semester-VII) B.Tech. (CSE)**

**Course Code:BCS34708 (Deep Learning)**

Teaching Scheme		Examination Scheme	
Lectures	4Hrs/week	CT-1	15 Marks
Tutorial	-	CT-2	15 Marks
Total Credit	4	CA	10 Marks
		ESE	60 Marks
		<b>Total</b>	<b>100 Marks</b>
		<b>Duration of ESE: 03Hrs 00Min.</b>	

**Course Objective:**

1	To introduce the basic concepts, definitions, and importance of deep learning and its relationship with Artificial Neural Networks (ANNs).
2	To understand the working of various optimization algorithms used for training deep models efficiently.
3	To explore Convolutional Neural Networks (CNNs) for image-based applications and understand architectures such as LeNet, AlexNet, VGG, and ResNet.
4	To understand Recurrent architectures like LSTM, GRU, and Encoder–Decoder models for sequence learning tasks.
5	To introduce Generative models such as Generative Adversarial Networks (GANs) and Auto encoders for data generation and reconstruction.

**Course Contents**

<b>Unit I</b>	Deep Neural Network: Types, Perceptron Training Rule, ANN Forward Neural network: Forward Neural Networks, Back propagation neural network, Gradient Descent & Back Propagation Algorithm: Gradient Descent, Stochastic Gradient, Vanishing Gradient problem
<b>Unit II</b>	Introduction to deep learning: Definition, Importance, Types of Deep Learning Networks Feed forward neural network (FFNN), Multi-layer Perceptron (MLP) Radial basis function Neural networks, Multi-layer perceptron, Convolution neural network (CNN), Recurrent. neural network. Application of Deep learning in real time.
<b>Unit III</b>	Deeplearningarchitectures:LSTM,GRU,Encoder/DecoderArchitectures, Long Short Term Memory Networks (LSTMs) Deep learning types of Auto encoders and Denoising Auto encoders, Adversarial Generative Networks, Autoencoder and Deep Belief Model DBM
<b>Unit IV</b>	Types of Algorithms used in Deep Learning: Image Classification, Object Detection, Recurrent Neural Networks (RNNs), Generative Adversarial Networks (GANs), Restricted Boltzmann's machine (RBM), Radial Basis Function Networks (RBFNs), Multilayer Perceptron's (MLPs), Self-Organizing Maps (SOMs), Deep Belief Networks (DBNs)
<b>Unit V</b>	Convolutional Neural Networks: CNN Architectures, Convolution, Pooling Evolution from LeNet and AlexNet to VGG, ResNet Layers, Variants of the Basic Convolution Function, Structured Outputs, DataTypes, Efficient Convolution Algorithms, Random or Unsupervised Features, LeNet, AlexNet

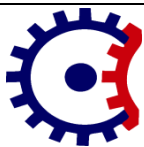
**Text Books**

T1	Simon Haykin, Charu C. Aggarwal, Satish Kumar, The Principles of Deep Learning Theory
T2	Nikhil Buduma & Nicholas Locascio, Neural Networks and Deep Learning,

<b>Reference Books</b>	
R1	Francois Chollet, Michael Nielsen, Adrian Rosebrock,
R2	Rajalingappaa Shanmugamani, Christopher Bishop,
<b>Useful Links</b>	
1	<a href="http://digimat.in/nptel/courses/video/106105215/L60.html">http://digimat.in/nptel/courses/video/106105215/L60.html</a>
2	<a href="https://onlinecourses.nptel.ac.in/noc25_cs106/preview?utm_source=chatgpt.com">https://onlinecourses.nptel.ac.in/noc25_cs106/preview?utm_source=chatgpt.com</a>

Sr. no.	Course Outcomes	CL	Class Session
1	<b>Understand</b> the fundamental concepts of Artificial Neural Networks (ANN) and Deep Neural Networks (DNN).	2	9
2	<b>Apply</b> Forward Propagation and Back Propagation algorithms, along with Gradient Descent and its variants.	3	9
3	<b>Analyze</b> and differentiate between various Deep Learning architectures and LSTM.	4	9
4	<b>Model</b> advanced deep learning models GRU, Autoencoders, Denoising Autoencoders, Generative Adversarial Networks (GANs)	3	9
5	<b>Implement</b> and interpret various Deep Learning algorithms including CNN, RNN, GAN, AlexNet, LeNet	3	9

