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BMS INSTITUTE OF TECHNOLOGY AND MANAGEMENT

(Autonomous Institute affiliated to VTU, Belagavi, Approved byAICTE New Delhi)

Yelahanka, Bengaluru 560064

Bachelor of Engineering

Department of Computer Science and Engineering

VI Semester Scheme & Syllabus
2022 Scheme
Effective from the AY 2024-25

VISION AND MISSION OF THE DEPARTMENT

VISION

To develop technical professionals acquainted with recent trends and technologies of computer science to serve as valuable resource for the nation/society.

MISSION

Facilitating and exposing the students to various learning opportunities through dedicated academic teaching, guidance and monitoring.

Program Educational Objectives (PEOs)

PEOs	
PEO1	Lead a successful career by designing, analysing and solving various problems in the field of Computer Science & Engineering.
PEO2	Pursue higher studies for enduring edification.
PEO3	Exhibit professional and team building attitude along with effective communication.
PEO4	Identify and provide solutions for sustainable environmental development.

Program Specific Outcomes (PSOs)

PSOs	
PSO-1	Analyze the problem and identify computing requirements appropriate to its solution.
PSO-2	Apply design and development principles in the construction of software systems of varying complexity.

BMS INSTITUTE OF TECHNOLOGY & MANAGEMENT

(Autonomous Institution Affiliated to VTU, Belagavi)

B. E.Computer Science and Engineering

Scheme of Teaching and Examinations – 2022 Scheme

Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2024-25 onwards)

VI Semester

Sl. No.	Course Category	Course Code	Course Title	Teaching Department (TD) andQuestion Paper Setting Board (PSB)	Credits Distribution				Examination				Contact Hours/week
					L	T	P	Total	CIE Marks	SEE Marks	Total Marks	SEE Duration (H)	
1	IPCC	BCS601	Cloud Computing	TD: CSE PSB: CSE/ISE	3	0	1	4	50	50	100	3	5
2	PCC	BCS602	Machine Learning		4	0	0	4	50	50	100	3	4
3	PCC	BCS603	Compiler Design		3	0	0	3	50	50	100	3	3
4	PEC	BCS604X	Professional Elective Course II		3	0	0	3	50	50	100	3	3
5	OEC	BCS605X	Open Elective Course I		3	0	0	3	50	50	100	3	3
6	PW	BCS606	Major Project Phase I		0	0	3	3	100	-	100	-	6
7	PCCL	BCSL607	Machine Learning Lab		0	0	1	1	50	50	100	3	2
8	AEC	BCS608X	AbilityEnhancement Course/Skill Enhancement Course		For Theorycourse				50	50	100	1	1
					1	0	0	1					
					For Practical course							2	2
					0	0	1	1					
9	NCMC	BNSK609	National Service Scheme (NSS)	NSS Coordinator	0	0	0	0	100	-	100	-	2
		BPEK609	Physical Education (Sportsand Athletics)	PED									
		BYOK609	Yoga	Yoga Teacher									
		BNCK609	National Cadet Corps (NCC)	NCC officer									
		BMUK609	Music	MusicTeacher									
10	NCMC	BIKS610	Indian Knowledge System	Any Department	0		0	0	100	-	100	-	1
TOTAL								**22**	**650**	**350**	**1000**	-	-

IPCC: Integrated Professional Core Course, **PCC**: Professional Core Courses, **PEC**: Professional Elective Course, **OEC**: Open Elective Course, **PCCL**: Professional Core Course laboratory, **NCMC**: Non Credit Mandatory Course, **ESC**: Engineering Science Course, **AEC**: Ability Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical, **CIE**: Continuous Internal Evaluation,

SEE: Semester End Evaluation.

Professional Elective Course II		**Open Elective Course I**		**Ability Enhancement Course**	
Course Code	**Course Name**	**Course Code**	**Course Name**	**Course Code**	**Course Name**
BCS604A	Cyber Security	BCS605A	Introduction to Data Structures	BCS608A	Generative AI
BCS604B	Block Chain Essentials	BAI605B	Data Analytics	BCS608B	Mobile Application Development
BCS604C	Full Stack Development			BCS608C	DevOps
BCS604D	Data warehousing and Data mining			BCS608D	Automated Software Testing
				BCS608E	Robotic Process Automation

Integrated Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical's of the same course. Credit for IPCC can be 04 and its Teaching–Learninghours (L: T: P) can be considered as (3: 0: 2) or (2: 2: 2). The theorypart of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated byonly CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

National Service Scheme /Physical Education/Yoga/NCC/Music: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE) (Sports and Athletics), Yoga (YOG), National Cadet Corps (NCC) and Music with the concerned coordinator of the course during the beginning of each semester starting from III semester to VII semester. In every semester, students should choose any one mandatory course among the available 5 courses without repeating the course again. Activities shall be carried out in each of the semesters from III semester to the VI semester (for 4 semesters). Successful completion of theregistered course andrequisite CIE score is mandatoryfor the award of the degree. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courseismandatoryfor theaward of degree.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering a professional elective is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses (OEC): Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor.

Selection of an openelective shall not be allowed if,

- The candidatehas studied the same course during the previous semesters of the program.
- Thesyllabus content of open electives is similar to that of the Departmental core courses or professional electives.
- A similar course, under anycategory, is prescribed in thehigher semesters of theprogram.
- Theminimum students' strength for offering open electives is 10. However, this condition shallnot be applicable to cases where theadmission tothe program is less than 10.

Project Phase-I: Students have to discuss with the mentor /guide and with their help he/she has to complete the literature survey and prepare the report and finally define the problem statement for the project work.

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B.E. COMPUTER SCIENCE AND ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER –VI

Cloud Computing (3:0:1) 4

(Effective from the academic year 2024-25)

Course Code	BCS601	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:2	SEE Marks	50
Total Number of Contact Hours	40 Hours	Exam Hours	03

Course Objectives:

1. Explain the technology and principals involved in building a cloud environment.
2. Contrast various programming models used in cloud computing.
3. Choose appropriate cloud model for a given application.

Module – I

The cloud ecosystem: Significance and scope of Cloud Computing, Cloud Computing in Economic growth of Nation, Impact of Cloud Computing on societal problems, sustainable solutions, Career perspective of Cloud Computing, current innovations in Cloud Computing, Cloud Computing in Research Cloud Computing at a Glance, The Vision of Cloud Computing, Defining a Cloud, A Closer Look, Cloud Computing Reference Model, Characteristics and Benefits, Challenges Ahead. **Enabling technologies**: Distributed Systems, Web 2.0, Service-Oriented Computing, Utility-Oriented Computing, Building Cloud Computing Environments, Application Development, Infrastructure and System Development

Text book-1: Chapter-1 **(8 hours)**

Module – II

Virtualization: Introduction, Characteristics of Virtualized, Environments Taxonomy of Virtualization Techniques, Execution Virtualization, Other Types of Virtualization, Virtualization and Cloud Computing, Pros and Cons of Virtualization, Technology Examples Xen: Para virtualization, VMware: Full Virtualization, Microsoft Hyper-V.

Text book-1: Chapter-3 **(8 hours)**

Module – III

Cloud Computing: Architecture, Introduction, Cloud Reference Model, Architecture, Infrastructure / Hardware as a Service, Platform as a Service, Software as a Service, Types of Clouds, Public Clouds, Private Clouds, Hybrid Clouds, Community Clouds, Economics of the Cloud, Open Challenges, Cloud Definition, Cloud Interoperability and Standards Scalability and Fault Tolerance Security, Trust, and Privacy Organizational Aspects.

Text book-1: Chapter-4 **(8 hours)**

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Module – IV
Aneka: Cloud Application Platform, Framework Overview, Anatomy of the Aneka Container, From the Ground Up: Platform Abstraction Layer, Fabric Services, foundation Services, Application Services, Building Aneka Clouds, Infrastructure Organization, Logical Organization, Private Cloud, Deployment Mode, Public Cloud Deployment Mode, Hybrid Cloud Deployment Mode, Cloud Programming and Management, Aneka SDK, Management Tools. **Text book-1:** Chapter-5 **(8 hours)**
Module – V
Cloud applications: Cloud application development and architectural styles, Coordination of multiple activities, Workflow patterns. Coordination based on a state machine model—zookeeper, MapReduce programming model, Case study: the GrepTheWeb application, Hadoop, Yarn, and Tez, SQL on Hadoop: Pig, Hive, and Impala. **Text book-2:** Chapter-11 **(8 hours)**
Course outcomes: CO1: Apply the concept of cloud computing to different real word examples. CO2: Analysis the cloud frameworks and technologies for different applications CO3: Design real-world cloud applications for data-intensive applications CO4: Configure various virtualization tools such as Virtual Box and VMware Workstation to design and deploy a web application on GAE

Text books:	
1.	Rajkumar Buyya, Christian Vecchiola, and Thamarai Selvi Mastering Cloud. Computing McGraw Hill Education. ISBN-13 (978-9355329509), 2nd Edition, 10th reprint-June 2024.
2.	Dan C. Marinescu, Cloud Computing Theory and Practice, 3rd Edition - February 15, 2022 Paperback ISBN: 9780323852777, eBook ISBN: 9780323910477
References:	
1.	Thomas Eri, Eric Barcelo Monroy, Cloud Computing: concepts, technology and Architecture, Pearson Education (29 February 2024); Pearson Education, ISBN-13: 978-8196943219, India.
2.	Shailendra Singh, Cloud Computing, Publisher : Oxford University Press; First Edition (1 June 2018), **ISBN-13 :** 978-0199477388, , India.

