Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B.Tech. (Computer Science and Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5CS401
Course Name	Cryptography and Network Security
Desired Requisites:	Computer Networks

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	Understand OSI security architecture and classical encryption techniques.
2	Acquire fundamental knowledge on the concepts of finite fields and number theory.
3	Understand various block cipher and stream cipher models.
4	Describe the principles of public key cryptosystems, hash functions and digital signature.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Apply the number theory concepts to different encryption and decryption techniques to solve problems related to confidentiality and authentication.	III	Apply
CO2	Analyze security of network protocols and systems	IV	Analyze
CO3	Justify various methods of authentication and access control for application of technologies to various sections of industry and society.	V	Evaluate
CO4	Identify and classify security threats and develop a security model to prevent, detect and recover from attack	VI	Create

Module	**Module Contents**	**Hours**
I	**INTRODUCTION** Security trends – Legal, Ethical and Professional Aspects of Security, Need for Security at Multiple levels, Security Policies – Model of network security – Security attacks, services and mechanisms – OSI security architecture – Classical encryption techniques: substitution techniques, transposition techniques, steganography- Foundations of modern cryptography: perfect security – information theory – product cryptosystem – cryptanalysis	8
II	**SYMMETRIC KEY CRYPTOGRAPHY** MATHEMATICS OF SYMMETRIC KEY CRYPTOGRAPHY: Algebraic structures – Modular arithmetic-Euclid‟s algorithm- Congruence and matrices SYMMETRIC KEY CIPHERS: Block cipher Principles of DES – Strength of DES – Differential and linear cryptanalysis – Block cipher design principles – Block cipher mode of operation – Evaluation criteria for AES – Advanced Encryption Standard – RC4	6

III	**PUBLIC KEY CRYPTOGRAPHY** MATHEMATICS OF ASYMMETRIC KEY CRYPTOGRAPHY: Primes – Primality Testing –Factorization – Euler‘s totient function, Fermat‘s and Euler‘s Theorem – Chinese Remainder Theorem – Exponentiation and logarithm – ASYMMETRIC KEY CIPHERS: RSA cryptosystem – Key distribution – Key management – Diffie Hellman key exchange -ElGamal cryptosystem –Elliptic curve cryptography.	6
IV	**MESSAGE AUTHENTICATION AND INTEGRITY** Properties of hash functions, MD2, MD5 and SHA-1, keyed hash functions, attacks on hash functions, Identity and Access Management (IAM), Digital signature– Entity Authentication: Passwords, challenge-response algorithms, zero-knowledge protocols, Authentication applications – Kerberos, X.509.	6
V	**NETWORK SECURITY** Network security basics: TCP/IP vulnerabilities, Packet Sniffing, ARP spoofing, port scanning, IP spoofing, TCP syn flood, DNS Spoofing, Denial of Service, Internet Security Protocols: SSL/TLS, IPSEC, Email Security: PGP,S/MIME.	7
VI	**SYSTEM SECURITY** Intruders, IDS, Firewalls, Honey Pots, Software Vulnerabilities, Malicious software – Viruses, Worms, Trojans, Logic Bomb, Bots, Rootkits, Wireless Security, Blockchain Cryptocurrencies and the Dark Web.	7

Textbooks	
1	William Stallings, *“Cryptography and Network Security: Principles and Practice”,* Prentice Hall of India.
2	Behrouz A. Forouzan “*Cryptography And Network Security*”. Tata Mcgraw-Hill, New Delhi India.

References	
1	“Applied Cryptography, Protocols Algorithms and Source Code in C”, Bruce Schneier, Wiley.
2	“Cryptography and Network Security”, Atul Kahate, Tata Mc Graw Hill.
3	Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone, “Handbook of Applied Cryptography”, CRC Press.
4	Johannes A. Buchmann, *“Introduction to Cryptography”,* Springer.

Useful Links	
1	

CO-PO Mapping

	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3											2	2
CO2	3	2											3	2
CO3	3	3											3	3
CO4	3	2											3	1

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High

Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2022-23

Course Information	
Programme	B.Tech. (Computer Science and Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5CS403
Course Name	Humanities 4-Legal, IPR, Safety
Desired Requisites:	Nil

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	1 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	15	10	25	50
		Credits: 1			

Course Objectives	
1	To introduce the students about Legal, IPR, Safety laws.
2	To disseminate knowledge on patents, patent regime in India and abroad and registration aspects.
3	To be aware about current trends in IPR and Govt. steps in fostering IPR.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Understand about Indian industry Legal, IPR, Safety laws.	II	Understanding
CO2	Interpret patent and copyright in innovative research work.	III	Applying
CO3	Illustrate the importance of Indian industry Legal, IPR, Safety laws	IV	Analyzing

Module	**Module Contents**	**Hours**
I	Overview of Bureau of Indian Standards Act of 1986	2
II	The Right to Information Act of 2005, In order to promote public education and public safety.	2
III	Intellectual Property, Patents, Copyrights, Trademarks.	3
IV	Other forms of IP, Current Contour.	2
V	Information technology Act 2008,Cyber laws.	3
VI	IT Laws and Regulations in Connection with IPR.	1

Textbooks

1	Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN:Cengage Learning India Private Limited.
2	Cyber Law by Duggal Pavan

References

1	Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.

Useful Links

1	Cell for IPR Promotion and Management (http://cipam.gov.in/)
2	https://law.resource.org/pub/in/bis/manifest.med.html
3	World Intellectual Property Organization (https://www.wipo.int/about-ip/en/)
4	Office of the Controller General of Patents, Designs & Trademarks (http://www.ipindia.nic.in/)

CO-PO Mapping														
	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1								1					1	1
CO2									2				1	1
CO3							1						2	1
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.														

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2022-23

Course Information	
Programme	B.Tech. (Computer Science and Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5CS453
Course Name	Cryptography and Network Security Lab
Desired Requisites:	Computer Networking

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives	
1	To learn different cipher techniques
2	To implement the algorithms DES, AES, RSA,MD5,SHA-1
3	To use network security tools and vulnerability assessment tools

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Develop code for classical Encryption Techniques to solve the real life problems	III	Apply
CO2	Analyze the network security system using open source tools	IV	Analyze
CO3	Evaluate the securities of different security protocols	V	Evaluate
CO4	Build cryptosystems by applying symmetric and public key encryption algorithms	VI	Create

List of Experiments / Lab Activities/Topics

List of Topics(Applicable for Interaction mode):

List of Lab Activities:

1. Perform encryption, decryption using the following substitution techniques
    a. Ceaser cipher,
    b. playfair cipher
    c. Hill Cipher
    d. Vigenere cipher
2. Perform encryption and decryption using following transposition techniques
    a. Rail fence
    b. row and Column Transformation
3. Implementation of Euclidean and Extended Euclidean Algorithm
4. Implementation of Chinese Remainder Theorem (CRT)
5. Apply DES algorithm for practical applications
6. Apply AES algorithm for practical applications
7. Implementation of RSA Algorithm
8. Implement the Diffie-Hellman Key Exchange algorithm for a given problem
9. Calculate the message digest of a text using the SHA-1 algorithm
10. Implement the SIGNATURE SCHEME – Digital Signature Standard
11. Demonstration of SSL using Wireshark
12. Automated Attack and Penetration Tools
    Exploring a Vulnerability Assessment Tool

In case of mini-projects, drawing, presentations etc, write the relevant details of the same.

Textbooks	
1	William Stallings, *"Cryptography and Network Security: Principles and Practice",* Prentice Hall of India.
2	Behrouz A. Forouzan "*Cryptography And Network Security*". Tata Mcgraw-Hill, New Delhi India.
References	
1	"Applied Cryptography, Protocols Algorithms and Source Code in C", Bruce Schneier, Wiley.
2	"Cryptography and Network Security", Atul Kahate, Tata Mc Graw Hill.
Useful Links	
1	

CO-PO Mapping

	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3												3	2
CO2	3	3			3								3	1
CO3	3	3		2									3	2
CO4	3	2											3	2

The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO, and preferably to only one PO.

Assessment

There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

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Course Information

Programme	B.Tech. (Computer science and engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5CS454
Course Name	Techno-Socio Activity
Desired Requisites:	This is the audit course. No pre-requisite

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	-	**LA1**	**LA2**	**ESE**	**Total**
Interaction	1 Hrs/ Week	15	15	20	50
		Credits: 1			

Course Objectives

1	To nurture technical knowledge mainly through various participations and competitions during their engineering study
2	To develop empathy by participating in social empowerment acts

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	To develop professional and soft skills to participations	IV	Analyse
CO2	To analyse real world problem, create and showcase the best solution of techno-socio domains	VI	Create

List of Experiments / Lab Activities/Topics

List of Topics(Applicable for Interaction mode):

List of Lab Activities:

Open to students. Student can undertake any techno-socio activity as listed below but not limited to it :

1. Each student or group of students may participate in any social activity like "Swach Bharat Abhiyan",
2. "Blood Donation Camp", or any social activity announced by Govt. / Corporation / Panchayat. Each student or group of students participating in technical events / competition.
3. Awards / recognition received in techno-socio activity
4. Completing the on line courses (on topics beyond syllabus) / certification of any companies / technologies (e.g. IBM / Oracle / CISCO etc.)
5. Developing any innovative gadget / solution / system and transfer in the interest of Nation / Society / Institute (WCE)
6. Published a papers in national / international conferences / journals
7. Coordinating the students clubs / services
8. Organizing techno-socio activity for the students / community in rural areas, backward areas.

