

AC: 29/06/2021

Item No: 6.15

UNIVERSITY OF MUMBAI



Bachelor of Engineering

in

Computer Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

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Sr. No.	Heading	Particulars
1	Title of the Course	Third Year Engineering (Computer Engineering)
2	Eligibility for Admission	After Passing Second Year Engineering as per the Ordinance 0.6243
3	Passing Marks	40%
4	Ordinances / Regulations (if any)	Ordinance 0.6243
5	No. of Years / Semesters	8 semesters
6	Level	P.G. / U.G./Diploma / Certificate (Strike out which is not applicable)
7	Pattern	Yearly / Semester (Strike out which is not applicable)
8	Status	New / Revised (Strike out which is not applicable)
9	To be implemented from Academic Year	With effect from Academic Year: 2021-2022

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Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2021-22. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2022-23, 2023-24, respectively.

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ncorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

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Preface by Board of Studies in Computer Engineering

Dear Students and Teachers, we, the members of Board of Studies Computer Engineering, are very happy to present Third Year Computer Engineering syllabus effective from the Academic Year 2021-22 (REV-2019'C' Scheme). We are sure you will find this syllabus interesting, challenging, fulfill certain needs and expectations.

Computer Engineering is one of the most sought-after courses amongst engineering students. The syllabus needs revision in terms of preparing the student for the professional scenario relevant and suitable to cater the needs of industry in present day context. The syllabus focuses on providing a sound theoretical background as well as good practical exposure to students in the relevant areas. It is intended to provide a modern, industry-oriented education in Computer Engineering. It aims at producing trained professionals who can successfully acquainted with the demands of the industry worldwide. They obtain skills and experience in up-to-date the knowledge to analysis, design, implementation, validation, and documentation of computer software and systems.

The revised syllabus is finalized through a brain storming session attended by Heads of Departments or senior faculty from the Department of Computer Engineering of the affiliated Institutes of the Mumbai University. The syllabus falls in line with the objectives of affiliating University, AICTE, UGC, and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements.

The salient features of the revised syllabus are:

1. Reduction in credits to 170 is implemented to ensure that students have more time for extracurricular activities, innovations, and research.
2. The department Optional Courses will provide the relevant specialization within the branch to a student.
3. Introduction of Skill Based Lab and Mini Project to showcase their talent by doing innovative projects that strengthen their profile and increases the chance of employability.
4. Students are encouraged to take up part of course through MOOCs platform SWAYAM

We would like to place on record our gratefulness to the faculty, students, industry experts and stakeholders for having helped us in the formulation of this syllabus.

Board of Studies in Computer Engineering

Prof. Sunil Bhirud	: Chairman
Prof. Sunita Patil	: Member
Prof. Leena Raga	: Member
Prof. Subhash Shinde	: Member
Prof. Meera Narvekar	: Member
Prof. Suprtim Biswas	: Member
Prof. Sudhir Sawarkar	: Member
Prof. Dayanand Ingle	: Member
Prof. Satish Ket	: Member

Program Structure for Third Year Computer Engineering
UNIVERSITY OF MUMBAI (With Effect from 2021-2022)

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.		Theory	Pract.	Total		
CSC501	Theoretical Computer Science	3	--		3	--	3		
CSC502	Software Engineering	3	--		3		3		
CSC503	Computer Network	3	--		3	--	3		
CSC504	Data Warehousing & Mining	3	--		3	--	3		
CSDLO501x	Department Level Optional Course- 1	3	--		3	--	3		
CSL501	Software Engineering Lab	--	2		--	1	1		
CSL502	Computer Network Lab	--	2		--	1	1		
CSL503	Data Warehousing & Mining Lab	--	2		--	1	1		
CSL504	Business Comm. & Ethics II	--	2*+2		--	2	2		
CSM501	Mini Project: 2 A	--	4 ^{\$}		--	2	2		
Total		15	14		15	07	22		
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract & oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg					
CSC501	Theoretical Computer Science	20	20	20	80	3	25	--	125
CSC502	Software Engineering	20	20	20	80	3	--	--	100
CSC503	Computer Network	20	20	20	80	3	--	--	100
CSC504	Data Warehousing & Mining	20	20	20	80	3	--	--	100
CSDLO501x	Department Level Optional Course -1	20	20	20	80	3	--	--	100
CSL501	Software Engineering Lab	--	--	--	--	--	25	25	50
CSL502	Computer Network Lab	--	--	--	--	--	25	25	50
CSL503	Data Warehousing & Mining Lab	--	--	--	--	--	25	25	50
CSL504	Business Comm. & Ethics II	--	--	--	--	--	50	--	50
CSM501	Mini Project : 2A	--	--	--	--	--	25	25	50
Total		--	--	100	400	--	175	100	775

* Theory class to be conducted for full class and \$ indicates workload of Learner (Not Faculty), students can form groups with minimum 2(Two) and not more than 4(Four). Faculty Load: 1hour per week per four groups.

Program Structure for Computer Engineering
UNIVERSITY OF MUMBAI (With Effect from 2021-2022)

Department Optional Courses

Department Level Optional Courses	Semester	Code & Course
Department Level Optional Course -1	V	CSDLO5011: Probabilistic Graphical Models CSDLO5012: Internet Programming CSDLO5013: Advance Database Management System

Course Code	Course Name	Credits
CSC501	Theoretical Computer Science	3

Prerequisite: Discrete Structures	
Course Objectives:	
1.	Acquire conceptual understanding of fundamentals of grammars and languages.
2.	Build concepts of theoretical design of deterministic and non-deterministic finite automata and push down automata.
3.	Develop understanding of different types of Turing machines and applications.
4.	Understand the concept of Undecidability.
Course Outcomes: At the end of the course, the students will be able to	
1.	Understand concepts of Theoretical Computer Science, difference and equivalence of DFA and NFA, languages described by finite automata and regular expressions.
2.	Design Context free grammar, pushdown automata to recognize the language.
3.	Develop an understanding of computation through Turing Machine.
4.	Acquire fundamental understanding of decidability and undecidability.

Module No.	Unit No.	Topics	Theory Hrs.
1.0		Basic Concepts and Finite Automata	09
	1.1	Importance of TCS, Alphabets, Strings, Languages, Closure properties, Finite Automata (FA) and Finite State machine (FSM).	
	1.2	Deterministic Finite Automata (DFA) and Nondeterministic Finite Automata (NFA): Definitions, transition diagrams and Language recognizers, Equivalence between NFA with and without ϵ -transitions, NFA to DFA Conversion, Minimization of DFA, FSM with output: Moore and Mealy machines, Applications and limitations of FA.	
2.0		Regular Expressions and Languages	07
	2.1	Regular Expression (RE), Equivalence of RE and FA, Arden's Theorem, RE Applications	
	2.2	Regular Language (RL), Closure properties of RLs, Decision properties of RLs, Pumping lemma for RLs.	
3.0		Grammars	08
	3.1	Grammars and Chomsky hierarchy	
	3.2	Regular Grammar (RG), Equivalence of Left and Right linear grammar, Equivalence of RG and FA.	