  
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**Fourth Year (Semester-VII) B.Tech. (CSE)**

**Course Code:BCS34709 (DevOps)**

Teaching Scheme		Examination Scheme	
Lectures	4 Hrs/week	CT-1	15 Marks
Tutorial	-	CT-2	15 Marks
Total Credit	4	CA	10 Marks
		ESE	60 Marks
		<b>Total</b>	<b>100 Marks</b>
		<b>Duration of ESE: 03Hrs 00Min.</b>	

**Course Objective:**

1	To understand the fundamental concepts, principles, and benefits of DevOps.
2	To explore GitHub integration for collaborative software development.
3	To integrate Selenium with Maven and Jenkins for automated testing.
4	To explore Docker commands, port binding, storage, volume, registry, compose, and swarm for orchestration.
5	To develop and customize dashboards in Grafana for pipeline and performance monitoring.

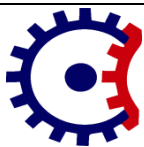
**Course Contents**

<b>Unit I</b>	<b>Introduction to DevOps Introduction:</b> Architecture, Lifecycle, Workflow Principles, DevOps Tools, Concept of Automation, Engineering, Pipeline Methodology, DevOps Vs Agile.
<b>Unit II</b>	<b>Continuous Development Code and Build Tools:</b> Version Control Using GIT: Introduction, Features, benefits, GitHub, staging and commits, undoing changes, inspecting changes, branching and merging, collaborating: fetch, pull and push. <b>Building Tools Mavens:</b> Introduction to maven, Architecture, integration, plugin management, master-slave architecture, delivery pipeline vs declarative pipeline
<b>Unit III</b>	<b>Testing/Continuous Integration/Continuous Deployment Selenium:</b> Basic terminology, features, limitations, selenium vsQTP, selenium tool suite, selenium with maven/Jenkins Jenkins: Introduction, work flow, continuous integration, advantage and disadvantages, architecture: master-slave, setup with github vs maven, configuration, management, user management, pipeline, notification, reporting, code analysis, distributed builds, automated deployment, metrics and trends,servermaintenance,continuousdeployment,Jenkinsmanagingplugin.
<b>Unit IV</b>	<b>Operate using Ansible /Puppet/ Docker /Kubernetes/Ansible:</b> Configuration and orchestration tools include <b>Ansible, Puppet, Docker and Kubernetes</b> . Ansible covers workflow, architecture, commands, playbooks, roles, modules and YAML-based automation. Puppet includes architecture, installation, modules, fileserver and classes. Docker focuses on containerization, architecture, CLI, volumes, registry and Compose/Swarm. Kubernetes includes Pods, ReplicaSets, Deployments, scaling, rollbacks, services, ConfigMaps, Secrets and StatefulSets.
<b>Unit V</b>	<b>Monitoring Tools: Nagios:</b> Introduction, features of Nagios, architecture: scheduler, GUI, plugin, installation of Nagios core, advantage and disadvantage. <b>Prometheus and Grafna:</b> Introduction to Prometheus and Grafana, Prometheus and GrafanaSetup, Monitoring using Prometheus, Dashboard Visualization using Grafana, creating Dashboard to monitor the Pipeline

<b>Text Books</b>	
T1	A Practical Guide to Continuous Delivery, Eberhard Wolf, Addison-Wesley 2017
T2	Devops with windows server 2016, Ritesh Modi ,PACKT Publishing enterprise
<b>Reference Books</b>	
R1	The Devops 2.0 Tool Kit Vikt or Farcic PACKTBIRMINGHAM-MUMBAI Publishing enterprise
R2	Implementing Devops with Ansible 2 Joathan Mc Allister PACKT BIRMINGHAM-MUMBAI Publishing enterprise
<b>Useful Links</b>	
1	<a href="https://www.youtube.com/watch?v=sz5gfkwPITE&amp;list=PLhNrFKat_aeIogDQc0xnEiZ2TLDKzZCEM">https://www.youtube.com/watch?v=sz5gfkwPITE&amp;list=PLhNrFKat_aeIogDQc0xnEiZ2TLDKzZCEM</a>
2	<a href="https://www.youtube.com/watch?v=hQcFE0RD0cQ&amp;list=PL9ooVrP1hQOE5ZDJJsnEXZ2upwK7aTYiX">https://www.youtube.com/watch?v=hQcFE0RD0cQ&amp;list=PL9ooVrP1hQOE5ZDJJsnEXZ2upwK7aTYiX</a>