Cloud Computing Laboratory (0:0:2)

	Programs List
1	Install Virtualbox/VMware Workstation with different flavours of linux or windows OS on top of windows7/8.
2	Install a C compiler in the virtual machine created using virtual box and execute Simple Programs.
3	Find a procedure to transfer the files from one virtual machine to another virtual machine
4	Install Google App Engine. Create hello world app and other simple web applications using python/java.
5	Use GAE launcher to launch the web applications

AAT Presentation

1. Install Hadoop single node cluster and run simple applications like word count. (Installation will be taught by subject teachers and students should run different applications.

B.E. COMPUTER SCIENCE AND ENGINEERING

Choice Based Credit System (CBCS) for 2022 scheme

SEMESTER–VI

MACHINE LEARNING (4:0:0) **4**

(Effective from the academic year 2024-25)

Course Code	BCS602	CIE Marks	**50**
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	**50**
Total Number of Contact Hours	50	Exam Hours	**3**

Course Objectives:

1. To familiarize students with the fundamental concepts, theories and applications of Machine Learning.
2. To demonstrate the characteristics of Decision Trees, Neural Networks, Bayesian Techniques for solving real world problems.
3. Perform statistical analysis of machine learning techniques.
4. Evaluate hypothesis and investigate Ensemble learning**,** Instance Based Learning and Reinforcement Learning.

Preamble:

This syllabus aims to equip students with a comprehensive understanding of the fundamental principles, algorithms, and techniques used to enable computers to learn from data, allowing them to build intelligent systems capable of making predictions and decisions, thereby preparing them to apply these transformative technologies on various applications.

Module –1

Introduction: Machine learning Landscape: what is ML?, Why, Types of ML, main challenges of ML.
Concept Learning: Concept learning task, Concept learning as search, Find-S algorithm, Version space, Candidate Elimination algorithm.
Text book 1: Chapter 1, Text Book2, Sections: 2.1-2.5

(10 Hours)

Module –2

Introduction to Classification: MNIST, training a Binary classifier, performance measure, multiclass classification, error analysis, multi label classification, multi output classification.
Decision Tree Learning: Decision tree representation, Appropriate problems for decision tree learning, Basic decision tree learning algorithm –ID3.
Text book 1: Chapter 3, Text Book 2, Sections: 3.1-3.4

(10 Hours)

Module –3

Artificial Neural Networks: Introduction, Neural Network representation, Appropriate problems, Perceptron- Perceptron Training rule, Back propagation algorithm.
Support Vector Machine: Linear, Nonlinear, SVM regression.
Text book 2, Sections: 4.1 – 4.5, Text book 1: Chapter 5

(10 Hours)

Module –4

Bayesian Learning: Introduction, Bayes theorem, Bayes theorem and concept learning, Naive Bayes classifier, Bayesian belief networks, EM algorithm

Instance-Based Learning: Introduction K- Nearest Neighbor Learning, locally weighted regression.
Text book 2, Sections: 6.1, 6.2,6.9, 6.11,6.12. Chapter 8 (8.1-8.3)

(10 Hours)

Module –5
Ensemble learning and Random Forest: Voting classifiers, Bagging and pasting, Random patches, Random forests, Boosting-Ada Boost, stacking. **Reinforcement Learning:** Introduction, The learning task, Q-Learning. **Textbook1: Chapter 7, Textbook2: Chapter 13 (13.1 – 13.3) (10 Hours)**
Course Outcomes: The students will be able to: CO1: Understand fundamentals of ML techniques to address the learning problem. CO2: Apply ML techniques for decision-making. CO3: Analyze various ML approaches to address real-time problems. CO4: Evaluate the performance of ML algorithms on an appropriate dataset.
Textbooks:
1. Aurelien Geron, Hands-on Machine Learning with Scikit-Learn & Tensor Flow, O'Reilly, Shroff Publishers and Distributors Pvt. Ltd 2019 2. Tom M Mitchell, "Machine Learning",1stEdition, Mc Graw Hill Education,2017.
References:-
1. Ethem Alpaydin, Introduction to Machine Learning, PHI Learning Pvt. Ltd, 2nd Ed., 2013 2. T. Hastie, R. Tibshirani, J. H. Friedman, The Elements of Statistical Learning, Springer, 1st edition, 2001 3. Machine Learning using Python, Manaranjan Pradhan, U Dinesh Kumar, Wiley, 2019 4. Machine Learning, Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, Pearson,2020
Alternate Assessment Tools (AATs) suggested: • MOOC Course-15hrs • Case Studies
• **Web links / e – resources:** **https://youtube.com/playlist?list=PLIg1dOXc_acbdJo-AE5RXpIM_rvwrerwR&si=iHKt4MTTvsTmMm02**

B.E. COMPUTER SCIENCE AND ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 scheme

SEMESTER VI

COMPILER DESIGN (3:0:0) 3

(Effective from the academic year 2024-25)

Course Code	BCS603	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course Objectives:

This course will enable students to:

1. Describe the phases of compiler.
2. Familiarize with various parsing techniques and design them for different grammars.
3. Understand the code generation and optimization techniques.

Preamble: The world depends on programming languages, because all the software running on all the computers will be written in some programming language. But, before a program can be run, it must be translated into a form in which it can be executed by a computer. The software systems that do this translation are called compilers. In this course, students will learn to how to design and implement compilers.

Module – 1

Language processors: The structure of a Compiler; The evolution of programming languages; The science of building a Compiler; Applications of compiler technology; Programming language basics. **Lexical analysis:** The Role of Lexical Analyzer; Input Buffering; Specifications of Tokens; Recognition of Tokens.

T1 : 1.1 - 1.6, 3.1 - 3.4 **(8 hours)**

Module – 2

Syntax Analysis – 1: Introduction, the role of the Parser, Error-Recovery Strategies, writing a Grammar, Top-down Parsing: Recursive-Descent Parsing, First and Follow, LL (1) Grammars, Non-recursive Predictive Parsing, Error Recovery in Predictive Parsing

T1 : 4.1, 4.3, 4.4 **(8 hours)**

Module – 3

Syntax Analysis – 2: Bottom-up Parsing: Reductions, Handle Pruning, Shift-Reduce Parsing, Conflicts During Shift-Reduce Parsing. **Introduction to LR Parsing:** Simple LR; More powerful LR parsers, Parser Generators.

T1 : 4.5-4.9 **(8 hours)**

Module – 4

Syntax-Directed Translation: Syntax-Directed Definitions, Evaluation Orders for SDD', Applications of SDT, **Intermediate Code Generation:** Variants of syntax trees, Three-address code, Types and Declarations, Translation of expressions, Type Checking, Control flow; Back patching; Switch statements;

T1 : 5.1-5.3, 6.1-6.8 **(8 hours)**

Module – 5

Code Generation: Issues in the design of Code Generator, The Target Language, Addresses in the target code, Basic blocks and Flow graphs, Optimization of basic blocks, A Simple Code Generator.

T1: 8.1-8.6 **(8 hours)**

Course Outcomes:

The students will be able to: **(List the COs as per the course requirements)**

CO1: Acquire fundamental understanding of the structure of a Compiler.

CO2: Apply the concept of tokenization, parsing, code generation, code optimization for the given piece of code written in any language.

CO3: Analyse the given set of grammars.

CO4: Demonstrate the grammars for a given code.

Textbooks:

1. Alfred V Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, Compilers-Principles, Techniques and Tools, Pearson, 2nd edition, 2007.

2. Doug Brown, John Levine, Tony Mason, Lex & YACC, O'Reilly Media, October 2012.

References:

1. Compiler Design, K Muneeswaran, Oxford University Press 2013.
2. System programming and Compiler Design, K C Louden, Cengage Learning

Alternate Assessment Tools (AATs) suggested:

Lex and YACC –The Simplest Lex Program, Grammars, Parser-Lexer Communication, A YACC Parser, The Rules Section, Running LEX and YACC, LEX and Hand- Written Lexers.

Using LEX - Regular Expression, Examples of Regular Expressions, A Word Counting Program.

Using YACC – Grammars, Recursive Rules, Shift/Reduce Parsing, What YACC Cannot Parse**.**

A YACC Parser - The Definition Section, The Rules Section, The LEXER, Compiling and Running a Simple Parser, Arithmetic Expressions and Ambiguity.

Text book 2: Chapter 1, 2 and 3.