	3.3	Context Free Grammars (CFG) Definition, Sentential forms, Leftmost and Rightmost derivations, Parse tree, Ambiguity, Simplification and Applications, Normal Forms: Chomsky Normal Forms (CNF) and Greibach Normal Forms (GNF), Context Free language (CFL) - Pumping lemma, Closure properties.	
4.0		Pushdown Automata(PDA)	04
	4.1	Definition, Language of PDA,PDA as generator, decider and acceptor of CFG, Deterministic PDA , Non-Deterministic PDA, Application of PDA.	
5.0		Turing Machine (TM)	09
	5.1	Definition, Design of TM as generator, decider and acceptor, Variants of TM: Multitrack, Multitape, Universal TM, Applications, Power and Limitations of TMs.	
6.0		Undecidability	02
	6.1	Decidability and Undecidability, Recursive and Recursively Enumerable Languages, Halting Problem, Rice's Theorem, Post Correspondence Problem.	
Total			39

Text Books:	
1.	John E. Hopcroft, Rajeev Motwani, Jeffery D. Ullman, <i>“Introduction to Automata Theory, Languages and Computation”</i> , 3 rd Edition, Pearson Education, 2008.
2.	Michael Sipser, <i>“Theory of Computation”</i> , 3 rd Edition, Cengage learning. 2013.
3.	Vivek Kulkarni, <i>“Theory of Computation”</i> , Illustrated Edition, Oxford University Press, (12 April 2013) India.
Reference Books:	
1.	J. C. Martin, <i>“Introduction to Languages and the Theory of Computation”</i> , 4 th Edition, Tata McGraw Hill Publication, 2013.
2.	Kavi Mahesh, <i>“Theory of Computation: A Problem Solving Approach”</i> , Kindle Edition, Wiley-India, 2011.

Assessment:	
Internal Assessment:	
1.	Assessment consists of two class tests of 20 marks each.
2.	The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed.
3.	Duration of each test shall be one hour.
Term work:	
1.	Term Work should consist of at least 06 assignments (at least one assignment on each module).

2.	Assignment (best 5 assignments)	20 marks
	Attendance	5 marks
3.	It is recommended to use JFLAP software (www.jflap.org) for better teaching and learning processes.	

End Semester Theory Examination:	
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1.	Question paper will comprise of 6 questions, each carrying 20 marks.
2.	The students need to solve total 4 questions.
3.	Question No.1 will be compulsory and based on entire syllabus.
4.	Remaining questions (Q.2 to Q.6) will cover all the modules of syllabus.

Useful Links:	
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1.	www.jflap.org
2.	https://nptel.ac.in/courses/106/104/106104028/
3.	https://nptel.ac.in/courses/106/104/106104148/

Course Code:	Course Title	Credit
CSC502	Software Engineering	3

Prerequisite: Object Oriented Programming with Java , Python Programming

Course Objectives:

- 1 To provide the knowledge of software engineering discipline.
- 2 To apply analysis, design and testing principles to software project development.
- 3 To demonstrate and evaluate real world software projects.

Course Outcomes: On successful completion of course, learners will be able to:

- 1 Identify requirements & assess the process models.
- 2 Plan, schedule and track the progress of the projects.
- 3 Design the software projects.
- 4 Do testing of software project.
- 5 Identify risks, manage the change to assure quality in software projects.

Module	Content	Hrs
1	Introduction To Software Engineering and Process Models	7
	1.1 Software Engineering-process framework, the Capability Maturity Model (CMM), Advanced Trends in Software Engineering	
	1.2 Prescriptive Process Models: The Waterfall, Incremental Process Models, Evolutionary Process Models: RAD & Spiral	
	1.3 Agile process model: Extreme Programming (XP), Scrum, Kanban	
2	Software Requirements Analysis and Modeling	4
	2.1 Requirement Engineering, Requirement Modeling, Data flow diagram, Scenario based model	
	2.2 Software Requirement Specification document format(IEEE)	
3	Software Estimation Metrics	7
	3.1 Software Metrics, Software Project Estimation (LOC, FP, COCOMO II)	
	3.2 Project Scheduling & Tracking	
4	Software Design	7
	4.1 Design Principles & Concepts	
	4.2 Effective Modular Design, Cohesion and Coupling, Architectural design	
5	Software Testing	7
	5.1 Unit testing, Integration testing, Validation testing, System testing	
	5.2 Testing Techniques, white-box testing: Basis path, Control structure testing black-box testing: Graph based, Equivalence, Boundary Value	
	5.3 Types of Software Maintenance, Re-Engineering, Reverse Engineering	
6	Software Configuration Management, Quality Assurance and Maintenance	7
	6.1 Risk Analysis & Management: Risk Mitigation, Monitoring and Management Plan (RMMM).	
	6.2 Quality Concepts and Software Quality assurance Metrics, Formal Technical Reviews, Software Reliability	
	6.3 The Software Configuration Management (SCM) ,Version Control and Change Control	
		39

Textbooks:	
1	Roger Pressman, " <i>Software Engineering: A Practitioner's Approach</i> ", 9 th edition , McGraw-Hill Publications, 2019
2	Ian Sommerville, " <i>Software Engineering</i> ", 9 th edition, Pearson Education, 2011
3	Ali Behfroz and Fredeick J. Hudson, " <i>Software Engineering Fundamentals</i> ", Oxford University Press, 1997
4	Grady Booch, James Rambaugh, Ivar Jacobson, " <i>The unified modeling language user guide</i> ", 2 nd edition, Pearson Education, 2005
References:	
1	Pankaj Jalote, " <i>An integrated approach to Software Engineering</i> ", 3 rd edition, Springer, 2005
2	Rajib Mall, " <i>Fundamentals of Software Engineering</i> ", 5 th edition, Prentice Hall India, 2014
3	Jibitesh Mishra and Ashok Mohanty, " <i>Software Engineering</i> ", Pearson , 2011
4	Ugrasen Suman, " <i>Software Engineering – Concepts and Practices</i> ", Cengage Learning, 2013
5	Waman S Jawadekar, " <i>Software Engineering principles and practice</i> ", McGraw Hill Education, 2004

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and the second-class test when an additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Only Four questions need to be solved.
4	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Useful Links	
1	https://nptel.ac.in/courses/106/105/106105182/
2	https://onlinecourses.nptel.ac.in/noc19_cs69/preview
3	https://www.mooc-list.com/course/software-engineering-introduction-edx