<b>BCS34709</b>	<b>Course Outcomes</b>	<b>CL</b>	<b>Class Session</b>
<b>BCS34709.1</b>	Explain DevOps architecture, lifecycle, workflow and compare with Agile.	2	9
<b>BCS34709.2</b>	Utilize Git/GitHub for version control with branching, merging and collaboration.	2	9
<b>BCS34709.3</b>	Build projects using Maven with plugins and automated pipelines..	3	9
<b>BCS34709.4</b>	Implement CI/CD using Selenium and Jenkins for automated testing and deployment.	4	9
<b>BCS34709.5</b>	Deploy automation/orchestration tools (Ansible, Puppet, Docker, Kubernetes) and monitor with Nagios, Prometheus, Grafana.	4	9





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**Fourth Year (Semester-VIII) B.Tech. (CSE)**

**Course Code:BCS34710 (Full Stack Development)**

Teaching Scheme		Examination Scheme	
Lectures	4 Hrs/week	CT-1	15 Marks
Tutorial	-	CT-2	15 Marks
Total Credit	4	CA	10 Marks
		ESE	60 Marks
		<b>Total</b>	<b>100 Marks</b>
		<b>Duration of ESE: 03Hrs 00Min.</b>	

**Course Objective:**

1	To Understand the concept of .NET full Stack Development using C#, ASP, MVC Controller.
2	To Apply the concept in .NET full stack development.
3	To Design various applications using .NET framework.
4	To develop a basic web application using the ASP.NET MVC framework.
5	To handle exceptions effectively using MVC's exception-handling mechanisms.

**Course Contents**

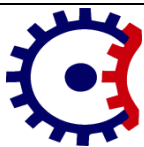
<b>Unit I</b>	<b>Introduction.NET:</b> Introduction NET, application and structure of application, Object Oriented Programming Concept in C#. Overview .NET Core, architecture, CLR, CTS, CLS, application structure and execution process. Fundamental programming concepts in C# including OOP principles such as classes, objects, inheritance, polymorphism, abstraction and encapsulation. Development of basic console applications using namespaces, assemblies and DLLs.
<b>Unit II</b>	<b>Introduction to Database:</b> Introduction concepts of LINQ, SQL Server and database objects including tables, triggers, stored procedures, functions and views. SQL operations covering DDL, DML, DCL, TCL and CRUD functionality. Practical handling of queries, joins, functions, database designing and trigger implementation.
<b>Unit III</b>	<b>Introduction to Front end:</b> HTML webpage construction, CSS styling, layout designing, DOM manipulation and form creation using JavaScript. ADO.NET connectivity for linking .NET applications with databases. Practical work includes frontend interface design, input validation, styling and integration with backend through ADO.NET.
<b>Unit IV</b>	<b>MVC:</b> MVC structure with Model, View and Controller interaction flow, routing mechanism and request-response lifecycle. Configuration through Program.cs and Startup.cs, middleware setup, controller creation and view rendering. Practical development of an MVC application from startup to output screen, including CRUD operations.
<b>Unit V</b>	<b>Implementation Data Validation:</b> Validation techniques using annotations, validation summary, exception handling and structured error flow management. API routing, parameter binding, JSON response generation and Postman-based API testing. Implementation includes validated form submission, custom error handling, Web API creation, route configuration and project-level integration.

**Text Books**

T1	C# 9 and .NET 5 – Modern Cross-Platform Development: Build intelligent apps, websites, and services with ASP.NET Core 5, Blazor, and Entity Framework Core using Visual Studio Code" by Mark J. Price - This book covers the introduction to .NET, object-oriented programming in C#, and ASP.NET Core MVC development.
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T2	HTML and CSS: Design and Build Websites" by Jon Duckett –This book offer sa beginner-friendly introduction to HTML and CSS for frontend web development.
<b>Reference Books</b>	
R1	Book Title: "C# 9 and .NET 5 – Modern Cross-Platform Development: Build intelligent apps, websites, and services with ASP.NET Core 5, Blazor, and Entity Framework Core using Visual Studio Code" Author: Mark J. Price
R2	Book Title: "Microsoft SQL Server 2019: A Beginner's Guide, Seventh Edition" Author: Dusan Petkovic
<b>Useful Links</b>	
1	<a href="https://www.youtube.com/watch?v=HOhW3BcD4y8">https://www.youtube.com/watch?v=HOhW3BcD4y8</a>
2	<a href="https://www.youtube.com/watch?v=bMd1sw-2RGg">https://www.youtube.com/watch?v=bMd1sw-2RGg</a>