Web links / e – resources:

1. https://web.stanford.edu/class/archive/cs/cs143/cs143.1128/
2. https://dl.acm.org/doi/pdf/10.5555/578789
3. https://courses.grainger.illinois.edu/cs421/sp2011/lectures/lecture7-2up.pdf
4. https://www.javatpoint.com/compiler-tutorial

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B.E. COMPUTER SCIENCE AND ENGINEERING

Choice Based Credit System (CBCS) for 2022 Scheme

SEMESTER -VI

MACHINE LEARNING LABORATORY (0:0:2) 1

(Effective from the academic year 2024-25)

Course Code	BCSL607	CIE Marks	50
Teaching Hours/Week (L:T:P)	0:0:2	SEE Marks	50
Total Number of Contact Hours	26	Exam Hours	3

Course Objectives:

This course will enable students to:

1. To learn and understand the Importance Machine learning Algorithms
2. Compare and contrast the learning techniques like ANN approach, Bayesian learning and reinforcement learning.
3. Able to solve and analyze the problems on ANN, Instance based learning and Reinforcement learning techniques.
4. To impart the knowledge of clustering and classification Algorithms for predictions and evaluating Hypothesis.

Program List

1.	For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
2.	Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
3.	Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets
4	Write a program to implement the naive Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
5.	Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Python ML library classes/API in the program.
6.	Write a program to implement k-Nearest Neighbor algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.
7.	Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.
8.	Implement the SVM algorithm for classification.
9.	Implement Random Forest in Python and calculate result matrices, evaluation matrices, and accuracy.

Laboratory Outcomes: The student should be able to:

CO1: Apply the concepts different classification and clustering algorithms.

CO2: Demonstrate the working of various algorithms with respect to training and test data sets.

CO3: Analyze the principles of Instance based, Ensemble Learning and Reinforcement learning techniques.

CO4: Elicit the importance and Applications of Supervised and unsupervised machine learning.

Text books:

1. Tom M Mitchell, **"Machine Learning",** 1st Edition, Mc Graw Hill Education,2017.

2. Aurelien Geron, Hands-on Machine Learning with Scikit-Learn & Tensor Flow, O'Reilly, Shroff Publishers and Distributors Pvt. Ltd 2019

Web links / e – resources:

1. **https://youtube.com/playlist?list=PLIg1dOXc_acbdJoAE5RXpIM_rvwrerwR&si=iHKt4MTTvsTmMm02**

PROFESSIONAL ELECTIVE COURSE II

B.E. COMPUTER SCIENCE AND ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER – VI

Cyber Security (3:0:0) 3

(Effective from the academic year 2024-25)

Course Code	BCS604A	CIE Marks	50
Teaching Hours/Week (L: T:P)	(3:0:0)	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course Objectives: This course will enable students to:

1. Understand the fundamental concepts of cybersecurity, cryptography, network security, and cloud security.
    1. Develop practical skills in Cyber threat intelligence, Vulnerability Scanning and Data Protection.
    2. Learn about cyber laws, compliance standards, and risk management frameworks.
    3. Gain hands-on experience with security tools and real-world case studies.
    4. Self-Learning for industry certifications such as CEH, CISSP, and Security+.

Preamble:

In today's digital age, network and cybersecurity are crucial for safeguarding information systems by ensuring data confidentiality, integrity, and availability. As cyber threats rapidly evolve, organizations and individuals must implement robust security measures to protect networks from malicious actors, unauthorized access, and data breaches. Understanding key principles such as secure communication protocols, firewalls, intrusion detection and prevention systems (IDS/IPS), and Virtual Private Networks (VPNs) is essential. Additionally, adopting cybersecurity frameworks, cryptographic techniques, and vulnerability management strategies strengthens defences against cyber threats. By enforcing strong security policies, access controls, and proactive monitoring, we can establish a secure digital environment, fostering trust and reliability in cyberspace.

Module – 1

Importance of cyber security: Scenarios for security, Understanding the attack surface, the threat landscape, the importance of securing the network and Applications, the history of breaches, how security helps to build trust.

Legacy cybersecurity systems, Transformations in cybersecurity, Advancements in security technology to security 2.0, How ML and Al will play a larger role in cybersecurity,

(Chapter 1 & 2 from Textbook1)

(8 Hours)

Module – 2

Learning cybersecurity Technologies Mobile security, advanced data security, cloud security, Modern day regulations, Incidence response and forensic, Enterprise security at scale, penetration testing, DevSecOps, IoT Security, User behaviour analytics (UBA), Endpoint detection and response (EDR). Attacker Mindset, the category of hackers, the traits of hackers, Social Characteristics of hackers, How hackers think (Motivators), What can be learned from the psychology of hackers?

(Chapter 3 & 5 from Textbook1)

(8 Hours)

Module – 3

Authentication: one way authentication (password based, certificate based), Mutual authentication (shared secret based, Asymmetric key-based, Authentication and key Agreement, use of Timestamps), Dictionary attacks (attack types, defeating Dictionary attacks).
Firewalls: firewall basics-firewall functionality, policies and access control lists, firewall types; practical issues-placement of firewalls, firewall configuration.
Textbook 2: Chapter 11 (11.1-11.3), Chapter 21 (21.1- 21.2)

(8 Hours)

Module – 4

Non-Cryptographic Protocol Vulnerabilities: DoS and DDoS (attack types, impact of SYN flooding), Session Hijacking and Spoofing (impersonation and session Hijacking, ARP spoofing); cross-site scripting (XSS): Vulnerabilities, SQL injection.
Intrusion Prevention and Detection: Introduction, Prevention versus Detection, Types of Intrusion Detection Systems,
Cyber Kill Chain: what is a kill chain, applying the cyber kill chain to detection

Textbook 2: Chapter 17 ,18,22 (17.1, 17.2, 18.4, 22.1- 22.4,)
Textbook 4: Chapter 16

(8 Hours)

Module – 5

Web Application Security: This Site Is Secure, The Core Security Problem: Users Can Submit Arbitrary Input, Key Problem Factors, The New Security Perimeter, Core Defense Mechanisms: Handling User Access, Handling User Input, Handling Attackers.

Penetration Testing of Web Applications: Using tools like BURP Suit and OWASP ZAP to find vulnerabilities in a web application.
https://portswigger.net/burp , https://owasp.org/
(Chapters 1 & 2 from TextBook 3)

(8 Hours)

Course Outcomes:

The students will be able to: **(List the COs as per the course requirements)**

CO1: Examine cybersecurity fundamental concepts, including cyber threats, attack types, cryptography, security frameworks and advanced security technologies while solving problems addressing threat detection, regulatory, data protection and regulatory compliance.

CO2 Analyze the psychology of hackers, including their traits and motivations, and their influence on security strategies.

CO3: Analyze security mechanisms including authentication, firewalls, intrusion detection and prevention systems, and secure communication protocols for the given problems.

CO4: Investigate network vulnerabilities, including DoS/DDoS attacks, session hijacking, SQL injection, and cross-site scripting to propose the solution to overcome the attacks.

CO5: Demonstrate hands-on skills using cybersecurity tools for Web applications vulnerability Assessment.

Textbooks:

1. Cybersecurity: The Beginner's Guide by Dr. Erdal Ozkaya 1st Edition 2019, Published by Packt Publishing Ltd. (Click Here - e-book)
2. Bernard L. Menezes, Ravinder Kumar, **Cryptography, Network Security, and Cyber Laws**, 2018 Cengage Learning India Pvt. Ltd.
3. The Web Application Hacker's Handbook Finding and Exploiting Security Flaws by Dafydd Stuttard Marcus Pinto 2nd Edition 2011 (Click Here - e-book)
4. Ira Winkler and Araceli Treu Gomes- Advanced Persistent Security, A Cyberwarfare Approach to Implementing Adaptive Enterprise Protection, Detection, and Reaction Strategies ISBN: 978-0-12-809316-0 , Publisher: Todd Green

References:

1. Thoms J. Mowbray, Cybersecurity, managing systems, Conducting Testing, and Investigating Instrusions
2. The Cyber Security Body of Knowledge (CyBok)- Awais Rashid, Howard Chivers, George Danezis, Emil Lupu, Andrew Martin
3. Cybersecurity and Cyberwar" by P.W. Singer for policy/ethics or "Blue Team Handbook" for incident response
4. Sunit Belapure, Nina Godbole, Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives Wiley India Pvt Ltd 2013
5. Surya Prakash Tripathi, Ritendra Goyal, Praveen Kumar Shukla, Introduction to information security and cyber laws, Dreamtech Press 2015
6. Thomas J. Mowbray, Cybersecurity: Managing Systems, Conducting Testing, and Investigating Intrusions John Wiley & Sons 2013
7. James Graham, Ryan Olson, Rick Howard, Cyber Security Essentials CRC Press 2010