Textbooks

1	Nil

References

1	The students may refer/undergo on line courses required to undertake any techno-socio activity.

Useful Links

1	Nil

CO-PO Mapping														
	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	--	--	--	--	--	--	--	--	--	--	1	--	--	--
CO2	--	--	--	--	--	--	--	--	--	--	2	--	--	--
CO3	--	--	--	--	--	--	--	--	--	--	--	--	--	--

The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO, and preferably to only one PO.

Assessment

There are three components of lab assessment, LA1, LA2 and Lab ESE.
IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%

Assessment	Based on	Conducted by	Typical Schedule	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	15
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	15
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	20

Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.

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AY 2022-23

Course Information	
Programme	B.Tech. (Computer science and engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5CS491
Course Name	Project-1
Desired Requisites:	Nil

Teaching Scheme		Examination Scheme (Marks)			
Practical	6 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 3			

Course Objectives	
1	To understand Software Development Life Cycle and prepare project proposal based on real life use case
2	To utilize state of the art CASE tools especially for design, development and testing phases.
3	To experience project management techniques.
4	To acquaint the ability to map technical skills to real life applications from customers perspective.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	Course Outcome Statement/s	Bloom's Taxonomy Level	Bloom's Taxonomy Description
CO1	demonstrate the state-of-art technological trends through planning and design project aspects.	II	Understanding
CO2	adopt agile methodology and mature team skills through various SDLC phases.	III	Applying
CO3	showcase the project working model with real life use case mainly to potential customers.	VI	Creating

List of Experiments / Lab Activities/Topics

List of Topics(Applicable for Interaction mode):

List of Lab Activities:

1. Project work is to be carried out in two semesters with group size of maximum three to four students
2. In first semester project group will select a project topic with consent from guide and approval from department and submit the brief document discussing the outline of the project with clear objectives.
3. Students should maintain a project log book containing weekly progress of the project.
4. At the end of the semester project group should complete the system design, Algorithm design and present with suitable model. (CFD, DFD & Data structure layout, SRS & UML diagram using project management tool)
5. Project report should be prepared using Latex and submitted in soft and hard form.

Textbooks	
1	Nil

References	
1	Nil

Useful Links	
1	Nil

CO-PO Mapping														
	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	--	3	--	2	--	--	--	--	1	--	--	--	--	--
CO2	--	--	3	--	--	--	--	--	--	1	--	--	--	--
CO3	--	--	--	3	--	--	--	--	--	--	--	--	--	--
The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO, and preferably to only one PO.														

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

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Course Information

Programme	B.Tech. (Computer Science Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5CS455
Course Name	Humanities 3-Project Management
Desired Requisites:	Software Engineering

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	-	**LA1**	**LA2**	**ESE**	**Total**
Interaction	1 Hrs/ Week	15	15	20	50
		Credits: 1			

Course Objectives

1	To provide in-depth coverage of project management principles using tools.
2	To Understand the Project management tools practiced in the IT industry.
3	To Comprehend the hands-on exploration of project management tools used on Software Development.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	Course Outcome Statement/s	Bloom's Taxonomy Level	Bloom's Taxonomy Description
CO1	Be familiar with project management concepts used in software development in industry.	II	Understanding
CO2	Utilize project management tools for developing a variety of software applications.	III	Applying
CO3	Get acquainted with the use of project management tools to achieve quality and industry readiness.	VI	Creating

List of Experiments / Lab Activities/Topics

List of Topics(Applicable for Interaction mode):

List of Lab Activities:

1. Overview of Jira software.
2. Study of Project management using Jira.
3. Understanding Workflow management.
4. Managing Tasks using Jira.
5. Jira user and role management.
6. Project Monitoring and Reporting.
7. Issue management using.
8. Bug tracking and reporting.
9. Performing Project Integration.
10. Agile best practices using Jira.
11. Version management using Jira.

Textbooks

1	Jira Project Management A Complete Guide - 2019 by Gerardus Blokdyk . The Art of Service
2	Jira Quick Start Guide: Manage your projects efficiently using the all-new Jira by Ravi Sagar

References

1	JIRA Essentials, Third Edition, Patrick Li,Packt enterprise

Useful Links	
1	https://www.atlassian.com/
2	https://www.javatpoint.com/jira-tutorial

CO-PO Mapping														
	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2											2	
CO2					3									
CO3				2		2								2
The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO, and preferably to only one PO.														

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

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Course Information

Programme	B.Tech. (Computer Science and Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5CS411
Course Name	Elective-5: High Performance Computing
Desired Requisites:	Data structures, Basic Programming knowledge

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To be introduced with current trends in parallel computer architectures and programming models (i.e. languages and libraries) for shared memory, many core/multicore architecture.
2	To understand parallel program design methodology. Also to calculate speedup and efficiency of parallel algorithm.
3	To learn various parallel algorithms for matrices, graphs.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Describe different parallel paradigms, inter connection networks, and tools for parallel programming.	II	Understand
CO2	Demonstrate design methodology and performance measurement of parallel algorithms on various parallel platforms.	III	Apply
CO3	Analyze a given problem for possibilities of parallel computations.	IV	Analyze

Module	**Module Contents**	**Hours**
I	**Introduction** What is parallel computing? The scope of parallel computing? Issues in parallel computing. Taxonomy of parallel architecture, Memory bound vs Compute bound problems, Dynamic interconnection networks, static interconnection networks, Routing mechanism for static network. Communication cost in static interconnection network.	8
II	**Parallel programming models and paradigms** Introduction, parallel applications and development, code granularity and level of parallelism, parallel programming models and tools, methodical design of parallel algorithm, parallel program paradigm, programming skeleton and templates.	6
III	**Performance and scalability of parallel systems** Performance Metrics for parallel systems. The effect of Granularity and Data Mapping on Performance. The Scalability of parallel systems, Isoefficiency metric of scalability, sources of parallel overhead, Minimum execution time and minimum cost-optimal execution time, parallel work efficiency, amdahl limiters, communication-computation overlap/pipelining.	8

IV	**Parallel programming libraries** OpenMP, MPI, Thread basics ,Work Sharing constructs, Scheduling, Reduction, Mutual Exclusion Synchronization & Barriers, The MPI Programming Model, MPI Basics, Global Operations , Asynchronous Communication, Modularity, Other MPI Features, Performance Issues, Thread programming C++11 Threads /OpenMP, MPI - two sided communication, one side communication based programming model aka PGAS (Partitioned Global Address Space) eg: OpenSHMEM/NVSHMEM.	6
V	**Parallel programming using accelerators** Introduction of CUDA/OpenCL, Chapel, etc. Basics of GPGPU, CUDA Programming model, CUDA memory type, CUDA and/or OpenCL for GPGPU hardware, case study.	6
VI	**Algorithms** Dense matrix algorithms, sorting, graph algorithms, prefix sum with decoupled lookback, parallel radix sort/batcher's sort	6

Textbooks	
1	"Introduction to Parallel Computing", (2nd ed.), by Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar.
2	"High Performance Cluster Computing : Programming and Applications", Volume 2 By Buyya Rajkumar.
3	"CUDA Programming: A Developer's Guide to Parallel Computing with GPUs", by Shane cook "Introduction to PARALLEL PROGRAMMING", by Peter Pacheco.

References	
1	"Parallel Programming in C with MPI and OpenMP", Michael J. Quinn, McGraw-Hill, 2004.