<b>BCS34710</b>	<b>Course Outcomes</b>	<b>CL</b>	<b>Class Session</b>
<b>BCS34710.1</b>	Understand .NET framework components, CLR, CTS/CLS and OOP principles in C#.	2	9
<b>BCS34710.2</b>	Apply OOP concepts to develop basic C# console applications using namespaces and assemblies.	3	9
<b>BCS34710.3</b>	Implement SQL Server operations using LINQ, triggers, stored procedures and CRUD queries	3	9
<b>BCS34710.4</b>	Design and integrate front-end interfaces using HTML, CSS, JavaScript with ADO.NET connectivity.	3	9
<b>BCS34710.5</b>	Develop and validate MVC applications with routing, controllers, CRUD operations, exception handling and Web API testing through Postman.	3	9



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**Fourth Year (Semester-VII) B.Tech. (CSE)**

**Course Code: BCS34711 Predictive Analysis**

Teaching Scheme		Examination Scheme	
Lectures	4 Hrs/week	CT-1	15 Marks
Tutorial	-	CT-2	15 Marks
Total Credit	4	CA	10 Marks
		ESE	60 Marks
		<b>Total</b>	<b>100 Marks</b>
		<b>Duration of ESE: 03Hrs 00Min.</b>	

**Course Objective:**

1	Understand and Apply Regression Techniques
2	Master Non-Linear Regression and Model Transformation
3	Analyze and Interpret Panel Data Models and Dummy Variables
4	Utilize Forecasting and Time Series Analysis Techniques
5	Explore Data Mining and Machine Learning for Business Insights

**Course Contents**

<b>Unit I</b>	<b>Simple Regression Analysis:</b> Concept Fundamentals of Regression Analysis Requirements in Regression Model Building Model Diagnostics Interpretation of Regression results for Management Decision. <b>Multiple Regression Analysis:</b> Concept Significance of Multiple Regression Analysis Structure of Model Estimation Testing Rule of Multiple Regression Analysis
<b>Unit II</b>	<b>Non-Linear Regression Analysis:</b> Concept Types of Non-linear Regression Models- Model Transformation Difference between Linear and Non-linear Regression Models. Diagnostics of Regression Modelling: Model Diagnostics Multicollinearity Autocorrelation
<b>Unit III</b>	<b>Dummy modelling and Panel Data Model Dummy modeling:</b> Dummy independent modelling-linear probability Model-Logit Model-Probit model Panel Data Model: Concept - Panel Data Models Fixed Effects Model Random Effects Model Forms of Panel Data Models - Applications to use Panel Data Models.
<b>Unit IV</b>	<b>Forecasting and Machine Learning:</b> Time Series Forecasting: Concept Forecasting Techniques Measures of Forecast Error Trend Analysis Time Series Models Auto Regressive Model Applications of Time Series Models. Machine Learning: Concept Predictive Analysis under Machine Learning Model of Artificial Neural Networks (ANN) Model of Random Forest Model of Support Vector Machine Assumptions under Machine Learning.
<b>Unit V</b>	<b>Data Mining and Simulation:</b> Data Mining: Concept Data Interpretation Data Reduction Classification and Clustering Techniques Association Rule Mining Cause and Effect Model.

**Text Books**

T1	Gujarati, D. N., & Porter, D. C. (2020). <i>Basic Econometrics</i> (5th Edition).
T2	Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). <i>Multivariate Data Analysis</i> (8th Edition).

### Reference Books

R1	Wooldridge, J. M. (2020). Introductory Econometrics: A Modern Approach (7th Edition).
R2	James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). An Introduction to Statistical Learning: With Applications in R.