Tools for Cyber Security Demonstration

a. OpenSSH, Hydra, Wireshark, Squid Proxy **(Module 3)**

b. MITRE ATT&CK Navigator, Metasploit Framework, Atomic Red Team, Snort, Hping3, UFONet , Nessus Essentials **(Module 4)**

c. BURP suite and OWASP Zap (**Module 5**)

d. Threat Modeling Tool, Threat Dragon, TMT (Threat Modeling Tool by IriusRisk) SIEM (Security Information and Event Management), Sysmon (Windows), OpenVAS, Nmap, Virus Total

e. **Indian Digital Signature Providers** –

- eMudhra
- SafeScrypt
- Capricorn CA

f. Autopsy, The Sleuth Kit (TSK), FTK Imager

Alternate Assessment Tools (AATs) suggested:

1. Practical demonstration of Tools in a team of two-three members choosing any 4-5 tools in the given list or any other tools in consultation with the course coordinator and report submission)

- Network Intrusion Detection and Analysis - (Tool: **Snort**)
- Event Log Aggregation, Correlation, and analysis- (Tool: **Splunk Enterprises/IBM Q radar**)
- Web Proxies – (caching, URI Filtering, Content Filtering, Squid Configuration, Squid Access Logfiles, Squid Cache, Web proxy analysis, Encrypted Web Traffic,)- (Tool: **Squid**)
- Traffic Analysis – Protocol Analysis, Packet Analysis, Higher-layer Traffic analysis- (Tool: **Wireshark**)
- Vulnerability Scanning and Management (Tools: **Nessus Essentials, Burp suite**)
- Servers Configuration – DHCP server, Name servers, Authentication Servers, Firewalls, Application Servers
- SMTP, Fishing Email Analysis – Tool: **Mx Toolbox, Virus Total, IP Void, URL Void, OpenVAS**

- Incident response Management, Cyber Kill Chain, MITRE ATT&CK Framework
- AI-driven cyberattacks, zero-trust security models, blockchain for security, and deepfake threats
- Penetration testing, ethical hacking tools (Metasploit, Nmap, Aircrack-ng, etc.)
- Cyber laws (GDPR, HIPAA, India's IT Act), compliance frameworks.
- Incident response lifecycle (NIST SP 800-61), forensics tools (Autopsy, FTK).
- Risk management (ISO 27001, NIST CSF).

Web links / e – resources:

https://www.snort.org/documents
https://docs.splunk.com/Documentation
https://www.ibm.com/docs/en/qradar-common
https://www.squid-cache.org/Doc/config/
https://www.wireshark.org/docs/
https://docs.tenable.com/nessus/Content/GettingStarted.htm
https://portswigger.net/web-security
https://bind9.readthedocs.io/en/v9.20.5/
https://docs.netgate.com/pfsense/en/latest/
https://www.freeradius.org/documentation/
https://mxtoolbox.com/SuperTool.aspx
https://www.virustotal.com/gui/home/upload
https://attack.mitre.org/
https://www.lockheedmartin.com/en-us/capabilities/cyber/cyber-kill-chain.html
https://csrc.nist.gov/pubs/sp/800/61/r2/final
https://www.nist.gov/cyberframework

B.E. COMPUTER SCIENCE & ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER – VI

Block Chain Essentials (3:0:0) 3

(Effective from the academic year 2024-25)

Course Code	**BCS604B**	CIE Marks	50
Teaching Hours/Week (L: T:P)	3:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course objectives:

•Understand blockchain fundamentals, including its history, structure, and consensus mechanisms.

•Learn about decentralization, smart contracts, and cryptographic principles.

•Explore major blockchain platforms like Bitcoin, Ethereum, Hyperledger, and Corda.

•Gain hands-on experience with wallets, smart contracts, and blockchain tools.Assess blockchain's benefits, challenges, and industry applications.

Preamble:

Blockchain technology is a decentralized, secure, and transparent system built on distributed consensus, cryptographic techniques, and smart contracts. It enables trustless transactions and supports applications like cryptocurrency, decentralized finance, and autonomous organizations. Key concepts include the CAP theorem, Byzantine Generals Problem, Bitcoin, Ethereum, and enterprise solutions like Hyperledger and Corda. Blockchain's impact spans industries, revolutionizing finance, supply chain, governance, and beyond. Understanding its fundamentals, consensus mechanisms, and cryptographic foundations is crucial for leveraging its full potential.

Module – 1

Distributed systems, CAP theorem, Byzantine Generals problem, Consensus. The history of blockchain, Introduction to blockchain, Various technical definitions of blockchains, Generic elements of a blockchain, Features of a blockchain, Applications of blockchain technology, Tiers of blockchain technology, Consensus in blockchain, CAP theorem and blockchain, Benefits and limitations of blockchain.

(8 Hours)

Module – 2

Decentralization using blockchain, Methods of decentralization, Blockchain and full ecosystem decentralization, Smart contract, Decentralized organizations, Decentralized autonomous organizations, Decentralized autonomous corporations, Decentralized autonomous societies Decentralized applications, Platforms for decentralization.

Cryptographic primitives: Symmetric cryptography, Asymmetric cryptography, Public and private keys Hash functions: Compression of arbitrary messages into fixed length digest,Easy to compute, Pre-image resistance, Second pre-image resistance,Collision resistance,Message Digest (MD),Secure Hash Algorithms (SHAs), Merkle trees, Patricia trees, Distributed hash tables (DHTs), Digital signatures, Elliptic Curve Digital signature algorithm (ECDSA)

(8 Hours)

Module – 3

Bitcoin, Bitcoin definition, Transactions, The transaction life cycle, The transaction structure, Types of transaction, The structure of a block , The structure of a block header, The genesis block, The bitcoin

network, Wallets, Smart Contracts-History, Definition, Ricardian contracts, Smart contract templates, Oracles, Smart Oracles, Deploying smart contracts on a blockchain, The DAO

(8 Hours)

Module – 4

Ethereum 101, Introduction, Ethereum clients and releases, The Ethereum stack, Ethereum blockchain, Currency (ETH and ETC), Forks, Gas, The consensus mechanism, The world state, Transactions, Contract creation transaction, Message call transaction, Elements of the Ethereum blockchain , Ethereum virtual machine (EVM), Accounts, Block, Ether, Messages, Mining, The Ethereum network

Hands-on: Clients and wallets -Geth

(8 Hours)

Module – 5

Hyperledger, Hyperledger as a protocol, Fabric, Hyperledger Fabric, Sawtooth lake, Corda

(8 Hours)

Course Outcomes:

The students will be able to: **(List the COs as per the course requirements)**

CO1: Illustrate the Blockchain terminologies with its applications. design.
CO2: Analyze the working principles of Blockchain.
CO3: Comprehend the principles and methodologies used in Bitcoin.
CO4: Create Ethereum Network, Wallets, Nodes, Smart contract & DApps.
CO5: Develop Blockchain Based Application Architecture using Hyperledger.
CO6: Illustrate the Smart Contract Lifecycle.

Textbooks:

1. Imran Bashir. "Mastring BlockChain", Packt

References:

1.Mastering Bitcoin: Programming the Open Blockchain Paperback – 2017 by Andreas M. O'rielly

Activity Based Learning (Suggested Activities in Class)/ Practical Based Learning

- Project-based learning
- Tool Demonstration

Web links and Video Lectures (e-Resources):

•https://nptel.ac.in/courses/106104220

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B.E. COMPUTER SCIENCE AND ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022

SEMESTER –VI

Full Stack Development(3:0:0) 3

(Effective from the academic year 2023-24)

Course Code	BCS604C	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	03

Course Objectives:

This course will enable students:

1. To outline the framework of full stack development.
2. To illustrate the JavaScript with its functional frameworks.
3. To apply Node.js features and applications with MongoDB.
4. To design simple responsive web applications using different frameworks.

Preamble: This course provides experience and exposures to develop front end and back end for web applications. Also this course builds strong foundations on JavaScript, Node.js & MongoDB for developing responsive web applications. Combining frameworks and libraries allow the students to build full-stack web applications that can handle complex logic on the server side while providing a responsive
and interactive user interface on the client side.

Module – I

Basics of Full Stack:

Understanding the Basic Web Development Framework – User – Browser – Webserver – Backend Services, Understanding the different stack components – The role of Express – Angular – Node – MongoDB – React, JavaScript: Defining Variables, Understanding JavaScript Data Types, Using Operators.

Text book 1: Chapters 1 & 2.1,2.2,2.3

(8 hours)

Module – II

JavaScript: Implementing Looping, Creating Functions, Understanding Variable Scope, Using, JavaScript object Manipulating Strings, working with array, Adding Error Handling: throw your own errors.

Text book 1: Chapters 2.4 to EOC.

(8 hours)

Module – III

Node.js:

Basics of Node.js, Installation of Node.js, Working with Node packages, Using Node package manager, creating a simple Node.js application, Using Events, Listeners, Timers.

Text Book 1: Chapters 3&4.