Useful Links	
1	Single-pass Parallel Prefix Scan with Decoupled Look-back https://research.nvidia.com/publication/single-pass-parallel-prefix-scan-decoupled-look-back
2	parallel radix sort/batcher's sort. https://developer.download.nvidia.com/video/gputechconf/gtc/2020/presentations/s21572-a-faster-radix-sort-implementation.pdf
3	High Performance Computing, Charles Severance, 1998. http://cnx.org/content/col11136/latest/
4	MPI: The Complete Reference, Marc Snir, Steve Otto, Steven Huss-Lederman, David Walker, and Jack Dongarra, 1996. http://www.netlib.org/utk/papers/mpi-book/mpi-book.html

CO-PO Mapping

	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2												1	1
CO2		3											3	1
CO3		2	2										2	1

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2022-23

Course Information	
Programme	B.Tech. (Computer Science and Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5CS412
Course Name	Elective-5 : Data Mining
Desired Requisites:	Database Engineering

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To gain the knowledge of theoretical background to several of the commonly used data mining techniques.
2	To analyze data, choose relevant models and algorithms for respective applications.
3	To evaluate the different data mining algorithms and tools
4	To develop research interest towards advances in data mining

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	**apply** the data pre-processing and data mining algorithms to **solve** real world problems	III	Apply
CO2	**analyze** a complex data mining problem and different data mining algorithms to **identify** solutions.	IV	Analyze
CO3	**measure** the performance of different data mining algorithms/tools, **evaluate** and **recommend** the optimal solution.	V	Evaluate
CO4	**Design** and **build** a data mining tool/solution to meet the given set of computing requirements in the context of the complex data mining problem.	VI	Create

Module	**Module Contents**	**Hours**
I	**Introduction** Data mining and its need, Different kinds of data that can be mined, Various patterns that can be mined, Technologies to be Used, Target applications, Major Issues in Data Mining.	5
II	**About Data and its pre-processing** Data objects and attribute types, basic statistical description of data, Data visualization, Data pre-processing : Overview, data cleaning, data integration, data transformation and data discretization.	7
III	**Classification** Basic concepts, decision tree induction and rule based classification, Bayes Classification, Artificial Neural Network (ANN) based classification, Metrics for Evaluating Classifier Performance	8
IV	**Clustering** Basic concepts, measuring data similarity and dissimilarity, partitioning methods, Hierarchical Methods, Density-Based methods, Evaluation of Clustering	6

V	**Association Rule Mining** Basic concepts, Frequent itemset mining methods, interesting patterns and its evaluation methods, Pattern Exploration and Application.	6
VI	**Web Mining** Introduction, web content mining, web structure mining, web usage mining	7

Textbooks	
1	Jiawei Han , Micheline Kamber and Jian Pei , *"Data Mining - Concepts and Techniques"* , Third Edition, Morgan Kaufmann, 2012, ISBN 978-0-12-381479-1
2	Dunham, Margaret H , *"Data Mining: Introductory and Advanced Topics"*, 1st Edition , PHI/Pearson, 2006 , ISBN 978-81-7758-785-2
References	
1	Sumathi, S., Sivanandam, S.N. , *"Introduction to Data Mining and its Applications"*, Springer , 2006 , ISBN 978-3-540-34351-6
2	P. Tan, M. Steinbach and V. Kumar, *"Introduction to Data Mining"*, 2nd Edition, Addison Wesley, 2019,
3	Related papers from various IEEE Transactions , Int. Journals / Conferences.
Useful Links	
1	Data sets : https://archive.ics.uci.edu/ml/index.php
2	IEEE Transactions on Knowledge and Data Engineering : https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=69
3	Tools - Tableau : https://www.tableau.com/developer/tools , SPSS : https://www.ibm.com/in-en/analytics/spss-statistics-software , Weka : https://www.cs.waikato.ac.nz/ml/weka/
4	Data Mining Resources : https://www.cs.purdue.edu/homes/ayg/CS590D/resources.html

CO-PO Mapping

	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2												2	
CO2		3												2
CO3				3									3	
CO4			3											3

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

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AY 2022-23

Course Information	
Programme	B.Tech. (Computer Science & Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5CS413
Course Name	Elective 6: Software Defined Network
Desired Requisites:	Computer Network and Data Communication

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To understand SDN/NFV motivation and benefits.
2	To describe how SDN/Openflow work.
3	To understand mininet and some programming languages.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	understand OpenFlow, challenges in SDN, and the recent development in SDN	II	Understanding
CO2	Analyse and apply implementation of SDN through Open Flow Switches, SDN-Controllers.	IV, III	Analysing, Applying
CO3	Evaluate the pros and cons of applying SDN, API approaches, Hypervisor overlays, and SDN Data Centre	V	Evaluating

Module	**Module Contents**	**Hours**
I	**History and Evolution of Software Defined Networking (SDN)** Introduction, Traditional Vs. SDN network, Separation of Control Plane and Data Plane, IETF Forces, Active Networking. Control and Data Plane Separation: Concepts, Advantages and Disadvantages.	8
II	**OpenFlow Protocol and Network Virtualization** Introduction to OpenFlow Protocol, OpenFlow Versions, OpenFlow with multiple flow tables, Virtualization: Concepts, Applications of virtual networking, Existing Network Virtualization Framework (VMWare and others), Open Virtual Switch (OVS), OpenFlow flow entries on OVS, Monitoring tools: Mininet, OpenDaylight, etc., Mininet introduction, Network virtualization with mininet and Mininet topologies.	7
III	**Control Plane** Overview, Existing SDN Controllers including Floodlight and Open Daylight projects. Customization of Control Plane: Switching and Firewall, Implementation using SDN Concepts.	6
IV	**Data Plane** Software-based and Hardware-based; Programmable Network Hardware. Programming SDNs: Northbound Application Programming Interface, Current Languages and Tools, Composition of SDNs.	6
V	**Network Functions Virtualization (NFV) and Software Defined Networks** Network architecture, NFV Infrastructure, NFV Management and Orchestration (MANO), NFV and SDN	5

VI	**Data Centre Networks** Packet, Optical and Wireless Architectures, Network Topologies. Use Cases of SDNs: Data Centres, Internet Exchange Points, Backbone Networks, Home Networks, Traffic Engineering.	7

Textbooks	
1	SDN: Software Defined Networks, an Authoritative Review of Network Programmability Technologies, By Thomas D. Nadeau, Ken Gray Publisher: O'Reilly Media, August 2013, ISBN: 978-1-4493-4230-2, ISBN 10:1-4493-4230-2.
2	Software Defined Networks: A Comprehensive Approach, by Paul Goransson and Chuck Black, Morgan Kaufmann, June 2014, Print Book ISBN: 9780124166752, eBook ISBN : 9780124166844
References	
1	SDN and OpenFlow for Beginners by Vivek Tiwari, Sold by: Amazon Digital Services, Inc., ASIN: , 2013.
2	Network Innovation through OpenFlow and SDN: Principles and Design, Edited by Fei Hu, CRC Press, ISBN-10: 1466572094, 2014
3	sdnhub.org
Useful Links	
1	https://www.youtube.com/watch?v=dkUDUb9GtH0&list=PLpherdrLyny8YN4M24iRJBMCXkLcGbmhY&ab_channel=NickFeamster

CO-PO Mapping														
	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1		2			3							1		
CO2					3							2		
CO3												2		

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information	
Programme	B.Tech. (Computer Science and Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5CS414
Course Name	Elective- 6: Computer Vision
Desired Requisites:	Digital Image Processing

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To impart knowledge of advanced techniques in computer vision.
2	To acquaint students with the concepts of color image processing, texture analysis, object recognition, video processing, 3D imaging etc. by applying the algorithms to build applications.
3	To allow students to compare various algorithms and select the one most appropriate for a particular application.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Demonstrate the knowledge of the various concepts of computer vision.	III	Applying
CO2	Apply and Analyse different computer vision algorithms to solve real life problems	IV	Analyze
CO3	Illustrate and critique different techniques employed in computer vision	V	Evaluate

Module	**Module Contents**	**Hours**
I	**Color Image Processing** Color Fundamentals, Color models, Gray level to color transformations, Basics of Color Image Processing, Color Transformations, Smoothing and Sharpening, Color Segmentation	6
II	**Texture Analysis** Definition, Types of texture, Texels, Texture analysis – concept and categories, Approaches to texture analysis, Statistics, Texture descriptors - statistical - Auto-correlation, co-occurrence matrices and features, edge density and direction, local binary partition, Law's texture energy measures, Wavelets and texture analysis.	7
III	**Representation & Description** Representation, Boundary Descriptors, Regional Descriptors, Use of Principal components for description, Relational Descriptors	6
IV	**Object Recognition & Restoration** **Object Recognition:** Object Detection Vs recognition, Patterns and Pattern Classes, Knowledge Representation, Statistical Pattern Recognition, Neural Nets, Syntactic Pattern Recognition,Optimization Techniques in Recognition. **Restoration:** Image Restoration Model, Noise Models,Restoration using spatial filtering, Reduction using frequency domain filtering.	8

V	**Moving Object Detection and Tracking** Introduction, Background Modeling, Connected Component Labeling, Shadow Detection, Single Object Tracking, Discrete Kalman Filtering, Particle-filter based tracking, Mean-shift tracking, Segmentation tracking via graph cuts	6
VI	**3D Vision** Introduction to 3D imaging ,applications. Case study based on the current trends in 3D imaging	6