Course Code:	Course Title	Credit
CSC503	Computer Network	3

Prerequisite: None	
Course Objectives:	
1	To introduce concepts and fundamentals of data communication and computer networks.
2	To explore the inter-working of various layers of OSI.
3	To explore the issues and challenges of protocols design while delving into TCP/IP protocol suite.
4	To assess the strengths and weaknesses of various routing algorithms.
5	To understand various transport layer and application layer protocols.
Course Outcomes: On successful completion of course, learner will be able to	
1	Demonstrate the concepts of data communication at physical layer and compare ISO - OSI model with TCP/IP model.
2	Explore different design issues at data link layer.
3	Design the network using IP addressing and sub netting / supernetting schemes.
4	Analyze transport layer protocols and congestion control algorithms.
5	Explore protocols at application layer

Module	Content	Hrs
1	Introduction to Networking	4
	1.1 Introduction to computer network, network application, network software and hardware components (Interconnection networking devices), Network topology, protocol hierarchies, design issues for the layers, connection oriented and connectionless services	
	1.2 Reference models: Layer details of OSI, TCP/IP models. Communication between layers.	
2	Physical Layer	3
	2.1 Introduction to Communication Electromagnetic Spectrum	
	2.2 Guided Transmission Media: Twisted pair, Coaxial, Fiber optics.	
3	Data Link Layer	8
	3.1 DLL Design Issues (Services, Framing, Error Control, Flow Control), Error Detection and Correction(Hamming Code, CRC, Checksum) , Elementary Data Link protocols , Stop and Wait, Sliding Window(Go Back N, Selective Repeat)	
	Medium Access Control sublayer 3.2 Channel Allocation problem, Multiple access Protocol(Aloha, Carrier Sense Multiple Access (CSMA/CD)	
4	Network layer	12
	4.1 Network Layer design issues, Communication Primitives: Unicast, Multicast, Broadcast. IPv4 Addressing (classfull and classless), Subnetting, Supernetting design problems ,IPv4 Protocol, Network Address Translation (NAT), IPv6	
	4.2 Routing algorithms : Shortest Path (Dijkstra's), Link state routing, Distance Vector Routing	
	4.3 Protocols - ARP,RARP, ICMP, IGMP	

	4.4	Congestion control algorithms: Open loop congestion control, Closed loop congestion control, QoS parameters, Token & Leaky bucket algorithms	
5		Transport Layer	6
	5.1	The Transport Service: Transport service primitives, Berkeley Sockets, Connection management (Handshake), UDP, TCP, TCP state transition, TCP timers	
	5.2	TCP Flow control (sliding Window), TCP Congestion Control: Slow Start	
6		Application Layer	6
	6.1	DNS: Name Space, Resource Record and Types of Name Server. HTTP, SMTP, Telnet, FTP, DHCP	

Textbooks:	
1	A.S. Tanenbaum, Computer Networks , 4 th edition Pearson Education
2	B.A. Forouzan, Data Communications and Networking , 5 th edition, TMH
3	James F. Kurose, Keith W. Ross, Computer Networking, A Top-Down Approach Featuring the Internet , 6 th edition, Addison Wesley
References:	
1	S.Keshav, An Engineering Approach To Computer Networking , Pearson
2	Natalia Olifer & Victor Olifer, Computer Networks: Principles, Technologies & Protocols for Network Design , Wiley India, 2011.
3	Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach , Second Edition, The Morgan Kaufmann Series in Networking

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Useful Links	
1	https://www.netacad.com/courses/networking/networking-essentials
2	https://www.coursera.org/learn/computer-networking
3	https://nptel.ac.in/courses/106/105/106105081
4	https://www.edx.org/course/introduction-to-networking

Course Code:	Course Title	Credit
CSC504	Data Warehousing and Mining	3

Prerequisite: Database Concepts	
Course Objectives:	
1.	To identify the significance of Data Warehousing and Mining.
2.	To analyze data, choose relevant models and algorithms for respective applications.
3.	To study web data mining.
4.	To develop research interest towards advances in data mining.
Course Outcomes: At the end of the course, the student will be able to	
1.	Understand data warehouse fundamentals and design data warehouse with dimensional modelling and apply OLAP operations.
2.	Understand data mining principles and perform Data preprocessing and Visualization.
3.	Identify appropriate data mining algorithms to solve real world problems.
4.	Compare and evaluate different data mining techniques like classification, prediction, clustering and association rule mining
5.	Describe complex information and social networks with respect to web mining.

Module	Content	Hrs
1	Data Warehousing Fundamentals	8
	Introduction to Data Warehouse, Data warehouse architecture, Data warehouse versus Data Marts, E-R Modeling versus Dimensional Modeling, Information Package Diagram, Data Warehouse Schemas; Star Schema, Snowflake Schema, Factless Fact Table, Fact Constellation Schema. Update to the dimension tables. Major steps in ETL process, OLTP versus OLAP, OLAP operations: Slice, Dice, Rollup, Drilldown and Pivot.	
2	Introduction to Data Mining, Data Exploration and Data Pre-processing	8
	Data Mining Task Primitives, Architecture, KDD process, Issues in Data Mining, Applications of Data Mining, Data Exploration: Types of Attributes, Statistical Description of Data, Data Visualization, Data Preprocessing: Descriptive data summarization, Cleaning, Integration & transformation, Data reduction, Data Discretization and Concept hierarchy generation.	
3	Classification	6
	Basic Concepts, Decision Tree Induction, Naïve Bayesian Classification, Accuracy and Error measures, Evaluating the Accuracy of a Classifier: Holdout & Random Subsampling, Cross Validation, Bootstrap.	
4	Clustering	6
	Types of data in Cluster analysis, Partitioning Methods (<i>k</i> -Means, <i>k</i> -Medoids), Hierarchical Methods (Agglomerative, Divisive).	
5	Mining frequent patterns and associations	6
	Market Basket Analysis, Frequent Item sets, Closed Item sets, and Association Rule, Frequent Pattern Mining, Apriori Algorithm, Association Rule Generation, Improving the Efficiency of Apriori, Mining Frequent Itemsets without candidate generation, Introduction to Mining Multilevel Association Rules and Mining Multidimensional Association Rules.	

6	Web Mining	5
	Introduction, Web Content Mining: Crawlers, Harvest System, Virtual Web View, Personalization, Web Structure Mining: Page Rank, Clever, Web Usage Mining.	

Textbooks:	
1	Paulraj Ponniah, “ <i>Data Warehousing: Fundamentals for IT Professionals</i> ”, Wiley India.
2	Han, Kamber, “ <i>Data Mining Concepts and Techniques</i> ”, Morgan Kaufmann 2 nd edition.
3	M.H. Dunham, “ <i>Data Mining Introductory and Advanced Topics</i> ”, Pearson Education.
References:	
1	Reema Theraja, “ <i>Data warehousing</i> ”, Oxford University Press 2009.
2	Pang-Ning Tan, Michael Steinbach and Vipin Kumar, “ <i>Introduction to Data Mining</i> ”, Pearson Publisher 2 nd edition.
3	Ian H. Witten, Eibe Frank and Mark A. Hall, “ <i>Data Mining</i> ”, Morgan Kaufmann 3 rd edition.