(8 hours)

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Module – IV
Handling Data I/O in Node.js Callbacks in Node.js: Implementing Callbacks, Handling Data I/O in Node.js: Working with JSON Using the Buffer Module to Buffer Data, Using the Stream Module to Stream Data, Compressing and Decompressing Data with Zlib. **Text Book 1:** Chapters 5 **(8 hours)**
Module – V
MongoDB: Understanding NoSQL and MongoDB, Building MongoDB Environment, User accounts, Access control, administering databases, Managing collections, MongoDB and Node.js. **Text Book 1:** Chapters 11, 12 & 13 **(8 hours)**
Course outcomes: CO1: Outline the use of Full stack framework to adopt use of web applications. CO2: Summarize the JavaScript framework for development of Full stack framework. CO3: Apply concepts of Node.js features for web applications with MongoDB. CO4: Experiment with the working of complete web applications and database connectivity.
Text books:

1.	Brad Dayley & Brendan Dayley, "Node.js, MongoDB and Angular Web Development", 2nd Ed., Addison-Wesley.
References:	
1.	Chris Northwood, The Full Stack Developer: Your Essential Guide to the Everyday Skills Expected of a Modem Full Stack Web Developer, Apress publisher.
2.	Adam Bretz & Colin J Ihrig, Full Stack JavaScript Development With MEAN, Sitepoint publisher.
3.	Jeffrey C. Jackson, "Web Technologies--A Computer Science Perspective", Pearson Education, 2012.
4.	Kirupa Chinnathambi, "Learning React: A Hands-On Guide to Building Web Applications Using React and Redux", Second Edition, Addison-Wesley Professional.
5.	Jon Duckett, "HTML and CSS-Design and Build Websites", John Wiley Sons.
6.	Kyle Banker, Peter Bakkum, Shaun Verch, Douglas Garrett and Tim Hawkins, "MongoDB in Action", Second Edition, Manning Publication, 2016.
	Alternate Assessment Tools (AATs) suggested: ● Mini Project to develop simple real time web applications. ● Coding Challenges on Platforms like: LeetCode
	Web links / e – resources: 1. https://www.coursera.org/professional-certificates/ibm-frontend-developer 2. https://www.coursera.org/professional-certificates/ibm-frontend-developer 3. https://www.udemy.com/course/the-complete-web-development-bootcamp/

B.E. COMPUTER SCIENCE & ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER – VI

Data warehousing and Data mining (3:0:0) 3

(Effective from the academic year 2024-25)

Course Code	**BCS604D**	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course Objectives:

This course will enable students to:

1. Be familiar with mathematical foundations of data warehousing and OLAP.
2. Implement classical models and algorithms in data warehouses and data mining & OLAP queries.
3. Discover interesting patterns using clustering, classification, association finding on real world data.
4. Develop skill in selecting the different algorithms and analyse it with the support of tools for solving practical problems.

Preamble:

This course focuses on the concepts, techniques, design and applications of data warehousing and OLAP. The students opting for this course will understand and implement classical algorithms in data warehousing. The course demonstrates how to analyse the data, identify the problems, and choose the relevant algorithms to apply. The students will be able to assess the strengths and weaknesses of the algorithms and analyse their behaviour on real datasets.

Module – 1

Data warehousing and OLAP: Data Warehouse basic concepts, Data Warehouse Modeling, Data Cube and OLAP: Characteristics of OLAP systems, Multidimensional view and Data cube, Data Cube Implementations, Data Cube operations, Implementation of OLAP and overview on
OLAP Software, Typical OLAP Operations.
Textbook 2: Ch.4.1,4.2
R1(Ch-8: 8.1 - 8.5)

(08 Hours)

Module – 2

Data warehouse implementation &Data Mining : Introduction, What is Data Mining?, Motivating Challenges, Data Mining Tasks, Which technologies are used for data mining, Kinds of pattern that can be mined, Data Mining Applications, Data Pre-processing, Data cleaning, data integration, data reduction and data transformation, An overview, Indexing OLAP Data: Bitmap index and join index, Efficient processing of OLAP Queries, OLAP server Architecture ROLAP versus MOLAP Versus HOLAP.
Textbook 2: Ch.4.4
Textbook1(Ch-1: 1.1 – 1.4) (08 Hours)
Textbook1(Ch-2: 2.3.1 – 2.3.7)

Module – 3

Association Analysis: Problem Definition, Frequent Item set Generation, Rule generation. Alternative Methods for Generating Frequent Item sets, FPGrowth Algorithm, Evaluation of Association Patterns.
Textbook 1: Ch 6.1 to 6.7 (Excluding 6.4)

(08 Hours)

Module – 4

Classification: Decision Trees Induction, Method for Comparing Classifiers, Rule Based Classifiers, Nearest Neighbor Classifiers, Bayesian Classifiers.
T1(Ch-4: 4.1 - 4.3)

(08 Hours)

Module – 5

Clustering Techniques: Overview, Features of cluster analysis, Types of Data and Computing Distance, Types of Cluster Analysis Methods, Partitional Methods, Hierarchical Methods, Density Based Methods, Quality and Validity of Cluster Analysis.

T1(Ch-7: 7.1 - 7.5) (08 Hours)

Course Outcomes:

The students will be able to:

- **CO1**: Demonstrate knowledge of the basic concepts and modelling involved in data Ware housing.
- **CO2**: Examine data and select suitable methods for applying data mining techniques and methods to data sets.
- **CO3**: Analyze the frequent patterns using association analysis algorithms.
- **CO4**: Demonstrate various algorithms based on data mining tools & OLAP.

Textbooks:

1. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, "Introduction to Data Mining", Addison-Wesley, First impression,2014.
2. Jiawei Han, Micheline Kamber, Jian Pei: Data Mining -Concepts and Techniques, 3rd Edition, Morgan Kaufmann Publisher, 2012.

References:

1. G. K. Gupta, "Introduction to Data Mining with Case Studies", 3rd Edition, PHI, New Delhi, 2009.
2. Sam Anahory, Dennis Murray: Data Warehousing in the Real World, Pearson, Tenth Impression,2012.

Alternate Assessment Tools (AATs) suggested:

- **Case Study on different Classification and clustering techniques.**
- **Case Study on different OLAP server Architecture ROLAP versus MOLAP Versus HOLAP.**

Web links / e – resources:

1. https://www.pearsonhighered.com/assets/preface/0/1/3/3/0133128903.pdf
2. https://developers.google.com/machine-learning/clustering/clustering-algorithms

OPEN ELECTIVE
COURSE I

B.E COMPUTER SCIENCE AND ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER -VI

INTRODUCTION TO DATA STRUCTURES (3:0:0) 3

(Effective from the academic year 2024-25)

Course Code	BCS605A	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	03

Course Objectives:

This course will enable students to:

1. Learn and identify different data structures in C programming language.
2. Assess the use of suitable data structures in problem-solving.
3. Implement data structures using C programming language.
4. Develop solutions for practical problems.

Preamble:

Data structures are fundamental in computer science for organizing and manipulating data efficiently. They form the backbone of algorithms and significantly affect software performance. This course will cover essential data structures like arrays, stacks, queues, linked lists, trees, and graphs, exploring their properties, operations, and applications. By mastering this course, students will be able to write efficient code and solve complex problems.

Module – I

C Recap: Pointers.

Data Structures: Introduction, Classification, Operations.

Arrays: Declarations, Accessing/Storing of Elements, Operations, Passing arrays to Functions, Pointers and Arrays, Arrays of Pointers. Sorting (selection, insertion, bubble), and searching (Linear, Binary), Programming Examples. **Dynamic memory allocation**.

Text book 1: 1.11, 2.1-2.3, 3.1-3.8, 14.1-14.3, 14.7-14.9. **Text Book 2:** 1.2.2.

(8 hours)

Module – II

Structures: Introductions, Nested Structures, Arrays of Structures, Structures and Functions, Self-referential Structures.

Linked Lists: Definition, Representation of linked lists in Memory, Singly Linked List,

Linked list operations: Traversing, Searching, Insertion, and Deletion. Doubly Linked lists, Circular linked lists, Circular Doubly Linked List—programming Examples.

Text Book 1: 5.1-5.5, 6.1-6.5.

(8 hours)

Module – III

Stacks: Definition, Stack Operations, Array Representation of Stacks, Linked representation of Stacks, Operations on Linked Stack, Programming Examples.

Recursion: Factorial, GCD, Fibonacci Sequence, Tower of Hanoi.

Text Book 1: 7.1-7.5, 7.7.4.

(8 hours)

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Module – IV

Queues: Introduction, Array representation of Queues, Linked representation of Queues, Types of Queues (Circular Queue, Dequeue, Priority Queue), Applications of Queues (Excluding Josephus Problem), Programming Examples.

Hashing: Introduction, Hash Tables, Hash Functions, Different Hash Functions, Collisions, Pros and Cons of Hashing, Applications of Hashing.

Text Book 1: 8.1-8.3,8.4.1-8.4.3,8.5, 15.1-15.7

(8 hours)

Module – V

Trees: Introduction, Types of Trees, Creating a Binary Tree, Binary Tree Traversals - Inorder, Postorder, Preorder, Level Order.