Textbooks	
1	R. C. Gonzalez, R. E. Woods, Digital Image Processing, 4th Edition. 2018, PHI
2	A. K. Jain, Fundamentals of Digital Image Processing, PHI
References	
1	Milan Sonka, Vaclav Hlavac, Boyle, Digital Image Processing and Computer Vision, Cengage Learning
2	S. Jayaraman, S. Esakkirajan, T. Veerkumar, Digital Image Processing, Tata McGrawHill
3	Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, Digital Image Processing Using MATLAB, 2nd ed.
Useful Links	
1	NPTEL course: Link
2	NPTEL course: Link

CO-PO Mapping

	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2													
CO2	3		2											
CO3			2	3										

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2022-23

Course Information

Programme	B.Tech. (Computer Science and Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5CS415
Course Name	Elective-6: MOOC on AI ML: Reinforcement Learning
Desired Requisites:	B.Tech. (Computer Science and Engineering)

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To illustrate and apply the algorithm Reinforcement techniques.
2	To explain and demonstrate different reinforcement techniques for real world problem
3	To analyse reinforcement algorithm while applying to computation problem

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Discuss the fundamentals of Reinforcement Learning.	II	Understanding
CO2	Apply knowledge of formulation of reinforcement techniques to solve real word solution	III	Applying
CO3	Critically analyze the various reinforcement techniques for a given problem.	IV	Analyzing

Module	**Module Contents**	**Hours**
I	Introduction, Bandit algorithms – UCB, PAC	6
II	Bandit algorithms –Median Elimination, Policy Gradient Full RL & MDPs	7
III	Bellman Optimalit, Dynamic Programming & TD Methods	6
IV	Eligibility Traces, Function Approximation	7
V	Least Squares Methods,Fitted Q, DQN & Policy Gradient for Full RL	6
VI	Hierarchical RL, POMDPs	7

Textbooks

1	R. S. Sutton and A. G. Barto. Reinforcement Learning - An Introduction. MIT Press. 1998.

References

1	R. S. Sutton and A. G. Barto. Reinforcement Learning - An Introduction. MIT Press. 1998.

Useful Links

1	https://onlinecourses.nptel.ac.in/noc22_cs34/preview

CO-PO Mapping

	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	--	--	--	--	--	--	--	--	--	--	--	--	--
CO2	3	1	--	--	--	--	--	--	--	--	--	--	--	--
CO3	--	3	--	2	--	--	--	--	--	--	--	--	--	--
CO4	--	--	--	2	--	--	--	--	--	--	--	--	--	--
CO5	--	--	3	--	--	--	--	--	--	--	--	--	--	--
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.														

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information	
Programme	B.Tech. (Computer Science and engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5CS451
Course Name	Elective 5 Lab-High Performance Computing Lab
Desired Requisites:	Data structures, Basic Programming knowledge

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs/ week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives	
1	To provide basics of parallel architectures
2	To provide basics of parallel algorithm design and analysis
3	To provide basics of parallel programming platforms
4	

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Comparison of different parallel architectures and performance evaluation	I	Understand
CO2	To measure performance of model using different metrics	II	Apply
CO3	To design a parallelization strategy for computing patterns on different hardware and using different parallel computing languages.	VI	Create

List of Experiments / Lab Activities/Topics

List of Topics(Applicable for Interaction mode):

List of Lab Activities:

A. Implementation of following tasks using OpenMP.

1. Implementation of sum of two lower triangular matrices.
2. Implementation of Matrix-Matrix Multiplication.
3. Implementation of dot product
4. Implementation of Prefix sum

B. Implementation of following tasks using MPI.

5. Implementation of Matrix-Vector Multiplication.
6. Implementation of Matrix-Matrix Multiplication.
7. Implementation of 2D Convolution
8. Implementation of dot product
9. Implementation of Prefix sum

C. Implementation of following tasks using CUDA.

10. Implementation of Matrix-matrix Multiplication using global memory.
11. Implementation of Matrix-Matrix Multiplication using shared memory.
12. Implementation of Histogram
13. Implementation of Odd even sort
14. Implementation of Prefix sum
15. Implement 2D Convolution using shared memory

D. Performance evaluation of following computations using open source libraries or OpenACC compare to sequential and explicit parallel implementation

16. Implementation of Matrix-Matrix multiplication using OpenACC MKL, and cuBLAS. Compare their performance with OpenMP based implementation from assignment no.2, 10 and 11.

Textbooks	
1	Zbigniew J. Czech, Introduction to Parallel Computing, Cambridge University Press, 2016.
2	Kumar, V., Grama, A., Gupta, A., & Karypis, G. (1994). Introduction to parallel computing (Vol. 110). Redwood City, CA: Benjamin/Cummings.
3	Chandra, R., Dagum, L., Kohr, D., Menon, R., Maydan, D., & McDonald, J. (2001). Parallel programming in OpenMP. Morgan kaufmann.
4	Cheng, J., Grossman, M., & McKercher, T. (2014). Professional CUDA c programming. John Wiley & Sons.

References	
1	Michael Quinn, Parallel Computing: Theory and Practice, McGrawHill Publishers, July 2017.
2	Arch Robison, James Reinders, and Michael Macoul, Structured Parallel Programming: Patterns for Efficient Computation, Morgan Kaufman, Elsevier, 2012.

Useful Links	
1	

CO-PO Mapping

	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1				1	1								1	1
CO2				2	2								2	1
CO3				2	2								2	1

The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO, and preferably to only one PO.

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

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Course Information

Programme	B.Tech. (Computer Science and Engineering)
Class, Semester	Final Year B. Tech., SemVII
Course Code	5CS452
Course Name	Elective 5 lab- Data Mining Lab
Desired Requisites:	Database Engineering

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction		30	30	40	100
		Credits: 1			

Course Objectives

1	The hands-on and practically implementation of the concepts/techniques studied in theory course.
2	Exposure to real life data sets for analysis and prediction.
3	Learning performance evaluation of data mining algorithms in a supervised and an unsupervised mode with different data mining tools.
4	Handling a mini data mining project for a given practical domain.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Interpret the data mining process and handle important issues around data cleaning, pre-processing and integration.	III	Apply
CO2	Analyse the real world problems using different data mining algorithms.	IV	Analyze
CO3	Measure the performance of different data mining algorithms / tools.	V	Evaluate
CO4	Design and build the data mining system for solving any complex problem.	VI	Create

List of Experiments / Lab Activities/Topic

List of Lab Activities:

1. For iris and breast cancer data set
   a) Calculate the mean, median, and standard deviation of conditional attributes.
   b) Draw histogram
   c) Draw the boxplots for pairs of attributes.
   d) Draw a scatter plot and a Quantile-Quantile (q-q) plot based on these two variables.

2. For iris and breast cancer data set, perform the
   a) Correlation analysis
   b) discretization using Binning and Histogram Analysis

3. Design and implementation of following classifiers :
   a. Regression classifier.
   b. Naïve Bayesian Classifier.
   c. k-NN classifier (Take k = 1,3,5,7)
   d. Three layer Artificial Neural Network (ANN) classifier (use back propagation)

4. Design and implementation of following clustering algorithms :
   a) Hierarchical clustering - AGNES & DIANA. Plot Dendrogram.
   b) k-Means
   c) k-Medoids (PAM)
   d) DBSCAN

5. Design and implementation of following Association Rule Mining algorithms :
   a) Basic Association Rule Mining Algorithm
   b) Apriori Algorithm

6. Design and implementation of following Web Mining algorithms :
   a) Implement the PageRank algorithm to calculate the rank of each page in the file. The outputshould be the 10 pages with the highest rank, together with their rank values.
   b) Implement the HITS algorithm to calculate the hub and the authority weight of each web page inthe data set. The output should be the 10 most authoritative pages and 10 most hubby pages.

7. Hands on with the state of the art data analytics tools like Tableau , Weka , SPSS, Oracle DataMiner etc.

8. Mini-project : Group (2/3) of students should search any research journal / literature on data miningand select small problem statement. Design and build the data mining system for chosen problem. OR instructor may assign any problem statement for each group.

Instructions :

1. Use the standard data sets from UCI Machine Learning Repository
2. Follow the design, modelling and implementation/documentation methodology using standard CASEtools.
3. Use Python as Programming Language. For database programming / scripting use PL/SQL T-SQL,MySQL/Oracle 11g /IBM DB2 9.7 as backend database server. Follow the submission guidelines.