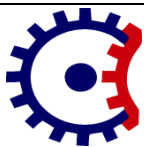
### Useful Links

1	<a href="https://nptel.ac.in/courses/111105042">https://nptel.ac.in/courses/111105042</a>
2	<a href="https://nptel.ac.in/courses/111104074">https://nptel.ac.in/courses/111104074</a>
3	<a href="http://www.youtube.com/watch?v=oh4hmT-3BWM">http://www.youtube.com/watch?v=oh4hmT-3BWM</a>
4	<a href="http://www.youtube.com/watch?v=5aMc1SKYbox">http://www.youtube.com/watch?v=5aMc1SKYbox</a>

BCS34711	Course Outcomes	CL	Class Session
BCS34711.1	<b>Understand</b> and apply various regression techniques to analyze relationships among variables.	2	9
BCS34711.2	<b>Demonstrate</b> proficiency in non-linear regression and model transformation for complex data patterns.	3	9
BCS34711.3	<b>Analyze</b> and interpret panel data models and incorporate dummy variables for categorical effects.	3	9
BCS34711.4	<b>Utilize</b> forecasting and time series analysis methods to predict future trends..	4	9
BCS34711.5	<b>Apply</b> data mining and machine learning techniques to derive meaningful business insights	4	9



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**Fourth Year (Semester-VII) B.Tech. (CSE)**

**Course Code: BEC34811 (Introduction to IOT)**

Teaching Scheme		Examination Scheme	
Lectures	4 Hrs/week	CT-1	15 Marks
Tutorial	-	CT-2	15 Marks
Total Credit	4	CA	10 Marks
		ESE	60 Marks
		Total	100 Marks
		Duration of ESE: 03Hrs 00Min.	

**Course Objective:**

1	<b>Categorize</b> Embedded Systems by using memory architecture and Processor
2	<b>Analyze</b> IoT and its architecture
3	<b>Distinguish</b> between IoT and M2M.
4	<b>Analyze</b> Communication Protocols and Sensor Networks.
5	<b>Review</b> the applications of industrial IoT.

**Course Contents**

<b>Unit I</b>	<b>Introduction:</b> Concepts behind the Internet of Things, Characteristics of IoT, IoT enabling technologies, IoT Communication Model, IoT architecture, Applications of IoT, Transducers, Sensors, Sensor classes, Sensor types, Actuators and its types.
<b>Unit II</b>	<b>IOT Protocols:</b> Application layer: MQTT, COAP, XMPP, AMQP, Network Layer: IPv4, IPv6, 6LoWPAN, IoT Communication protocols: IEEE802.15.4, ZigBee, Wireless HART, Zwave, Bluetooth, NFC, RFID.
<b>Unit III</b>	<b>Wireless Sensor networks:</b> Components of sensor nodes, Node Behavior in WSNs, Applications, WSN Coverage, OGDC algorithm, Stationary and Mobile Wireless Sensor Networks.
<b>Unit IV</b>	<b>Machine to Machine Communication:</b> Node types, IP and Non IP based M2M network Interoperability in Internet of Things: Current Challenges in IoT, Interoperability, Types of Interoperability
<b>Unit V</b>	<b>Software-Defined Networking:</b> Current Network to SDN, SDN Architecture, Challenges, OpenFlow Protocol, APIs in SDN, Controller Placement, Recent Advances of SDN in IoT, Industrial internet of things, Case studies.

**Text Books**

T1	Internet of Things: A Hands-On Approach, Arsheep Bahga, Vijay Madiseti.
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**Reference Books**

R1	Introduction to IOT Latest S.Misra , A. Mukherjee, A.Roy, 2020.
R2	Introduction to Industrial Internet of Things and Industry S. Misra, C. Roy, and A. Mukherjee, 2020.

**Useful Links**

1	<a href="https://onlinecourses.nptel.ac.in/noc21_cs17/preview">https://onlinecourses.nptel.ac.in/noc21_cs17/preview</a>
2	<a href="https://onlinecourses.nptel.ac.in/noc21_ee85/preview">https://onlinecourses.nptel.ac.in/noc21_ee85/preview</a>

Sr. no.	Course Outcomes	CL	Class Session
1	<b>Demonstrate</b> proficiency in interfacing sensors and actuators with Arduino and Raspberry Pi platforms.	2	9
2	<b>Develop</b> and implement embedded system applications for real-time data acquisition, processing, and display.	6	9
3	<b>Design</b> communication protocols for data exchange between embedded systems and cloud platforms for remote data storage and analysis.	6	9
4	<b>Integrate</b> IoT hardware with web technologies to enable real-time monitoring and control through online interfaces.	3	9
5	<b>Evaluate</b> and troubleshoot complete IoT systems comprising embedded devices, cloud connectivity, and user interfaces for optimized performance.	5	9