<u>Assessment:</u>	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example, If Q.2 part (a) from module 3 then part (b) can be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.
Useful Links	
1	https://onlinecourses.nptel.ac.in/noc20_cs12/preview
2	https://www.coursera.org/specializations/data-mining

Course Code:	Course Title	Credit
CSDL05011	Probabilistic Graphical Models	3

Prerequisite: Engineering Mathematics, Discrete Structure	
Course Objectives:	
1	To give comprehensive introduction of probabilistic graphical models
2	To make inferences, learning, actions and decisions while applying these models
3	To introduce real-world trade-offs when using probabilistic graphical models in practice
4	To develop the knowledge and skills necessary to apply these models to solve real world problems.
Course Outcomes: At the end of the course, the student will be able to	
1	Understand basic concepts of probabilistic graphical modelling.
2	Model and extract inference from various graphical models like Bayesian Networks, Markov Models
3	Perform learning and take actions and decisions using probabilistic graphical models
4	Represent real world problems using graphical models; design inference algorithms; and learn the structure of the graphical model from data.
5	Design real life applications using probabilistic graphical models.

Module		Content	Hrs
1.		Introduction to Probabilistic Graphical Modeling	5
	1.1	Introduction to Probability Theory: Probability Theory, Basic Concepts in Probability, Random Variables and Joint Distribution, Independence and Conditional Independence, Continuous Spaces, Expectation and Variances	
	1.2	Introduction to Graphs: Nodes and Edges, Subgraphs, Paths and Trails, Cycles and Loops	
	1.3	Introduction to Probabilistic Graph Models: Bayesian Network, Markov Model, Hidden Markov Model	
	1.4	Applications of PGM	
2.		Bayesian Network Model and Inference	10
	2.1	Directed Graph Model: Bayesian Network-Exploiting Independence Properties, Naive Bayes Model, Bayesian Network Model, Reasoning Patterns, Basic Independencies in Bayesian Networks, Bayesian Network Semantics, Graphs and Distributions. Modelling: Picking variables, Picking Structure, Picking Probabilities, D-separation	
	2.2	Local Probabilistic Models: Tabular CPDs, Deterministic CPDs, Context Specific CPDs, Generalized Linear Models.	

	2.3	Exact inference variable elimination: Analysis of Complexity, Variable Elimination, Conditioning, Inference with Structured CPDs.	
3.		Markov Network Model and Inference	8
	3.1	Undirected Graph Model : Markov Model-Markov Network, Parameterization of Markov Network, Gibb's distribution, Reduced Markov Network, Markov Network Independencies, From Distributions to Graphs, Fine Grained Parameterization, Over Parameterization	
	3.2	Exact inference variable elimination: Graph Theoretic Analysis for Variable Elimination, Conditioning	
4.		Hidden Markov Model and Inference	6
	4.1	Template Based Graph Model : HMM- Temporal Models, Template Variables and Template Factors, Directed Probabilistic Models, Undirected Representation, Structural Uncertainty.	
5.		Learning and Taking Actions and Decisions	6
	5.1	Learning Graphical Models: Goals of Learning, Density Estimation, Specific Prediction Tasks, Knowledge Discovery. Learning as Optimization: Empirical Risk, over fitting, Generalization, Evaluating Generalization Performance, Selecting a Learning Procedure, Goodness of fit, Learning Tasks. Parameter Estimation: Maximum Likelihood Estimation, MLE for Bayesian Networks	
	5.2	Causality: Conditioning and Intervention, Correlation and Causation, Causal Models, Structural Causal Identifiability, Mechanisms and Response Variables, Learning Causal Models. Utilities and Decisions: Maximizing Expected Utility, Utility Curves, Utility Elicitation. Structured Decision Problems: Decision Tree	
6.		Applications	4
	6.1	Application of Bayesian Networks: Classification, Forecasting, Decision Making	
	6.2	Application of Markov Models: Cost Effectiveness Analysis, Relational Markov Model and its Applications, Application in Portfolio Optimization	
	6.3	Application of HMM: Speech Recognition, Part of Speech Tagging, Bioinformatics.	

Textbooks:

- | | |
|-----------|---|
| 1. | Daphne Koller and Nir Friedman, " Probabilistic Graphical Models: Principles and Techniques ", Cambridge, MA: The MIT Press, 2009 (ISBN 978-0-262-0139-2). |
| 2. | David Barber, " Bayesian Reasoning and Machine Learning ", Cambridge University Press, 1 st edition, 2011. |

References:

1.	Finn Jensen and Thomas Nielsen, " Bayesian Networks and Decision Graphs (Information Science and Statistics) ", 2nd Edition, Springer, 2007.
2.	Kevin P. Murphy, " Machine Learning: A Probabilistic Perspective ", MIT Press, 2012.
3.	Martin Wainwright and Michael Jordan, M., " Graphical Models, Exponential Families, and Variational Inference ", 2008.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

- | | |
|----|---|
| 1. | Question paper will comprise of total six questions. |
| 2. | All question carries equal marks |
| 3. | Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3) |
| 4. | Only Four question need to be solved. |
| 5. | In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus. |

Useful Links

- | | |
|-----|---|
| 1. | https://www.coursera.org/specializations/probabilistic-graphical-models |
| 2. | https://www.mooc-list.com/tags/probabilistic-graphical-models |
| 3. | https://scholarship.claremont.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=2690&context=cmc_theses |
| 4. | https://www.upgrad.com/blog/bayesian-networks/ |
| 5. | https://www.utas.edu.au/_data/assets/pdf_file/0009/588474/TR_14_BNs_a_resource_guide.pdf |
| 6. | https://math.libretexts.org/Bookshelves/Applied_Mathematics/Book%3A_Applied_Finite_Mathematics_(Sekhon_and_Bloom)/10%3A_Markov_Chains/10.02%3A_Applications_of_Markov_Chains/10.2.01%3A_Applications_of_Markov_Chains_(Exercises) |
| 7. | https://link.springer.com/chapter/10.1007/978-3-319-43742-2_24 |
| 8. | https://homes.cs.washington.edu/~pedrod/papers/kdd02a.pdf |
| 9. | https://core.ac.uk/download/pdf/191938826.pdf |
| 10. | https://cs.brown.edu/research/pubs/theses/ugrad/2005/dbooksta.pdf |

11.	https://web.ece.ucsb.edu/Faculty/Rabiner/ece259/Reprints/tutorial%20on%20hmm%20and%20applications.pdf
12.	https://mi.eng.cam.ac.uk/~mjfg/mjfg_NOW.pdf
13.	http://bioinfo.au.tsinghua.edu.cn/member/jgu/pgm/materials/Chapter3-LocalProbabilisticModels.pdf