Textbooks	
1	Jiawei Han , Micheline Kamber and Jian Pei , “Data Mining - Concepts and Techniques” , Third Edition, Morgan Kaufmann, 2012, ISBN 978-0-12-381479-1
2	Dunham, Margaret H , “Data Mining: Introductory and Advanced Topics”, 1st Edition , PHI/Pearson, 2006 , ISBN 978-81-7758-785-2
3	
4	
References	

1	Sumathi, S., Sivanandam, S.N. , “Introduction to Data Mining and its Applications”, Springer , 2006 , ISBN 978-3-540-34351-6
2	P. Tan, M. Steinbach and V. Kumar, "Introduction to Data Mining", 2nd Edition, Addison Wesley, 2019,
3	Related papers from various IEEE Transactions , Int. Journals / Conferences.
4	Open source tools for data analytics and machine learning.
Useful Links	
1	Data sets : https://archive.ics.uci.edu/ml/index.php
2	Tableau tool : https://www.tableau.com/developer/tools
3	SPSS tool : https://www.ibm.com/in-en/analytics/spss-statistics-software
4	Weka tool : https://www.cs.waikato.ac.nz/ml/weka/

CO-PO Mapping

	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3												1	
CO2		3												2
CO3					2								3	
CO4			3											3

The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO, and preferably to only one PO.

Assessment

There are three components of lab assessment, LA1, LA2 and Lab ESE.
IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%

Assessment	Based on	Conducted by	Typical Schedule	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40

Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.

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Course Information	
Programme	B. Tech. (Computer Science and Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5OE471
Course Name	Open Elective 5: Cyber Security
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	Exhibit knowledge to secure corrupted systems, protect personal data, and secure computer networks in an Organization
2	Develop cyber security strategies and policies
3	Understand principles of web security and to guarantee a secure network by monitoring and analyzing the nature of attacks through cyber/computer forensics software/tools.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Understand the concepts of cyber security and data privacy in today's environment.	II	Understand
CO2	Perform fundamental incident response functions including detecting, responding, and recovering from security incidents.	III	Apply
CO3	Analyze and resolve security issues in networks and computer systems to secure an IT infrastructure	IV	Analyze
CO4	Evaluate and communicate the human role in security systems with an emphasis on ethics, social engineering vulnerabilities and training.	V	Evaluate
CO5	Design appropriate security technologies and policies to protect computers and digital information.	VI	Create

Module	**Module Contents**	**Hours**
I	**Introduction to Cyber Space** Internet Architecture and the Protocol Layers- Basics of Internet, Layered architecture, OSI Reference Model, Protocol Data Unit(PDU), TCP/IP Model, IP addressing, Layers of security, Cyber Crime, Information Security, CIA Triad, Computer Ethics & Security Policies.	7
II	**Web Browsers and Email Security** Basics of Cryptography, Guidelines to choose Web Browsers, Security measures for using Web Browsers, Antivirus, Email Security, IDS, Firewall.	7
III	**Social Media and basic Windows Security** Guidelines for Social Media Security, Tips & best practices for Safer Social Media Networking, Best Security Practices for Windows Desktops & Laptops, Guidelines for generation of User Accounts & Passwords, Wi-Fi Security.	6
IV	**Smartphone Security** Introduction to Mobile Devices, Security Techniques for using Mobile Devices, Best Security Practices for Android Devices, Best Security Practices for IOS Devices.	6

V	**Online Banking, Credit Card & UPI Security, POS & ATM Security** Online Banking Security Techniques, Mobile Banking Security Techniques, Security for Debit & Credit Cards, UPI & e-Wallet Security Guidelines, Security for using Micro-ATMs & POS (Point of Sales).	7
VI	**Cyber Security Initiatives in India** Counter Cyber Security Initiatives in India, Cyber Security Incident Handling, **Information Destroying and Recovery Tools-** Recovering from Information Loss, Destroying Sensitive Information, CCleaner for Windows, How Cyber Criminal Works & Cyber Laws, IT ACT & how to prevent yourself from being a victim of Cyber Crime, **Cybercrime: Examples and Mini-Cases.**	7

Textbooks	
1	Nina Godbole and Sunit Belpure, "*Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives"*, Wiley
2	B. B. Gupta, D. P. Agrawal, Haoxiang Wang, *"Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives"*, CRC Press, ISBN 9780815371335, 2018

References	
1	"*Cyber Security Essentials*", James Graham, Richard Howard and Ryan Otson, CRC Press

Useful Links	
1	https://onlinecourses.swayam2.ac.in/ugc19_hs25/preview m2.ac.in
2	https://www.classcentral.com/course/swayam-introduction-to-cyber-security-14116
3	https://www.youtube.com/watch?v=AU3sdN-ZPCQ

CO-PO Mapping

	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3											2	
CO2		3			2								3	
CO3	3	3											3	3
CO4		2	3										3	1
CO5				3									2	

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

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AY 2022-23

Course Information	
Programme	B.Tech. (Computer Science and Engineering)
Class, Semester	Final Year B. Tech., Sem VIII
Course Code	5CS421
Course Name	Industry Course : Data Management, Protection and Governance (By Veritas)
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	Get acquainted with the high-level phases of data life cycle management.
2	Acquire knowledge about the various aspects of data storage, data availability, data protection.
3	Gain exposure to various solutions/reference architectures for various use-cases.
4	Understand the technical capabilities and business benefits of data protection.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Illustrate data management world and various types of data threats and approaches to ensure data center security.	II	Understand
CO2	Apply different standards for compliance and governance of data.	III	Apply
CO3	Analyze various types of data threats and approaches to ensure data centre security.	IV	Analyze
CO4	Discriminate various concepts and technologies for enabling data storage and high availability	V	Evaluate
CO5	Design data intensive enterprise applications and industry standard solutions in data management.	VI	Create

Module	**Module Contents**	**Hours**
I	**Introduction to data life cycle management (DLM)** Goals of data life cycle management, Challenges involved- Volume of data source, Ubiquity of data locations, User demand for access, Stages of data life cycle – creation, storage, usage, archival, destruction, Risks involved without DLM, benefits, best practices.	4
II	**Data storage and data availability** **Storage technology**: Hard Disk Device (HDD), Solid State Devices (SSD), memory devices, Data access - block, files, object, Data center End to End View – overview of complete stack including storage, network, host, cluster, applications, virtual machines, cloud storage, Storage virtualization technologies - RAID level, storage pooling, storage provisioning, Advance topics in storage virtualization – storage provisioning, thin provisioning, Cloud storage – S3, glacier, storage tiering, High Availability-Introduction to high availability, clustering, failover, parallel access, Disaster Recovery -Need of disaster recovery, Building blocks - global cluster, wide-area-connector (WAC), heartbeat, Split-brain – problem and solutions , Preparing for DR – firedrill.	8

III	**Data Threats and Data center security** Type of Threats-Denial of Service (DoS), man in the middle attacks, Unintentional data loss, Repudiation, Malicious attacks to steal data, Understanding, Identification and Threat modelling tools, Introduction to Ransomware, Security- Authorization and authentication - access control, Transport Layer Security (TLS), key management, security in cloud, Design and architecture considerations for security.	7
IV	**Introduction to data protection** Introduction-Need for data protection, basic of back-up/restore, Snapshots for data protection, copy-data management (cloning, DevOps), De- duplication, Replication, Long Term Retention – LTR, Archival, Design considerations-System recovery, Solution architecture, Backup v/s Archival, media considerations and management (tapes, disks, cloud), challenges with new edge technology (cloud, containers).	8
V	**Data regulation, compliance and governance** Regulations requirements and Privacy Regulations-General Data Protection Regulation (GDPR), The Health Insurance Portability and Privacy Act of 1996 (HIPPA), PII (Personal Identity Information), Information Governance-Auditing, Legal Hold, Data classification and tagging (Natural Language Processing).	5
VI	**Applications uninterrupted** Understand data management aspects of traditional and new edge applications, Reference architecture/best practices (pick 2-3 case studies from below topics)-Transactional Databases (Oracle, MySQL, DB2), NoSQL Databases (MongoDB, Cassandra), Distributed applications (micro service architectures), Cloud applications – Platform as Service (PaaS), Software as Service (SaaS), Kubernetes, Multi-Tiered applications, ETL workloads, Data analytics (AI/ML).	7

Textbooks	
1	Robert Spalding, "*Storage Networks: The complete Reference*" Tata McGraw-Hill
2	Vic (J.R.) Winkler, "Securing The Cloud: Cloud Computing Security Techniques and Tactics" (Syngress/Elsevier) - 978-1-59749-592-9.
3	TBD – online reference for each topic.

References	
1	"Designing Data-Intensive Applications " (O'Reilly, Martin Kleppmann).
2	TBD: provide more online material details and books (This can include some publicly available white-paper, solution guides etc.)