Binary Search Trees: BST create, Insert, and search, Programming Examples.

Graphs: Introduction, Terminologies, Directed graphs, Matrix and Adjacency List Representation of Graphs, Breadth First Search, Depth First Search - Programming Examples.

Text Book 1: 9.1-9.4, 10.1, 10.2.1, 10.2.2, 10.2.3, 13.1-13.3, 13.5, 13.6.

(8 hours)

Course outcomes:

CO1: Understand the concepts of data structures.

CO2: Implement data structures using C Programming language.

CO3: Apply various data structures in problem-solving using C language.

CO4: Design and develop solutions using Data Structures for practical problems.

Text books:

1.	Reema Thareja, Data structures using C, 2nd Ed, Oxford University Press.
2.	Ellis Horowitz and Sartaj Sahni, Fundamentals of Data Structures in C, 2nd Ed, Universities Press, 2014.

References:

1.	Seymour Lipschutz, Data Structures Schaum's Outlines, Revised 1st Ed, McGraw Hill, 2014

Alternate Assessment Tools (AATs) suggested:

- Case Study
- Programming Assignment
- Gate Based Aptitude Test
- Project Based Learning

Web links / e – resources:

- https://nptel.ac.in/courses/106/105/106105171/
- http://www.nptelvideos.in/2012/11/data-structures-and-algorithms.html
- https://nptel.ac.in/courses/106/102/106102064/
- https://ds1-iiith.vlabs.ac.in/exp/stacks-queues/index.html
- https://ds1-iiith.vlabs.ac.in/exp/linked-list/basics/overview.html
- https://ds1-iiith.vlabs.ac.in/exp/tree-traversal/index.html
- https://ds1-iiith.vlabs.ac.in/exp/tree-traversal/depth-first-traversal/dft-practice.html

B.E. COMPUTER SCIENCE AND ENGINEERING

Choice Based Credit System(CBCS) For 2022 Scheme

SEMESTER VI

DATA ANALYTICS (3:0:0) 3

(Effective from the academic year 2024-25)

Course Code	**BAI605B**	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course Objectives:

This course will enable students to: (List as per the requirement of your course)

- Understand different techniques of Data Analysis.
- Be familiar with concepts of data streams.
- Be exposed to data analytics algorithms.
- Derive the performance measures of Regression and Classification algorithms.
- Examine the applications of data analytics for real time applications.

Preamble:

To provide strong foundation for data analytics and application area related to it and understand the underlying core concepts and emerging technologies in data analytics. This course provides a understanding and framework for basic analytics tasks, including data extraction, cleaning, manipulation, and analysis. This course also guides in decision making and examine real-world examples to improve decision-making.

Module – 1

What Can We Do with Data? -Big Data and Data Science, Big Data Architectures, Small Data, what is Data? A Short Taxonomy of Data Analytics, Examples of Data Use, A Project on Data Analytics.

Descriptive Statistics, Scale Types, Descriptive Univariate Analysis, Descriptive Bivariate Analysis Final Remarks.

Textbook 1: Chapter 1.1- 1.7, 2.1 - 2.5 (8 Hours)

Module – 2

Descriptive Multivariate Analysis: Multivariate Frequencies, Multivariate Data Visualization, Multivariate Statistics, Infographics and Word Clouds, Final Remarks,

Data Quality and Preprocessing, -Data Quality, converting to a Different Scale Type, Converting to a Different Scale, Data Transformation, Dimensionality Reduction.

Textbook 1: Chapter 3,4 (8 Hours)

Module – 3

Clustering: Distance Measures, Clustering Validation, Clustering Techniques.

Frequent Pattern Mining- Frequent Itemset, Association Rules, Behind Support and Confidence, Other Types of Patterns

Textbook 1: Chapter 5,6 (8 Hours)

Module – 4

Regression -Predictive Performance Estimation, Finding the Parameters of the Model, Technique and Model Selection.

Classification -Binary Classification, Predictive Performance Measures for Classification, Distance-based Learning Algorithm

Textbook 1: Chapter 8,9 (8 Hours)

Module – 5

Applications for Text, Web and Social Media-Working with Texts, Recommender Systems, Social Network Analysis.

Textbook 1: Chapter 13 **(8 Hours)**

Course Outcomes:

The students will be able to:

CO1: Explore the fundamental concepts of data analytics
CO2: Understand data analysis techniques for applications handling large data
CO3: Understand various algorithms used in data analytics process
CO4: Apply and present the inference of Regression and Classification algorithms
CO5: Analyze the applications of a data analytics for real time applications.

Textbooks:

1. "A general introduction to data analytics " Jõao Mendes Moreira, André de Carvalho, Tomás Horváth., |a Hoboken, Wiley, 2019.

References:

1. Data Analytics Made Accessible by Dr. Anil Maheshwari
2. Principles of Data Wrangling, by Joseph M. Hellerstein, Tye Rattenbury, Jeffrey Heer, Sean Kandel, Connor Carreras, Released July 2017
3. Visual Analytics with Tableau by Alexander Loth , Nate Vogel, et al.

Alternate Assessment Tools (AATs) suggested:

- Experiential Learning/ MOOC/Certification Courses (Infosys Springboard, Geek for Geeks, IBM, Hacker earth, Math works)
- Model presentation
- Video

Web links / e – resources:

1. http://www.cse.iitm.ac.in/~ravi/nptel-courses/intro-to-data-analytics/
2. https://www.youtube.com/watch?v=CaqJ65CIoMw

ABILITY ENHANCEMENT COURSE

B.E COMPUTER SCIENCE AND ENGINEERING

Choice Based Credit System(CBCS) applicable from 2022 scheme

SEMESTER – VI

Generative AI (0:0:2:0) 1

(Effective from the academic year 2024 -25)

Course Code	**BCS608A**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	0:0:2:0	SEE Marks	50
Total Number of Contact Hours	15	Exam Hours	3 Hours

Course Objectives:

This course will enable students to:

- Understand the principles and concepts behind generative AI models, including architecture of ChatGPT
- Explain the knowledge gained to implement generative models using Prompt design frameworks.
- Apply various Generative AI applications for increasing productivity.
- Develop and Operationalizing Large Language Modes-based Apps.

Preamble:

The advancement of artificial intelligence (AI) has resulted in the emergence of a remarkable field known as generative AI. Generative AI is a type of AI technology that allows machines to generate new content, data, or outputs that are like human-created content. It uses large datasets to learn the underlying structure and characteristics of the data, enabling it to produce original and contextually relevant outputs. Generative AI can generate various data types, including text, images, sounds, animations, and 3D models, and it can create entirely new data based on the patterns it has learned.

Descriptions

Design, develop, and implement the specified programs as given in the list given below using python Language under LINUX /Windows environment.

SL. No.	Program List
1.	Text Generation with GPT-2: Experiment with OpenAI's GPT-2 model for generating diverse and coherent text based on prompts.
2.	Image Synthesis using DALL-E: Dive into image generation with OpenAI's DALL-E, creating unique and imaginative visuals based on textual descriptions.
3.	Music Composition with Magenta: Explore Magenta, a project by Google, to generate music compositions using machine learning techniques.
4.	Code Generation with OpenAI Codex: Try your hand at code generation using OpenAI Codex, which is proficient in understanding and generating programming code.
5.	Artistic Creations with StyleGAN: Use StyleGAN for artistic projects, generating visually striking images with control over specific visual attributes.
6.	Story Writing with ChatGPT: Engage in creative writing by utilizing ChatGPT for generating dialogues, narratives, and even collaborative storytelling.
7.	Facial Image Generation with StyleGAN: Experiment with StyleGAN for creating realistic and diverse facial images, exploring the nuances of facial feature synthesis.
8.	Language Translation with Marian MT: Implement language translation using Marian MT, a multilingual transformer model, for translating text between different languages.

Course outcomes:

At the end of the course the student will be able to:

CO1: Understand the foundations and principles behind generative models.
CO2: Apply prompt engineering skills to real-world scenarios, such as information retrieval, question-answering, or text generation.
CO3: Apply the learned skills and techniques through the models that involve the future with ChatGPT.
CO4: Apply different architectures used in large language models, such as transformers, and understand their advantages and limitations.

Textbooks

1. **Modern Generative AI with ChatGPT and OpenAI Models:**Leverage the Capabilities of OpenAI's LLM for Productivity and Innovation with GPT3 and GPT4, by Valentina Alto, Packt Publishing Ltd, 2023.
2. **Generative AI for Cloud Solutions:** Architect modern AI LLMs in secure, scalable, and ethical cloud environments, by Paul Singh, Anurag Karuparti ,Packt Publishing Ltd, 2024.