Suggested List of Experiments:

Sr. No	Experiment
1.	Experiment on Probability Theory
2.	Experiment on Graph Theory
3.	Experiment on Bayesian Network Modelling
4.	Experiment on Markov Chain Modeling
5.	Experiment on HMM
6.	Experiment on Maximum Likelihood Estimation
7.	Decision Making using Decision Trees
8.	Learning with Optimization

**** Suggestion: Laboratory work based on above syllabus can be incorporated along with mini project in CSM501: Mini-Project.**

Course Code:	Course Title	Credit
CSDL05012	Internet Programming	3

Prerequisite: Data Structures

Course Objectives:

1	To get familiar with the basics of Internet Programming.
2	To acquire knowledge and skills for creation of web site considering both client and server-side programming
3	To gain ability to develop responsive web applications
4	To explore different web extensions and web services standards
5	To learn characteristics of RIA
6	To learn React js

Course Outcomes:

1	Implement interactive web page(s) using HTML and CSS.
2	Design a responsive web site using JavaScript
3	Demonstrate database connectivity using JDBC
4	Demonstrate Rich Internet Application using Ajax
5	Demonstrate and differentiate various Web Extensions.
6	Demonstrate web application using Reactive Js

Module		Content	Hrs
1		Introduction to Web Technology	10
	1.1	Web Essentials: Clients, Servers and Communication, The Internet, Basic Internet protocols, World wide web, HTTP Request Message, HTTP Response Message, Web Clients, Web Servers HTML5 – fundamental syntax and semantics, Tables, Lists, Image, HTML5 control elements, Semantic elements, Drag and Drop, Audio – Video controls CSS3 – Inline, embedded and external style sheets – Rule cascading, Inheritance, Backgrounds, Border Images, Colors, Shadows, Text, Transformations, Transitions, Animation, Basics of Bootstrap.	
2		Front End Development	7
	2.1	Java Script: An introduction to JavaScript–JavaScript DOM Model–Date and Objects-Regular Expressions- Exception Handling-Validation-Built-in objects-Event Handling, DHTML with JavaScript–JSON introduction – Syntax – Function Files – Http Request –SQL.	
3.		Back End Development	7
	3.1	Servlets: Java Servlet Architecture, Servlet Life Cycle, Form GET and POST actions, Session Handling, Understanding Cookies, Installing and Configuring Apache Tomcat Web Server, Database Connectivity: JDBC perspectives, JDBC program example JSP: Understanding Java Server Pages, JSP Standard Tag Library (JSTL), Creating HTML forms by embedding JSP code.	
4		Rich Internet Application (RIA)	4
	4.1	Characteristics of RIA, Introduction to AJAX: AJAX design basics, AJAX vs Traditional Approach, Rich User Interface using Ajax, jQuery framework with AJAX.	
5		Web Extension: PHP and XML	6
	5.1	XML –DTD (Document Type Definition), XML Schema, Document Object Model, Presenting XML, Using XML Parsers: DOM and SAX, XSL-eXtensible Stylesheet Language	

	5.2	Introduction to PHP- Data types, control structures, built in functions, building web applications using PHP- tracking users, PHP and MySQLdatabase connectivity with example.	
6		React js	5
	6.1	Introduction, React features, App “Hello World” Application, Introduction to JSX, Simple Application using JSX.	
			39

Textbooks:	
1	Ralph Moseley, M.T. Savliya, “Developing Web Applications”, Willy India, Second Edition, ISBN: 978-81-265-3867-6
2	“Web Technology Black Book”, Dremtech Press, First Edition, 978-7722-997
3	Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5" Third Edition, O'REILLY, 2014. (http://www.ebooksbucket.com/uploads/itprogramming/javascript/Learning_PHP_MySQL_Javascript_CSS_HTML5__Robin_Nixon_3e.pdf)
4	Dana Moore, Raymond Budd, Edward Benson,Professional Rich Internet Applications: AJAX and Beyond Wiley publications. https://ebooks-it.org/0470082801-ebook.htm
5.	Alex Banks and Eve Porcello, Learning React Functional Web Development with React and Redux,OREILLY, First Edition
References:	
1	Harvey & Paul Deitel& Associates, Harvey Deitel and Abbey Deitel, Internet and World Wide Web - How To Program, Fifth Edition, Pearson Education, 2011.
2	Achyut S Godbole and AtulKahate, —Web Technologies, Second Edition, Tata McGraw Hill, 2012.
3	Thomas A Powell, Fritz Schneider, —JavaScript: The Complete Reference, Third Edition, Tata McGraw Hill, 2013
4	David Flanagan, —JavaScript: The Definitive Guide, Sixth Edition, O'Reilly Media, 2011
5	Steven Holzner —The Complete Reference - PHP, Tata McGraw Hill, 2008
6	Mike Mcgrath—PHP & MySQL in easy Steps, Tata McGraw Hill, 2012.

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The firstclass test is to be conducted when approx. 40% syllabus is completed and the secondclass test when an additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Useful Links	
1	https://books.goalkicker.com/ReactJSBook/
2	https://www.guru99.com/reactjs-tutorial.html
3	www.nptelvideos.in
4	www.w3schools.com
5	https://spoken-tutorial.org/
6	www.coursera.org
The following list can be used as a guideline for mini project:	

1	Create Simple web page using HTML5
2	Design and Implement web page using CSS3 and HTML5
3	Form Design and Client-Side Validation using: a. Javascript and HTML5, b. Javascript and JQuery
4	Develop interactive web pages using HTML 5 with JDBC database connectivity
5	Develop simple web page using PHP
6	Develop interactive web pages using PHP with database connectivity MYSQL
7	Develop XML web page using DTD, XSL
8	Implement a web page using Ajax and PHP
9	Case study based on Reactive js
10	Installation of the React DOM library.
* Suggestion: Laboratory work based on above syllabus can be incorporated as mini project in CSM501: Mini-Project.	