Useful Links	
1	https://www.enterprisestorageforum.com/storage-hardware/storage-virtualization.html
2	https://www.hitechnectar.com/blogs/three-goals-data-lifecycle-management/
3	https://www.bmc.com/blogs/data-lifecycle-management/
4	https://www.dataworks.ie/5-stages-in-the-data-management-lifecycle-process/

CO-PO Mapping

	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1		3											2	
CO2	3												3	
CO3	3	2												3
CO4		3												1
CO5		3												

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	B.Tech. (Computer Science and engineering)
Class, Semester	Final Year B. Tech., Sem VIII
Course Code	5CS492
Course Name	Project-II
Desired Requisites:	Nil

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	12 Hrs/ week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 6			

Course Objectives

1	To experience project management principles to become IT industry savvy.
2	To utilize state of the art CASE tools especially for design, development and testing phases.
3	To acquaint the ability to map technical skills to real life applications from customers perspective.
4	To practice of specifying & using artifacts as per quality standards.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	demonstrate the state-of-art technological trends through planning and design project aspects.	III	Apply
CO2	adopt agile methodology and mature team skills through various SDLC phases.	V	Evaluate
CO3	showcase the project with real life use case mainly to potential customers.	VI	Create
CO4	analyse performance of developed product and write/publish technical artifacts	IV	Analyse

List of Experiments / Lab Activities/Topics

List of Topics(Applicable for Interaction mode):

List of Lab Activities:

1. Preferably project work is to be continued from Project-I
2. Students should maintain a project log book containing weekly progress of the project
3. At the end of the semester project group should achieve all the proposed objectives of the problem statement.
4. The work should be completed in all aspects of design, implementation and testing.
5. Project report and technical artifacts should be prepared, submitted in soft and hard form along with all the code and datasets.
6. Group should demonstrate the work with various test cases and results obtained and explain future scope.
7. The group should participate in technical symposiums, paper presentations to demonstrate their work and findings in technical community.

Textbooks

1	Nil

References

1	Nil

Useful Links	
1	

CO-PO Mapping														
	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	--	--	--	--	--	--	--	3	2	--	--	--	--	--
CO2	--	--	--	--	3	--	--	--	2	3	--	--	--	--
CO3	--	--	2	3	--	--	--	--	--	--	2	--	--	--
CO4	--	--	--	--	2	--	--	--	2	--	--	--	--	--
The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO, and preferably to only one PO.														

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

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Course Information	
Programme	B.Tech. (Computer Science and Engineering)
Class, Semester	Final Year B. Tech., Sem VIII
Course Code	5CS431
Course Name	Elective-7:Search Engine Design and Optimization
Desired Requisites:	Programming Laboratory – 3

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To inculcate understanding of detailed functions of search engines and different SEO techniques.
2	To illustrate working of different search engine designs and different SEO techniques.
3	To emphasize on optimizing design of search engines and use of SEO techniques.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	describe working of search engines and SEO techniques	II	Understand
CO2	illustrate various SEO techniques and use SEO tools	III	Apply
CO3	comprehend strengths and weaknesses of SEO techniques and use appropriate SEO technique as per real life scenario and analyze the performance of a website on a search engine using tools and analytical data	IV	Analyze

Module	**Module Contents**	**Hours**
I	**Search Engines and SEO Overview** SEO – What is it, History, Evolution and Importance, Types of SEO Techniques, How Search Engines Work, SERP, Google Search Engine Architecture and Algorithm, How Machine Learning in Search Works, Panda Update, Other advanced Search Engine algorithms	5
II	**Keyword Research and Analysis** What is keyword, Importance of Keyword, Keyword Phrases and Keyword Length, Keyword-Value Pyramid, where to start, Keyword Density, Finding Keywords, Keyword Selection Tips, Common Keyword Problems and Solutions, Keyword Analysis Tools	6
III	**On-page Optimization Techniques** The difference – On-page and Off-page optimization, On-page Optimization Techniques - The Page Title, Meta Descriptions & Meta Keywords, Headings, Bold Text, Domain Names & Suggestions, Canonical Tag, Meta Tags, Images and Alt Text, Internal Link Building, The Sitemap, Invisible Text, Server and Hosting Check, Robots Meta Tag, Doorway Pages, 301 Redirects, 404 Error, Duplicate content	9

IV	**Off-page Optimization Techniques** Local marketing of websites on the basis of locations, Social Media optimization techniques, Introduction of link building and its types, Directory submission, Blog and article submission, Forum posting, Forum signatures and commenting, Free classifieds, Classifieds posting, Press release submission, Video submission, Business listing submission, Guest blog, Detail knowledge on Link building and backlinks, Social bookmarking, Photo & Video Sharing, Infographics sharing, Document Sharing, Content Marketing and its importance, Question and answers, Web 2.0 submission, Importance of backlinks / Link building, Home page promoting tips and techniques, Strategies to build qualitative and relevant backlinks, Competitors backlink research and submission. Tracking the links, Submission to do follow websites, RSS Feed submissions.	7
V	**User Interface, Local and Social Media SEO** UX/UI, SEO and UX/UI, Best Practices. Local SEO and its importance, Local Searches, NAP, Directories, Top Local Search Signals, Reviews and Feedback. Introduction to Social Media SEO and their importance, Social Media Impact on SEO, Social Media and Local SEO.	6
VI	**SEO Tools, Reporting and Tracking** Keyword Research Tools, On-page SEO Tools, Link Building Tools, Technical SEO Tools, Rank Tracking Tools, Analytics Tools, and Local SEO Tools.	6

Textbooks	
1	Jessie Stricchiola, Stephan Spencer, Eric Enge, "The Art of SEO - Mastering Search Engine Optimization".
2	Moz, "Beginner's Guide to SEO".

References	
1	Adam Clarke, "SEO 2021: Learn search engine optimization with smart internet marketing"

Useful Links	
1	https://analytics.google.com/analytics/academy/course/6

CO-PO Mapping

	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1		1											1	
CO2	2	2	3										2	
CO3		3	2		3								2	1

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information	
Programme	B.Tech. (Computer Science and Engineering)
Class, Semester	Final Year B. Tech., Sem VIII
Course Code	5CS432
Course Name	Elective-7: Computer Forensic
Desired Requisites:	Cyber Security

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To understand the basic digital forensics and techniques for conducting the forensic examination on different digital devices.
2	To understand how to examine digital evidence such as data acquisition, identification analysis.
3	To understand cyber related crimes and various investigative strategies
4	To understand various data storage methods, formats and computer forensic tools

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Apply the methods for data recovery, evidence collection and data seizure.	III	Applying
CO2	Analyze a large amount of digital evidence and identify the most significant data.	IV	Analysing
CO3	Evaluate the different types of computer forensics technologies	V	Evaluating
CO4	Apply a number of different computer forensic tools to a given scenario.	III	Applying

Module	**Module Contents**	**Hours**
I	**Introduction** Computer forensics fundamentals, Benefits of forensics, computer crimes, computer forensics evidence and courts, legal concerns and private issues.	6
II	**Understanding Computing Investigations** Procedure for corporate High-Tech investigations, understanding data recovery workstation and software, conducting investigations.	6
III	**Methods of Storing Data** Understanding the binary number system & Conversions, Encoding and Decoding formats, Methods of storing data, Computer Memory, Development of hard disk, physical construction, CHS & LBA addressing, Understanding file system and file formats, Cloud storage and forensics.	6

IV	**Storage Formats and Digital Evidence** Data acquisition- understanding storage formats and digital evidence, determining the best acquisition method, acquisition tools, validating data acquisitions, performing RAID data acquisitions, remote network acquisition tools, other forensics acquisitions tools.	7
V	**Cyber Crime and Incident Response** Processing crimes and incident scenes, securing a computer incident or crime, seizing digital evidence at scene, storing digital evidence, obtaining digital hash, reviewing case.	6
VI	**Computer Forensics Tools** Software, hardware tools, validating and testing forensic software, addressing data-hiding techniques, performing remote acquisitions, E-Mail investigations- investigating email crime and violations, understanding E-Mail servers, Specialized E-Mail forensics tool.	8

Textbooks	
1	Warren G. Kruse II and Jay G. Heiser, "Computer Forensics: Incident Response Essentials", Addison Wesley
2	B Nelson, B, Phillips, A, Enfinger, F, Stuart, C., "Guide to Computer Forensics and Investigations", 2nd ed., Thomson Course Technology
3	
4	

References	
1	Vacca, J, "Computer Forensics, Computer Crime Scene Investigation", 2nd Ed, Charles River Media, ISBN: 1-58450-38
2	
3	
4	

Useful Links	
1	
2	
3	
4	

CO-PO Mapping

	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2										2	
CO2	1	1	2										3	
CO3	3	3											2	3
CO4	3	2			3								2	1

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	B.Tech. (Computer Science and Engineering)
Class, Semester	Final Year B. Tech., Sem VIII
Course Code	5CS433
Course Name	Elective-8: Human Computer Interaction
Desired Requisites:	Nil