Reference Books

1. The Artificial Intelligence and Generative AI Bible: [5 in 1] The Most Updated and Complete Guide | From Understanding the Basics to Delving into GANs, NLP, Prompts, Deep Learning, and Ethics of AI ,Kindle Edition by Alger Fraley .
2. "Ripples of Generative AI: How Generative AI Impacts, Informs and Transforms Our Lives" by Jacob Emerson, ISBN-10: 1088221610 Publisher: Artificial Intelligence, 2023
3. "Demystifying Prompt Engineering: AI Prompts at Your Fingertips (A Step-By-Step Guide)" ,Kindle Edition ,by Harish Bhat

Alternate Assessment Tools (AATs) suggested:

- Experiential Learning/ MOOC/Certification Courses (Infosys Springboard, Geek for Geeks, IBM, Hacker earth, Math works)
- Model presentation
- Video

Web links / e – resources:

- https://onlinecourses.swayam2.ac.in/imb24_mg116/preview
- https://www.cloudskillsboost.google/paths/118

B.E. COMPUTER SCIENCE AND ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER – VI

MOBILE APPLICATION DEVELOPMENT (0:0:2) 1

(Effective from the academic year 2024-25)

Course Code	**BCS608B**	CIE Marks	**50**
Teaching Hours/Week (L:T:P)	**0:0:2**	SEE Marks	**50**
Total Number of Contact Hours	**28**	Exam Hours	**3**

Course Objectives:

This course will enable students to:

1. Learn and acquire the art of Android Programming.
2. Install and Configure Android studio and its development tools to run the applications.
3. Use User Interface components for android application development.
4. Create Android applications using database like SQLITE.
5. Inspect different methods of sharing data using services.

Preamble:

This is a practical course on Mobile Application Development. The lab is designed to provide hands-on experience in creating, developing, and testing mobile applications across various platforms. By leveraging state-of-the-art tools and methodologies, students will gain a deep understanding of the entire mobile app lifecycle, from initial concept to the development of applications using SQLite that run on Andriod Operating System.

Prerequisite

Basic knowledge on programming and database concepts.

List of Experiments

- Installation of Android studio and Development Of Hello World Application. Create an application to design a Visiting Card.
- The Visiting card should have a company logo at the top right corner. The company name should be displayed in Capital letters, aligned to the center. Information like the name of the employee, job title, phone number, address, email, fax and the website address is to be displayed. Insert a horizontal line between the job title and the phone number.

1. Develop an Android application using controls like Button, TextView, EditText for designing a Calculator having basic functionality like Addition, Subtraction, Multiplication, and Division.

2. Design a basic alarm clock application that allows users to set a recurring alarm and provides an option to cancel the alarm

3. Create a SIGN Up activity with Username and Password. Validation of password should happen based on the following rules:
    a. Password should contain uppercase and lowercase letters.
    b. Password should contain letters and numbers.
    c. Password should contain special characters.
    d. Minimum length of the password (the default value is 8).

On successful SIGN UP proceed to the next Login activity. Here the user should SIGN IN using the Username and Password created during signup activity. If the Username and Password are matched then navigate to the next activity which displays a message saying “Successful Login” or else display a toast message saying “Login Failed”. The user is given only two attempts and after

that display a toast message saying "Failed Login Attempts" and disable the SIGN IN button. Use Bundle to transfer information from one activity to another.

4. Create two files of XML and JSON type with values for City_Name, Latitude, Longitude, Temperature, and Humidity. Develop an application to create an activity with two buttons to parse the XML and JSON files which when clicked should display the data in their respective layouts side by side.

5. Create an activity like a phone dialer with CALL and SAVE buttons. On pressing the CALL button, it must call the phone number and on pressing the SAVE button it must save the number to the phone contacts.

6. Write a program to enter Medicine Name, Date and Time of the Day as input from the user and store it in the SQLite database. Input for Time of the Day should be either Morning or Afternoon or Evening or Night. Application should input the Date and Time of the Day and display the Medicine Name.

7. Create an application to receive an incoming SMS which is notified to the user. On clicking this SMS notification, the message content and the number should be displayed on the screen. Use appropriate emulator control to send the SMS message to your application.

8. Develop an application that makes use of the clipboard framework for copying and pasting of the text. The activity consists of two EditText controls and two Buttons to trigger the copy and paste functionality.

CO1 : Design and develop user interfaces for mobile apps using basic building blocks.
CO2 : Apply methods of storing, sharing and retrieving the data in Android Applications
CO3: Analyze the responsive user interface across a wide range of devices.
CO4: Design a mobile Application by using various components of android app development.

Text Books :

1. Reto Meier, Professional Android 4 Application Development, Wrox Publication,2012,
2. Baijian Yang, Pei Zheng, Lionel M. Ni, Professional Microsoft Smartphone Programming, Wrox Publication,2007.

Alternate Assessment Tools (AATs) suggested:

1. Development of an mobile application

Reference Books:

1. Erik Hellman, "Android Programming – Pushing the Limits", 1st Edition, Wiley India Pvt Ltd, 2014. ISBN-13: 978-8126547197
2. Dawn Griffiths and David Griffiths, "Head First Android Development", 1st Edition, O'Reilly SPD Publishers, 2015. ISBN-13: 978-9352131341
3. Bill Phillips, Chris Stewart and Kristin Marsicano, "Android Programming: The Big Nerd Ranch Guide", 3rd Edition, Big Nerd Ranch Guides, 2017. ISBN-13: 978-0134706054

Web links / e – resources:

1. Google Developer Training, "Android Developer Fundamentals Course – Concept Reference",Google Developer Training Team, 2017. https://www.gitbook.com/book/google-developertraining/android-developerfundamentals-course-concepts/details (Download pdf file from the above link)

B.E COMPUTER SCIENCE AND ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER – VI

DevOps (0:0:2) 1

(Effective from the academic year 2024-25)

Course Code	**BCS608C**	CIE Marks	**50**
Teaching Hours/Week (L:T:P)	**0:0:2**	SEE Marks	**50**
Total Number of Contact Hours	**15**	Exam Hours	**3**

Course Objectives:

This course will enable students to: (List as per the requirement of your course)

1. Understand and apply the DevOps tools used in SDLC.
2. Examine the docker containerization in detail.

Preamble: The DevOps Foundation course provides a comprehensive overview of understanding the DevOps competencies needed to accelerate time-to-market by improving the flow of value through the continuous delivery pipeline. Students will map the current value stream through their delivery pipeline from idea to cash, and identify practices that will eliminate bottlenecks to workflow.

List of Programs

1. To perform version control on websites or software using Git by managing repositories through a browser-based interface and synchronizing changes with push and pull commands from the command line and GUI.
2. Install Docker, explore its containerization commands, create Docker containers using various operating system images, and deploy containerized applications using Docker and Docker Hub.
3. Design, Deploy, and Manage a micro services architecture on your local machine using Docker and docker-compose
4. Install and configure SonarQube on your local machine and create a Jenkins CI/CD pipeline that integrates SonarQube to perform static code analysis.
5. Create a Maven Project, Understanding the POM File, Dependency Management and Plugins.
6. Build and Run a Java Application with Maven, Migrate the Same Application to Gradle.

Course Outcomes: The students will be able to:

CO1:	Understand the concept of Devops and workflow with different tools. Experiment with
CO2:	GIT, IT, Dockers and Containerization. Jenkins
CO3:	Create CICD Pipeline using tools like SonarQube.

Textbooks:

1. Effective DevOps Building a Culture of Collaboration, Affinity, and Tooling at Scale, Jennifer Davis and Ryn Daniels, June 2016: First Edition Published by O'Reilly Media Inc.

References:

1. The Devops Handbook: How to Create World-Class Agility, Reliability, & Security in Technology Organizations, by Gene Kim , Jez Humble, 2016, It Revolution Press.
2. DevOpson the Microsoft Stack, by Wouter de Kort, Aperss.

Alternate Assessment Tools (AATs) suggested:

- **Demonstrate the use of one or two DevOps tools in SDLC lifecycle.**

Web links / e – resources:

1. **https://www.youtube.com/results?search_query=github+tutorial**
2. **https://www.youtube.com/results?search_query=setup+and+configure+S ONAR+Q**
3. **https://www.youtube.com/watch?v=A0g7I4A6GN4&pp=ygUWY29udGFpb mVycyBhbmQgZG9ja2Vycw%3D%3D**

B.E. COMPUTER SCIENCE AND ENGINEERING

Choice Based Credit System (CBCS) applicable for 2022 Scheme

SEMESTER – VI

AUTOMATED SOFTWARE TESTING (0:0:2) 1

(Effective from the academic year 2024-25)

Course Code	**BCS608D**	CIE Marks	**50**
Teaching Hours/Week (L:T:P)	**0:0:2**	SEE Marks	**50**
Total Number of Contact Hours	**26**	Exam Hours	**2**

Course Objectives:

This course will enable students to:

1. Study the fundamental concepts of software testing.
2. Describe test suites for software.
3. Discuss various software testing issues and solutions for unit, integration and system testing.
4. Learn Selenium tool and demonstrate it using a script in Java/PHP.