Course Code:	Course Title	Credit
CSDL05013	Advance Database Management System	3

Prerequisite: Database Management System

Course Objectives:

- | | |
|---|--|
| 1 | To provide insights into distributed database designing |
| 2 | To specify the various approaches used for using XML and JSON technologies. |
| 3 | To apply the concepts behind the various types of NoSQL databases and utilize it for MongoDB |
| 4 | To learn about the trends in advance databases |

Course Outcomes: After the successful completion of this course learner will be able to:

- | | |
|---|--|
| 1 | Design distributed database using the various techniques for query processing |
| 2 | Measure query cost and perform distributed transaction management |
| 3 | Organize the data using XML and JSON database for better interoperability |
| 4 | Compare different types of NoSQL databases |
| 5 | Formulate NoSQL queries using MongoDB |
| 6 | Describe various trends in advance databases through temporal, graph based and spatial based databases |

Module	Content	Hrs
1	Distributed Databases	3
	1.1 Introduction, Distributed DBMS Architecture, Data Fragmentation, Replication and Allocation Techniques for Distributed Database Design.	
2	Distributed Database Handling	8
	2.1 Distributed Transaction Management – Definition, properties, types, architecture Distributed Query Processing - Characterization of Query Processors, Layers/ phases of query processing.	
	2.2 Distributed Concurrency Control- Taxonomy, Locking based, Basic TO algorithm, Recovery in Distributed Databases: Failures in distributed database, 2PC and 3PC protocol.	
3	Data interoperability – XML and JSON	6
	3.1 XML Databases: Document Type Definition, XML Schema, Querying and Transformation: XPath and XQuery.	
	3.2 Basic JSON syntax, (Java Script Object Notation),JSON data types, Stringifying and parsing the JSON for sending & receiving, JSON Object retrieval using key-value pair and JQuery, XML Vs JSON	
4	NoSQL Distribution Model	10
	4.1 NoSQL database concepts: NoSQL data modeling, Benefits of NoSQL, comparison between SQL and NoSQL database system.	
	4.2 Replication and sharding, Distribution Models Consistency in distributed data, CAP theorem, Notion of ACID Vs BASE, handling Transactions, consistency and eventual consistency	
	4.3 Types of NoSQL databases: Key-value data store, Document database and Column Family Data store, Comparison of NoSQL databases w.r.t CAP theorem and ACID properties.	
5	NoSQL using MongoDB	6

	5.1	NoSQL using MongoDB: Introduction to MongoDB Shell, Running the MongoDB shell, MongoDB client, Basic operations with MongoDB shell, Basic Data Types, Arrays, Embedded Documents	
	5.2	Querying MongoDB using find() functions, advanced queries using logical operators and sorting, simple aggregate functions, saving and updating document. MongoDB Distributed environment: Concepts of replication and horizontal scaling through sharding in MongoDB	
6		Trends in advance databases	6
	6.1	Temporal database: Concepts, time representation, time dimension, incorporating time in relational databases.	
	6.2	Graph Database: Introduction, Features, Transactions, consistency, Availability, Querying, Case Study Neo4J	
	6.3	Spatial database: Introduction, data types, models, operators and queries	
			39

Textbooks:

1	Korth, Siberchatz, Sudarshan, "Database System Concepts", 6 th Edition, McGraw Hill
2	Elmasri and Navathe, "Fundamentals of Database Systems", 5 th Edition, Pearson Education
3	Ozsu, M. Tamer, Valduriez, Patrick, "Principles of distributed database systems", 3 rd Edition, Pearson Education, Inc.
4	Pramod Sadalge, Martin Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Addison Wesley/ Pearson
5	Jeff Friesen, Java XML and JSON, Second Edition, 2019, apress Inc.

References:

1	Peter Rob and Carlos Coronel, Database Systems Design, Implementation and Management, Thomson Learning, 5 th Edition.
2	Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.
3	Adam Fowler, NoSQL for dummies, John Wiley & Sons, Inc.
4	Shashank Tiwari, Professional NOSQL, John Willy & Sons. Inc
5	Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH
6	MongoDB Manual : https://docs.mongodb.com/manual

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

NOTE: Suggested that in Mini Projects (CSM501) can be included NoSQL databases for implementation as a backend.

Useful Links

1	https://cassandra.apache.org
2	https://www.mongodb.com
3	https://riak.com
4	https://neo4j.com
5	https://martinfowler.com/articles/nosql-intro-original.pdf

Lab Code	Lab Name	Credit
CSL501	Software Engineering Lab	1

Prerequisite: Object Oriented Programming with Java , Python Programming	
Lab Objectives:	
1	To solve real life problems by applying software engineering principles
2	To impart state-of-the-art knowledge on Software Engineering
Lab Outcomes: On successful completion of laboratory experiments, learners will be able to :	
1	Identify requirements and apply software process model to selected case study.
2	Develop architectural models for the selected case study.
3	Use computer-aided software engineering (CASE) tools.

Suggested List of Experiments - Assign the case study/project as detail statement of problem to a group of two/three students. Laboratory work will be based on course syllabus with minimum 10 experiments. Open source computer-aided software engineering (CASE) tools can be used for performing the experiment.	
Sr. No.	Title of Experiment
1	Application of at least two traditional process models.
2	Application of the Agile process models.
3	Preparation of software requirement specification (SRS) document in IEEE format.
4	Structured data flow analysis.
5	Use of metrics to estimate the cost.
6	Scheduling & tracking of the project.
7	Write test cases for black box testing.
8	Write test cases for white box testing.
9	Preparation of Risk Mitigation, Monitoring and Management Plan (RMMM).
10	Version controlling of the project.

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of “Software Engineering”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of CSC502 and CSL501 syllabus

Lab Code	Lab Name	Credit
CSL502	Computer Network Lab	1

Prerequisite: None	
Lab Objectives:	
1	To practically explore OSI layers and understand the usage of simulation tools.
2	To analyze, specify and design the topological and routing strategies for an IP based networking infrastructure.
3	To identify the various issues of a packet transfer from source to destination, and how they are resolved by the various existing protocols
Lab Outcomes: On successful completion of lab, learner will be able to	
1	Design and setup networking environment in Linux.
2	Use Network tools and simulators such as NS2, Wireshark etc. to explore networking algorithms and protocols.
3	Implement programs using core programming APIs for understanding networking concepts.

Suggested List of Experiments	
Sr. No.	Title of Experiment
1.	Study of RJ45 and CAT6 Cabling and connection using crimping tool.
2.	Use basic networking commands in Linux (ping, tracert, nslookup, netstat, ARP, RARP, ip, ifconfig, dig, route)
3.	Build a simple network topology and configure it for static routing protocol using packet tracer. Setup a network and configure IP addressing, subnetting, masking.
4.	Perform network discovery using discovery tools (eg. Nmap, mrtg)
5.	Use Wire shark to understand the operation of TCP/IP layers: <ul style="list-style-type: none"> ● Ethernet Layer: Frame header, Frame size etc. ● Data Link Layer: MAC address, ARP (IP and MAC address binding) ● Network Layer: IP Packet (header, fragmentation), ICMP (Query and Echo) ● Transport Layer: TCP Ports, TCP handshake segments etc. ● Application Layer: DHCP, FTP, HTTP header formats
6.	Use simulator (Eg. NS2) to understand functioning of ALOHA, CSMA/CD.
7.	Study and Installation of Network Simulator (NS3)
8.	a. Set up multiple IP addresses on a single LAN. b. Using nestat and route commands of Linux, do the following: <ul style="list-style-type: none"> ● View current routing table ● Add and delete routes ● Change default gateway c. Perform packet filtering by enabling IP forwarding using IPtables in Linux.
9	Design VPN and Configure RIP/OSPF using Packet tracer.
10.	Socket programming using TCP or UDP
11.	Perform File Transfer and Access using FTP
12.	Perform Remote login using Telnet server