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To inculcate understanding of detailed functions of HCI and different HCI techniques.
2	To illustrate working of different HCI designs and different HCI techniques.
3	To emphasize on HCI evaluation and Implementation techniques.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Describe working of HCI and HCI basics.	II	Understand
CO2	Illustrate various HCI design principals.	III	Apply
CO3	Comprehend strengths and weaknesses of HCI design techniques and use appropriate HCI technique as per real life.	IV	Analyze

Module	**Module Contents**	**Hours**
I	**Foundations of Human–Computer Interaction** What is HCI – design, models, evaluation, Need to understand people, computers and methods. Basic human abilities - vision, hearing, touch, memory. Computers – speed, interfaces, widgets, and effects on interaction. Humans – Memory, Attention Span, Visual Perception, psychology, ergonomics. Understanding Users. Methods for evaluation of interfaces with users: goals of evaluation, approaches, ethics, introspection, extracting the conceptual model, direct observation, constructive interaction, interviews and questionnaires, continuous evaluation via user feedback and field studies, choosing an evaluation method.	07
II	**The Design Process** Interaction Design Basics, Interaction Styles. HCI in the Software Process. HCI design principles and rules: design principles, principles to support usability, golden rules and heuristics, HCI patterns, design rules, HCI design standards. Universal Design, User-centered design, task analysis/GOMS, Graphic Design, Real life scenario study in design process.	06
III	**Implementation** Implementation Tools, Technology and change designing for the Web, designing for portable devices. Handling errors and Designing Help. Prototyping and UI Software. Real life scenario study in implementation process.	07

IV	**Evaluation and User Support** Evaluation of User Interfaces. Web Browsers - Fonts, Color Palette, Color Depth, Resolution, Layout, Size, Orientation. Mobile devices issues – design, limitations, what next. User Support, Real life scenario study in implementation process.	07
V	**Users Models** Predictive Models, Cognitive Models. Interaction with Natural Languages, Next Generation Interface. Socio-organizational Issues and Stakeholder Requirements. Heuristic Evaluation, Evaluation with Cognitive Models, Evaluation with Users, Real life scenario study in implementation process.	06
VI	**Case Study of Modern Systems** Group ware, Virtual Reality, Augmented Reality, Hypertext, Multimedia and World Wide web, GUI design for a mobile phone based Matrimonial application during emergency.	06

Textbooks	
1	Alan J, Dix. Janet Finlay, Rusell Beale, "Human Computer Interaction", Pearson Education, 3rd Edition, 2004, ISBN 81-297-0409-9
2	Jenny Preece, Rogers, Sharp, “Interaction Design-beyond human-computer interaction”, WILEY-INDIA, ISBN 81-265-0393-9

References	
1	Jonathan Lazar, Jinjuan Feng, Harry Hochheiser, “Research Methods in Human-Computer Interaction", Third Edition, Morgan Kaufmann, 2017, ISBN: 9780128053904.
2	Mary Beth Rosson and John M. Carroll, “Usability Engineering: Scenario-Based Development of Human-Computer Interaction”, Morgan Kaufmann, 2001, ISBN-13: 978- 1558607125

Useful Links	
1	https://nptel.ac.in/courses/106/103/106103115/
2	https://www.coursera.org/learn/human-computer-interaction

CO-PO Mapping

	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1		1											1	
CO2	2	2	3										2	
CO3		3	2		3								2	1

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2022-23

Course Information	
Programme	B.Tech. (Computer Science and Engineering)
Class, Semester	Final Year B. Tech., Sem VIII
Course Code	5CS434
Course Name	Elective-8: MOOC Course on Social Networks
Desired Requisites:	Discrete Mathematics and Linear Algebra, Programming and Algorithms

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To provide knowledge of the basics of social networks.
2	To describe various social network algorithms.
3	To demonstrate social network analysis applicable to real world data, with examples from today's most popular social networks
4	To understand real world problems for social network

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Describe basic characteristics of social network and social network analysis	II	Understand
CO2	Illustrate different social network analyzing algorithms and concepts	III, IV	Apply,Analyze
CO3	Evaluate different social networks with the help of real time datasets	V	Evaluate
CO4	Create social network for real world problems	VI	Create

Module	**Module Contents**	**Hours**
I	**Introduction** Introduction to networkx, challenges of social networks, Searching in a network, link prediction, the contagions, Importance of acquaintances, marketing on social networks, handling real world network datasets.	8
II	**Strength of weak ties and homophily** Granovetter's Strength of weak ties, Triads, Clustering coefficient and neighborhood overlap, Structure of weak ties bridges and local bridges, Embedeness, structural holes, Social capital, Finding communities in a graph, Foci closure membership closure.	6
III	**Positive negative relationships and link analysis** Structural balance, Characterising the structure of a balanced network, Balance theorem and its proof, Introduction to positive and negative edges, the web graph, collecting the web graph, equal coin distribution, random coin dropping, Introduction to hubs and authorities.	6
IV	**Cascading Behaviors in networks** Diffusion in networks, modelling diffusion, impact of communities on diffusion, Cascade and clusters.	6

V	**Richer get richer phenomenon** Introduction to powerlaw, detection of powerlaw, forced vs random removal of nodes, richer ger richer phenomenon, epidemics, spreading models, percolation models.	7
VI	**Small world effect** Small world effect, milgram's experiment, Generative model and decentralised search, how to go viral on web.	7

Textbooks	
1	Matthew A. Russell. Mining the Social Web: Data Mining Facebook, Twitter, Linkedin, Google+, Github, and More, 2nd Edition, O'Reilly Media, 2013.
2	Jennifer Golbeck, Analyzing the social web, Morgan Kaufmann, 2013.
References	
1	Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011.
Useful Links	
1	https://nptel.ac.in/courses/106106169
2	http://cse.iitkgp.ac.in/~pawang/courses/SC16.html

CO-PO Mapping

	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1		1											2	
CO2	1												3	
CO3	3	3												3
CO4		2												1

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

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AY 2022-23

Course Information

Programme	B.Tech. (Computer Science and Engineering)
Class, Semester	Final Year B. Tech., Sem VIII
Course Code	5CS435
Course Name	Elective-8: MOOC Course on Virtual Reality
Desired Requisites:	Nil

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To inculcate understanding of detailed functions of VR and different VR techniques
2	To illustrate working of different VR designs and different VR techniques
3	To emphasize on VR evaluation and Implementation techniques

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Describe working of VR and VR basics.	II	Understand
CO2	Illustrate various VR design principals	III	Apply
CO3	Comprehend strengths and weaknesses of VR design techniques and use appropriate VR technique as per real life	IV	Analyze
CO4			

Module	**Module Contents**	**Hours**
I	**Introduction** Course mechanics, Goals and VR definitions, Historical perspective, Birds-eye view (general), Birds-eye view (general), Birds-eye view (hardware), Birds-eye view (software) 8. Birds-eye view (sensation and perception)	4
II	**Geometry of Virtual Worlds** Geometric modeling, Transforming models, Matrix algebra and 2D rotations, 3D rotations and yaw, pitch, and roll, 3D rotations and yaw, pitch, and roll, contd, Axis-angle representations, Quaternions, Converting and multiplying rotations, Converting and multiplying rotations, contd, Homogeneous transforms, The chain of viewing transforms, Eye transforms, Canonical view transform, Viewport transform	5
III	**Light and Optics** Three interpretations of light, Refraction, Simple lenses, Diopters, Optical system of eyes	5
IV	**Visual Physiology** Photoreceptors, Sufficient resolution for VR, Light intensity, Eye movements	4
V	**Visual Perception** Depth perception, Depth perception, Motion perception, Frame rates and displays, Frame rates and displays	4
VI	**Tracking Systems** Overview, Orientation tracking, Tilt drift correction, Tracking with a camera, Perspective n-point problem, Filtering	4

Textbooks	
1	Doug A. Bowman,Ernst Kruijff, Joseph J. LaViola, and Ivan Poupyrev, 3D User Interfaces, AddisonWesley, 2005
2	K.S. Hale and K. M.Stanney, Handbook on Virtual Environments, 2nd edition, CRC Press, 2015
References	
1	George Mather, Foundations of Sensation and Perception:Psychology Press; 2 edition, 2009
2	Peter Shirley, MichaelAshikhmin, and Steve Marschner, Fundamentals of Computer Graphics,A K Peters/CRC Press; 3 edition, 2009
Useful Links	
1	http://msl.cs.uiuc.edu/vr/
2	http://nptel.iitm.ac.in/

CO-PO Mapping

	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1		1											1	
CO2	2	2	3										2	
CO3		3	2		3								2	1

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2022-23

Course Information	
Programme	B.Tech. (Computer Science and Engineering)
Class, Semester	Final Year B. Tech., Sem VIII
Course Code	5CS436
Course Name	Elective-8: MOOC Course on Blockchain and Its applications
Desired Requisites:	Computer Networks; Operating Systems; Cryptography and Network Security.