Preamble:

Automation Software Testing is essential for ensuring software quality, efficiency and reliability. This lab provides hands-on experience with designing and executing automated test cases, utilizing modern test automation tool - Selenium, and understanding the latest trends in software testing. Students will learn to develop and implement robust testing strategies, integrate testing into Continuous Integration/Continuous Deployment (CI/CD) pipelines, and leverage AI and machine learning to enhance testing processes. The lab focuses on practical skills required to perform effective automation testing for real-world software development and quality assurance.

Sl. No.	Experiments
1	Write a program to check if a number is prime using the following constructs: 1. do...while 2. while...do 3. if...else 4. switch 5. for loop
2	Design and develop a program in a language of your choice to solve the triangle problem defined as follows: Accept three integers which are supposed to be the three sides of a triangle and determine if the three values represent an equilateral triangle, isosceles triangle, scalene triangle, or they do not form a triangle at all. Assume that the upper limit for the size of any side is 10. Derive test cases for your program based on boundary-value analysis, execute the test cases and discuss the results.
3	Take any system (ex: Library Management System) and study its system specification and report the various bugs.
4	Design test cases for any application (ex: e-commerce).
5	Install a basic setup for a Selenium test suite, creation of test scripts and configuration of the test environment to perform data scraping.
6	Execute simple Selenium test cases to verify basic website functionality, such as navigating pages and interacting with elements.
7	Organize a Selenium test suite using TestNG, grouping and executing multiple test cases.
8	Integrate Selenium test suites with CI tools like Jenkins, including test execution and reporting setup.

9	Generate and analyse test reports for Selenium test suites using tools like Allure or Extent Reports.
10	Perform cross-browser testing within a Selenium test suite by running tests across multiple browsers and addressing any compatibility issues. Across multiple browsers and addressing any compatibility issues.

Course Outcomes:

The students will be able to:

CO1: Apply manual and automation testing techniques.

CO2: Apply strategies for generating system test case and test plan document.

CO3: Examine the Selenium environment and execute test suites.

CO4: Design test cases for data-driven, cross-browser testing, CI integration, and report generation.

Textbooks:

1. Paul C. Jorgensen: Software Testing, A Craftsman‟s Approach, 3rd Edition, Auerbach Publications, 2008.
2. Aditya P Mathur: Foundations of Software Testing, Pearson Education, 2008.
3. "Testing in 30+ Open Source Tools", Rahul Shende, Shroff Publishers & Distributor Pvt. Ltd, ISBN 13: 9789350231005 (Page numbers from 15 to 117)

Alternate Assessment Tools (AATs) suggested:

- Demonstration of TOSCA automation tool.

Web links / e – resources:

1. http://seleniumhq.org/
2. http://sourceforge.net/projects/sahi/
3. http://testing.org/doc/index.html
4. https://www.coursera.org/specializations/software-testing-automation
5. https://onlinecourses.nptel.ac.in/noc22_cs61/preview

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B.E COMPUTER SCIENCE AND ENGINEERING

Choice Based Credit System (CBCS) applicable from 2022 scheme

SEMESTER -VI

Robotic Process Automation (0:0:2) 1

(Effective from the academic year 2024-25)

Course Code	BCS608E	CIE Marks	50
Teaching Hours/Week (L:T:P)	0:0:2	SEE Marks	50
Total Number of Contact Hours	15 hrs	Exam Hours	02

Course Objectives:

This course will enable students to:

1. Gain a clear understanding of RPA and benefits, understanding the limits and constraints of automation.
2. Understand the basic RPA components, features and technology.
3. Acquire the knowledge on purpose and use of the control center.
4. Understand the various use cases and write bots.

Preamble

RPA is growing rapidly with changing IT climate & bringing up many tools & capabilities which are as deep as machine learning & artificial intelligence. UiPath is a powerful automation tool that can be used by technical professionals, including software engineers and IT professionals, to create complex and efficient automation workflows. This provides a range of advanced features and capabilities, such as the ability to integrate with multiple systems and applications, execute complex logic, and handle large amounts of data.

List of Experiments

Download, Install and Activate Ui-Path Studio. Learn all the basics of RPA (Variables, arguments and Control flow etc.)

1. Generate unicorn names from the website https://www.rpasamples.com/ to an excel sheet.

2. Build a flowchart to:
   a. Ask the user's name and extract the first 3 characters from the given name and display it.
   b. Ask the user a number and display whether it is a odd or even number.
   c. Show how an integer variable will increase from 5 to 50 in increments of 5 using while control flow activity.
3. Build a flowchart to:
   a. Check whether the given year is leap year or not via do-while activity. You need to continue taking the input as long as the customer gives non leap year.
   b. Ask two numbers from the user and check whether the sum is less than 20
   c. Move all the files from a source folder to destination folder using for-each activity.

4. Perform the following operations on an Excel file
   i) Read cell ii) Write cell iii) Read Range iv) Write Range v) Append Range.

5. UiPath Studio includes a recording feature, that can help you save time when automating your business processes. Demonstrate Basic, Desktop and Web recording for some use cases.

6. Flipkart.com or amazon.com has lot of mobile phones listed with all the details like price, model, make etc. Build an Automation Process to extract this and build a data table and dump into an excel sheet using data scraping via UiPath.

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7. Extract invoice details from multiple PDF files and consolidate them into an Excel sheet.

8. Compare two Excel sheets and update the cells accordingly using Lookup data table activity.

9. Take a look at the above image. Interpret how you can extract the text via OCR activity. Also discuss the types of OCR available in UiPath studio. (with UiPath flowchart)

Course Outcomes: The students will be able to:

CO1: Demonstrate the record and play feature, task recorder, different types of variables, control flow and data manipulation techniques.

CO2: Apply various control techniques, OCR, strategies to handle exceptions in real time applications in RPA.

CO3: Interpret various case studies influencing customer experience in implementing RPA technology.

Textbooks:

1. Nandan Mullakara, Arun Kumar Asokan, Robotic Process Automation Projects: Build real-world RPA solutions using UiPath and Automation Anywhere, First Edition, Packt Publishing Ltd., 2020.
2. Alok Mani Tripathi, Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool – UiPath, First Edition, Packt Publishing Ltd., 2018

Alternate Assessment Tools (AATs) suggested:

1.Certification course from UiPath /any other MOOCS.

SEMESTER – VI

INDIAN KNOWLEDGE SYSTEM
(Common to All UG Programs)
Applicable for the Academic Year 2024-25 for 2022 scheme onwards

Course Code	**BIKS610**	CIE Marks	100
Teaching Hours/Week (L: T:P)	1:0:0- NCMC	SEE Marks	-
Total Number of Lecture Hours	13	Total marks	100

Course objectives:

1. To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the importance of roots of knowledge system.
2. To make the students understand the traditional knowledge and analyse it and apply it to their day-to-day life.

Module – 1

Introduction to Indian Knowledge Systems (IKS): Overview, Vedic Corpus, Philosophy, Character, scope and importance, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge vs. western knowledge. **5 Hours**

Module – 2

Traditional Knowledge in Humanities and Sciences: Linguistics, Number and measurements- Mathematics, Chemistry, Physics, Art, Astronomy, Astrology, Crafts and Trade in India and Engineering and Technology. **4 Hours**

Module – 3

Traditional Knowledge in Professional domain: Town planning and architecture-Construction, Health, wellness and Psychology-Medicine, Agriculture, Governance and public administration, United Nations Sustainable development goals. **4 Hours**

Course Outcomes: After completing the course, the students will be able to	
CO1:	Provide an overview of the concept of the Indian Knowledge System and its importance.
CO2:	Appreciate the need and importance of protecting traditional knowledge.
CO3:	Recognize the relevance of Traditional knowledge in different domains.
CO4:	Establish the significance of Indian Knowledge systems in the contemporary world.

Reference Books:

1	**Introduction to Indian Knowledge System- concepts and applications**, B Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana R N, 2022, PHI Learning Private Ltd, ISBN-978-93-91818-21-0
	Traditional Knowledge System in India, Amit Jha, 2009, Atlantic Publishers and Distributors (P) Ltd., ISBN-13: 978-8126912230,
2	**Knowledge Traditions and Practices of India**, Kapil Kapoor, Avadesh Kumar Singh, Vol. 1, 2005, DK Print World (P) Ltd., ISBN 81-246-0334,

Suggested Web Links:

1.	**https://www.youtube.com/watch?v=LZP1StpYEPM**
2.	**http://nptel.ac.in/courses/121106003/**
3.	http://www.iitkgp.ac.in/department/KS;jsessionid=C5042785F727F6EB46CBF432D7683B63 (Centre of Excellence for Indian Knowledge System, IIT Kharagpur)
4.	https://www.wipo.int/pressroom/en/briefs/tk_ip.html
5.	https://unctad.org/system/files/official-document/ditcted10_en.pdf
6.	http://nbaindia.org/uploaded/docs/traditionalknowledge_190707.pdf
7.	https://unfoundation.org/what-we-do/issues/sustainable-development-goals/?gclid=EAIaIQobChMInp-Jtb_p8gIVTeN3Ch27LAmPEAAYASAAEgIm1vD_BwE