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of “Computer Network”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks,

	Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of CSC503: Computer Network

Useful Links	
1	https://www.netacad.com/courses/packet-tracer/introduction-packet-tracer
2	https://www.coursera.org/projects/data-forwarding-computer-networks
3	https://www.edx.org/course/ilabx-the-internet-masterclass

Lab Code	Lab Name	Credit
CSL503	Data Warehousing and Mining Lab	1

Prerequisite: Database Concepts	
Lab Objectives:	
1.	Learn how to build a data warehouse and query it.
2.	Learn about the data sets and data preprocessing.
3.	Demonstrate the working of algorithms for data mining tasks such Classification, clustering, Association rule mining & Web mining
4.	Apply the data mining techniques with varied input values for different parameters.
5.	Explore open source software (like WEKA) to perform data mining tasks.
Lab Outcomes: At the end of the course, the student will be able to	
1.	Design data warehouse and perform various OLAP operations.
2.	Implement data mining algorithms like classification.
3.	Implement clustering algorithms on a given set of data sample.
4.	Implement Association rule mining & web mining algorithm.

Suggested List of Experiments	
Sr. No.	Title of Experiment
1	One case study on building Data warehouse/Data Mart <ul style="list-style-type: none"> Write Detailed Problem statement and design dimensional modelling (creation of star and snowflake schema)
2	Implementation of all dimension table and fact table based on experiment 1 case study
3	Implementation of OLAP operations: Slice, Dice, Rollup, Drilldown and Pivot based on experiment 1 case study
4	Implementation of Bayesian algorithm
5	Implementation of Data Discretization (any one) & Visualization (any one)
6	Perform data Pre-processing task and demonstrate Classification, Clustering, Association algorithm on data sets using data mining tool (WEKA/R tool)
7	Implementation of Clustering algorithm (K-means/K-medoids)
8	Implementation of any one Hierarchical Clustering method
9	Implementation of Association Rule Mining algorithm (Apriori)
10	Implementation of Page rank/HITS algorithm

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 1 assignment on content of theory and practical of “Data Warehousing and Mining”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance (Theory & Practical): 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of CSC504 : Data Warehousing and Mining

Course Code	Course Name	Credit
CSL504	Business Communication & Ethics II	02

Course Rationale: This curriculum is designed to build up a professional and ethical approach, effective oral and written communication with enhanced soft skills. Through practical sessions, it augments student's interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global Industrial and Corporate requirements. It further inculcates the social responsibility of engineers as technical citizens.	
Course Objectives	
1	To discern and develop an effective style of writing important technical/business documents.
2	To investigate possible resources and plan a successful job campaign.
3	To understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement.
4	To develop creative and impactful presentation skills.
5	To analyze personal traits, interests, values, aptitudes and skills.
6	To understand the importance of integrity and develop a personal code of ethics.
Course Outcomes: At the end of the course, the student will be able to	
1	Plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles.
2	Strategize their personal and professional skills to build a professional image and meet the demands of the industry.
3	Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.
4	Deliver persuasive and professional presentations.
5	Develop creative thinking and interpersonal skills required for effective professional communication.
6	Apply codes of ethical conduct, personal integrity and norms of organizational behaviour.

Module	Contents	Hours
1	ADVANCED TECHNICAL WRITING: PROJECT/PROBLEM BASED LEARNING (PBL)	06
	<p>Purpose and Classification of Reports: Classification on the basis of: Subject Matter (Technology, Accounting, Finance, Marketing, etc.), Time Interval (Periodic, One-time, Special), Function (Informational, Analytical, etc.), Physical Factors (Memorandum, Letter, Short & Long)</p> <p>Parts of a Long Formal Report: Prefatory Parts (Front Matter), Report Proper (Main Body), Appended Parts (Back Matter)</p> <p>Language and Style of Reports: Tense, Person & Voice of Reports, Numbering Style of Chapters, Sections, Figures, Tables and Equations, Referencing Styles in APA & MLA Format, Proofreading through Plagiarism Checkers</p> <p>Definition, Purpose & Types of Proposals: Solicited (in conformance with RFP) & Unsolicited Proposals, Types (Short and Long proposals)</p> <p>Parts of a Proposal: Elements, Scope and Limitations, Conclusion</p> <p>Technical Paper Writing: Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References), Language and Formatting, Referencing in IEEE Format</p>	

2	EMPLOYMENT SKILLS	06
	<p>Cover Letter & Resume: Parts and Content of a Cover Letter, Difference between Bio-data, Resume & CV, Essential Parts of a Resume, Types of Resume (Chronological, Functional & Combination)</p> <p>Statement of Purpose: Importance of SOP, Tips for Writing an Effective SOP</p> <p>Verbal Aptitude Test: Modelled on CAT, GRE, GMAT exams</p> <p>Group Discussions: Purpose of a GD, Parameters of Evaluating a GD, Types of GDs (Normal, Case-based & Role Plays), GD Etiquettes</p> <p>Personal Interviews: Planning and Preparation, Types of Questions, Types of Interviews (Structured, Stress, Behavioural, Problem Solving & Case-based), Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual</p>	
3	BUSINESS MEETINGS	02
	<p>Conducting Business Meetings: Types of Meetings, Roles and Responsibilities of Chairperson, Secretary and Members, Meeting Etiquette</p> <p>Documentation: Notice, Agenda, Minutes</p>	
4	TECHNICAL/ BUSINESS PRESENTATIONS	02
	<p>Effective Presentation Strategies: Defining Purpose, Analyzing Audience, Location and Event, Gathering, Selecting & Arranging Material, structuring a Presentation, Making Effective Slides, Types of Presentations Aids, Closing a Presentation, Platform skills</p> <p>Group Presentations: Sharing Responsibility in a Team, Building the contents and visuals together, Transition Phases</p>	
5	INTERPERSONAL SKILLS	08
	<p>Interpersonal Skills: Emotional Intelligence, Leadership & Motivation, Conflict Management & Negotiation, Time Management, Assertiveness, Decision Making</p> <p>Start-up Skills: Financial Literacy, Risk Assessment, Data Analysis (e.g. Consumer Behaviour, Market Trends, etc.)</p>	
6	CORPORATE ETHICS	02
	<p>Intellectual Property Rights: Copyrights, Trademarks, Patents, Industrial Designs, Geographical Indications, Integrated Circuits, Trade Secrets (Undisclosed Information)</p> <p>Case Studies: Cases related to Business/ Corporate Ethics</p>	

List of assignments: (In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)

Sr. No.	Title of Experiment
1	Cover Letter and Resume
2	Short Proposal
3	Meeting Documentation
4	Writing a Technical Paper/ Analyzing a Published Technical Paper
5	Writing a SOP
6	IPR
7	Interpersonal Skills
Note:	
1	The Main Body of the project/book report should contain minimum 25 pages (excluding Front and Back matter).