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	Inculcate how blockchain systems (mainly Bitcoin and Ethereum) work,
2	Illustrate process of Design, build, and deploy smart contracts and distributed applications,
3	Inculcate how to Integrate ideas from blockchain technology into their own projects.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Describe basic principles of Blockchain	II	Understand
CO2	Illustrate the different techniques used in Blockchain	III	Apply
CO3	Analyse different Designs, security, privacy, and efficiency of a given blockchain system.	IV	Analyse
CO4			

Module	**Module Contents**	**Hours**
I	Introduction to Blockchain Technology and its Importance	4
II	Basic Crypto Primitives Cryptographic Hash, Digital Signature	7
III	Evolution of the Blockchain Technology, Elements of a Blockchain	8
IV	Blockchain Consensus Permissionless Models, Permissioned Models	7
V	Smart Contract Hands On and Decentralized Identity Management Ethereum Smart Contracts (Permissionless Model), Hyperledger Fabric (Permissioned Model)	8
VI	Blockchain Interoperability and Applications	5

Textbooks	
1	Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, 3rd Edition, Imran Bashir, Packt Publishing, 2020, ISBN: 9781839213199, book website: https://www.packtpub.com/product/mastering-blockchain-third-edition/9781839213199

References	
1	NPTEL course on Blockchain and its applications
2	Hyperledger Tutorials - https://www.hyperledger.org/use/tutorials
3	Ethereum Development Resources - https://ethereum.org/en/developers

Useful Links	
1	https://onlinecourses.nptel.ac.in/noc22_cs44/preview

CO-PO Mapping														
	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2												1	
CO2		1											1	
CO3			2										1	
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.														

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information	
Programme	B.Tech. (Computer Science and Engineering)
Class, Semester	Final Year B. Tech., Sem VIII
Course Code	5CS437
Course Name	Elective 8 : MOOC Course on Computing: Introduction to parallel programming with OpenMP and MPI
Desired Requisites:	Programming in C.

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To introduce concepts & programming principles involved in developing scalable parallel applications
2	To apply knowledge of writing scalable programs for multi-core architectures using OpenMP and C.
3	To analyze parallel architecture and discuss the performance metrics of HPC programs.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	To introduce the concepts of high performance computing (HPC) to science and engineering students	II	Understanding
CO2	To apply different parallel computing tools like MPI, OpenMP and CUDA will be used in connection with domain specific problems.	III	Applying
CO3	To apply knowledge of Multi-CPU computing using both distributed and shared memory architecture using OpenMP and MPI based parallelization.	III	Applying
CO4			

Module	**Module Contents**	**Hours**
I	Single Processor Architecture and Basic OpenMP Constructs and Functions, More OpenMP constructs & functions	8
II	Basic Linear Algebra using OpenMP and OpenMP tasks	8
III	Critical Sections, locks and Matrix Factorization using OpenMP	7
IV	Distributed Memory programming and Message Passing Interface (MPI)	6
V	MPI Collectives and Interconnection architectures, Some applications on distributed memory architectures	7
VI	Applications to Graph Algorithms	5

Textbooks	
1	Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, "Introduction to Parallel Computing", Addison-Wesely, 2nd Edition, 2003

References	
1	Grama, A., Gupta, A., Karypis, G., and Kumar, V., Introduction to Parallel Computing, Addison Wesley, 2003

2	Gropp, W, Ewing L, and Anthony S. Using MPI: portable parallel programming with the message-passing interface. Vol. 1. MIT press, 1999.
3	Cook, S., CUDA Programming: A Developer's Guide to Parallel Computing with GPUs, M K Publishers, 2012 NVIDIA, CUDA C Programming guide, 2012
Useful Links	
1	https://onlinecourses.nptel.ac.in/noc20_me61/preview
2	OpenMP Tutorial from LLNL (https://computing.llnl.gov/tutorials/openMP

CO-PO Mapping

	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2												1	1
CO2		3											3	1
CO3		2	2										2	1

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

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Course Information	
Programme	B.Tech. (Computer Science and Engineering)
Class, Semester	Final Year B. Tech., Sem VIII
Course Code	5CS438
Course Name	Elective 9 - Advanced Machine Learning
Desired Requisites:	Introduction to Machine Learning

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	Introduces various mathematical concepts required for machine learning.
2	Understand GAN components, build basic GANs using PyTorch and advanced DCGANs using convolutional layers, control your GAN and build conditional GAN

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Explain advanced mathematical concept required for machine learning	II	Understand
CO2	Understand the intuition behind the fundamental components of Transformers and Recommender system	II	Understand
CO3	Implement case studies on GAN, Transformers and Recommender systems.	III	Apply
CO4	Build conditional GANs capable of generating examples from determined categories	VI	Create

Module	**Module Contents**	**Hours**
I	**Introduction** Backpropagation and automatic differentiation, Machine learning frameworks I: the user interface, Overfitting, Generalization error, Early stopping, Our first hyperparameters: step size/learning rate, minibatch size, Regularization, Application-specific forms of regularization, The condition number, Momentum and acceleration, Momentum for quadratic optimization, Momentum for convex optimization.	8
II	**Intro to GANs and Deep Convolutional GAN** Learn about GANs and their applications, understand the intuition behind the basic components of GANs, and build your very own GAN using PyTorch, Build a more sophisticated GAN using convolutional layers. Learn about useful activation functions, batch normalization, and transposed convolutions to tune your GAN architecture and apply them to build an advanced DCGAN specifically for processing images.	6

III	**Specialized GANs** **Wasserstein GANs with Normalization:** Reduce instances of GANs failure due to imbalances between the generator and discriminator by learning advanced techniques such as WGANs to mitigate unstable training and mode collapse with a W-Loss and an understanding of Lipschitz Continuity. **Conditional and Controllable GANs:** Understand how to effectively control your GAN, modify the features in a generated image, and build conditional GANs capable of generating examples from determined categories.	8
IV	**Transformers** Motivation, attention models, architecture types, BERT, Roberta, Albert	6
V	**Recommender System** Collaborative filtering, content-based filtering	6
VI	**Case Studies** on GANs, Transformers and Recommender Systems	6

Textbooks	
1	Jacub langr, "GANs in Action: Deep learning with Generative Adversarial Networks" 1st Edition
References	
1	
Useful Links	
1	https://nptel.ac.in/courses/106/106/106106198/
2	https://www.cs.cornell.edu/courses/cs6787/2019fa/
3	https://www.deeplearning.ai/program/generative-adversarial-networks-gans-specialization/

CO-PO Mapping

	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3													
CO2					3									
CO3			1		2									
CO4			1		2									

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

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AY 2022-23

Course Information	
Programme	B.Tech. (Computer Science and Engineering)
Class, Semester	Final Year Sem VIII
Course Code	5CS439
Course Name	Elective 9- Big Data Computing
Desired Requisites:	Data Structure & Algorithms, Computer Architecture, Operating System, Database Management Systems

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To explain the fundamentals of Big data computing problems, applications and characteristics.
2	To discuss various enabling, storage and streaming ways of Big Data
3	To present Machine learning techniques for Big Data

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Illustrate fundamentals of Big data computing terminology	II	Understanding
CO2	Demonstrate various Big Data enabling techniques	IV	Analyze
CO3	Discuss various Big data storage and streaming platform.	III	Apply

Module	**Module Contents**	**Hours**
I	**Introduction to Big Data** Why Big data computing, where did it come from, big data problems, applications, Characteristics.	5
II	**Introduction to Enabling Technologies for Big Data** Brief introduction of big data enabling techniques Hadoop HDFC, Hadoop YARN MapReduce, Apache Cassandra, HBase, Big Data Streaming Platforms: Apache Spark Streaming, Apache Kafka	7
III	**Hadoop For Big Data** Hadoop distribution file system (HDFS), Goal of Hadoop, read/write process of HDFS, Main configuration tuning parameters to control HDFS performance and robustness, Hadoop 1.0, Hadoop 2.0	7
IV	**Spark** Overview of spark, fundamentals of scala & functional programming, spark concepts. Spark operations, Job execution.	6
V	**Introduction to Big Data Storage Platforms for Large Scale Data Storage** Data placement strategies, CAP theorem, Consistency solution, Design of Zookeeper, Cassandra Query Language. HBase	7
VI	**Big Data Streaming Platforms and Performance engine** Real-time Big data processing with Spark streaming and sliding window analytics, Big data performance engine	8

Textbooks	
1	

References	
1	NPTEL Course Big Data Computing, IIT Patna Dr. Rajiv Misra
Useful Links	
1	*https://nptel.ac.in/courses/106104189*

CO-PO Mapping														
	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2													
CO2	2	2												
CO3	2	3												
CO4														
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