2	The group size for the final report presentation should not be less than 5 students or exceed 7 students.
3	There will be an end–semester presentation based on the book report.
Assessment:	
Term Work:	
1	Term work shall consist of minimum 8 experiments.
2	The distribution of marks for term work shall be as follows: Assignment : 10 Marks Attendance : 5 Marks Presentation slides : 5 Marks Book Report (hard copy) : 5 Marks
3	The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.
Internal oral: Oral Examination will be based on a GD & the Project/Book Report presentation.	
	Group Discussion : 10 marks Project Presentation : 10 Marks Group Dynamics : 5 Marks
Books Recommended: Textbooks and Reference books	
1	Arms, V. M. (2005). <i>Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition</i> . Boston, MA: McGraw-Hill.
2	Bovée, C. L., &Thill, J. V. (2021). <i>Business communication today</i> . Upper Saddle River, NJ: Pearson.
3	Butterfield, J. (2017). <i>Verbal communication: Soft skills for a digital workplace</i> . Boston, MA: Cengage Learning.
4	Masters, L. A., Wallace, H. R., & Harwood, L. (2011). <i>Personal development for life and work</i> . Mason: South-Western Cengage Learning.
5	Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). <i>Organizational behaviour</i> . Harlow, England: Pearson.
6	Meenakshi Raman, Sangeeta Sharma (2004) <i>Technical Communication, Principles and Practice</i> . Oxford University Press
7	Archana Ram (2018) <i>Place Mentor, Tests of Aptitude for Placement Readiness</i> . Oxford University Press
8	Sanjay Kumar &PushpLata (2018). <i>Communication Skills a workbook</i> , New Delhi: Oxford University Press.

Course Code	Course Name	Credits
CSM501	Mini Project 2A	02

Objectives	
1	To understand and identify the problem
2	To apply basic engineering fundamentals and attempt to find solutions to the problems.
3	Identify, analyze, formulate and handle programming projects with a comprehensive and systematic approach
4	To develop communication skills and improve teamwork amongst group members and inculcate the process of self-learning and research.
Outcome: Learner will be able to...	
1	Identify societal/research/innovation/entrepreneurship problems through appropriate literature surveys
2	Identify Methodology for solving above problem and apply engineering knowledge and skills to solve it
3	Validate, Verify the results using test cases/benchmark data/theoretical/inferences/experiments/simulations
4	Analyze and evaluate the impact of solution/product/research/innovation /entrepreneurship towards societal/environmental/sustainable development
5	Use standard norms of engineering practices and project management principles during project work
6	Communicate through technical report writing and oral presentation. <ul style="list-style-type: none"> ● The work may result in research/white paper/ article/blog writing and publication ● The work may result in business plan for entrepreneurship product created ● The work may result in patent filing.
7	Gain technical competency towards participation in Competitions, Hackathons, etc.
8	Demonstrate capabilities of self-learning, leading to lifelong learning.
9	Develop interpersonal skills to work as a member of a group or as leader
Guidelines for Mini Project	
1	Mini project may be carried out in one or more form of following: Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification/development, simulation, software development, integration of software (frontend-backend) and hardware, statistical data analysis, creating awareness in society/environment etc.
2	Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
3	Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor or head of department/internal committee of faculties.
4	Students shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini projects.
5	A logbook may be prepared by each group, wherein the group can record weekly work progress, guide/supervisor can verify and record notes/comments.
6	Faculty supervisors may give inputs to students during mini project activity; however, focus shall be on self-learning.
7	Students under the guidance of faculty supervisor shall convert the best solution into a working model using various components of their domain areas and demonstrate.
8	The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai. Software requirement specification (SRS) documents, research papers, competition certificates may be submitted as part of

	annexure to the report.
9	With the focus on self-learning, innovation, addressing societal/research/innovation problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Mini Project 2 in semesters V and VI.
10	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above, gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.

Term Work	
The review/ progress monitoring committee shall be constituted by the heads of departments of each institute. The progress of the mini project to be evaluated on a continuous basis, based on the SRS document submitted. minimum two reviews in each semester.	
In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.	
Distribution of Term work marks for both semesters shall be as below:	
	Marks 25
1	Marks awarded by guide/supervisor based on logbook
2	Marks awarded by review committee
3	Quality of Project report
	10
	10
	05
Review / progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines	
One-year project:	
1	In one-year project (sem V and VI), first semester the entire theoretical solution shall be made ready, including components/system selection and cost analysis. Two reviews will be conducted based on a presentation given by a student group. <ul style="list-style-type: none"> <input type="checkbox"/> First shall be for finalization of problem <input type="checkbox"/> Second shall be on finalization of proposed solution of problem.
2	In the second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester. <ul style="list-style-type: none"> <input type="checkbox"/> First review is based on readiness of building working prototype to be conducted. <input type="checkbox"/> Second review shall be based on poster presentation cum demonstration of working model in the last month of the said semester.
Half-year project:	
1	In this case in one semester students' group shall complete project in all aspects including, <ul style="list-style-type: none"> <input type="checkbox"/> Identification of need/problem <input type="checkbox"/> Proposed final solution <input type="checkbox"/> Procurement of components/systems <input type="checkbox"/> Building prototype and testing
2	Two reviews will be conducted for continuous assessment, <ul style="list-style-type: none"> <input type="checkbox"/> First shall be for finalization of problem and proposed solution <input type="checkbox"/> Second shall be for implementation and testing of solution.

Mini Project shall be assessed based on following points	
1	Clarity of problem and quality of literature Survey for problem identification
2	Requirement Gathering via SRS/ Feasibility Study
3	Completeness of methodology implemented
4	Design, Analysis and Further Plan
5	Novelty, Originality or Innovativeness of project
6	Societal / Research impact
7	Effective use of skill set : Standard engineering practices and Project management standard
8	Contribution of an individual's as member or leader
9	Clarity in written and oral communication
10	Verification and validation of the solution/ Test Cases
11	Full functioning of working model as per stated requirements
12	Technical writing /competition/hackathon outcome being met

In one year project (sem V and VI), first semester evaluation may be based on first 10 criteria and remaining may be used for second semester evaluation of performance of students in mini projects.

In case of half year projects (completing in V sem) all criteria in generic may be considered for evaluation of performance of students in mini projects.

Guidelines for Assessment of Mini Project Practical/Oral Examination:	
1	Report should be prepared as per the guidelines issued by the University of Mumbai.
2	Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by the head of Institution.
3	Students shall be motivated to publish a paper/participate in competition based on the work in Conferences/students competitions.