



Society of St. Francis Xavier, Pilar's  
**Fr. Conceicao Rodrigues College of Engineering**  
Fr. Agnel Ashram, Bandstand, Bandra (W), Mumbai – 400 050  
(Autonomous College affiliated to University of Mumbai)



# CURRICULUM STRUCTURE

## THIRD YEAR UG: B.E.

### COMPUTER ENGINEERING

REVISION: FRCRCE-1-24

Effective from Academic Year 2024-25  
Board of Studies Approval:08/03/2024  
Academic Council Approval:16/03/2024



Dr. DEEPAK BHOIR  
Dean Academics

Dr. Sujata P. Deshmukh  
HOD (Computer)

DR. SURENDRA RATHOD  
Principal



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## **Preamble:**

Greetings and congratulations to all the education partners Fr Conceicao Rodrigues College of Engineering for getting autonomous status to the college from the year 2024-25. University Grant Commission vide letter No. F. 2-10/2023(AC-Policy) dated 23<sup>rd</sup> Nov 2023 conferred the autonomous status to Fr. Conceicao Rodrigues College of Engineering, Fr. Agnel Ashram, Bandstand, Bandra (West), Mumbai 400050 affiliated to University of Mumbai for a period of 10 years from the academic year 2024-2025 to 2033-2034 as per clause 7.5 of the UGC (Conferment of Autonomous Status Upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations, 2023. We look towards autonomy as a great opportunity to design and implement curriculum sensitive to needs of Learner, Indian Society and Industries.

The National Education Policy (NEP), 2020 suggests that students must actively engage with the practical side of their learning as part of a holistic education to further improve their employability. *Fr. CRCE has taken a strategic decision to implement revised assessment scheme to support more experiential learning and continuous assessment in the form of ISE-1, MSE, ISE-2 and ESE to be taken by the college. The curriculum content and credit structure is maintained same as prescribed by University of Mumbai for third year students of academic year 2024-25.*

## **Honours and Minor Degree Eligibility Criteria for Students:**

- i. Following is the eligibility criteria for students opting the Honours/ Minor Degree program:
  - a. Students with no backlog in semester I, II, and III
  - b. The CGPI (based on semester I, II, and III) of the students must be 6.75 and above
  - c. For direct second year (DSE) admitted students - No backlog in semester III and CGPI must be 6.75 and above
- ii) Each eligible student can opt for maximum one Honour's or one Minor Programs at any time.
- iii) However, it is optional for learners to take Honours/Minor degree program.
- iv) The Honours/ Minor degree program can be opted only during regular engineering studies
- v) The student have to complete the Honours/ Minor degree program in stipulated four semesters only.

## **Note:**

1. Technical support team for registration of Academic Bank of Credits (ABC), registration of elective/optional courses, registration of online courses, registration for degree options etc. under supervision of Dean Academics.



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## SEMESTERWISE CURRICULUM STRUCTURE

### THIRD YEAR Computer Engineering Program:

SEM-V									
Course Code	Course Name		Contact Hours	Examination Marks					Credits
				ISE 1	MS E	ISE 2	ES E	Total	Total
CSC 501	Theoretical Computer Science	TH	3	20	30	20	30	100	3
		TU	1	10	--	15	-	25	1
CSC 502	Software Engineering	TH	3	20	30	20	30	100	3
CSC 503	Computer Network	TH	3	20	30	20	30	100	3
CSC 504	Data Warehousing & Mining	TH	3	20	30	20	30	100	3
CSDLO501x	Department Level Optional Course - I	TH	3	20	30	20	30	100	3
CSL501	Software Engineering Lab	PR	2	25	-	25	--	50	1
CSL502	Computer Network Lab	PR	2	25	-	25	--	50	1
CSL503	Data Warehousing and Mining Lab	PR	2	25	-	25	--	50	1
CSL504	Professional Communication and Ethics II	PR	4	25	-	25	-	50	2
CSM501	Mini Project: 2A	PR	4	15	-	15	20	50	2
<b>Total</b>			<b>TH:TU:PR :TOT 15:1:14:30</b>					<b>775</b>	<b>23</b>

#### Department Level Optional Courses:

Department Level Optional Course - I	
CSDLO5011	Probabilistic Graphical Models
CSDLO5012	Internet Programming
CSDLO5013	Advanced Database Management System

SEM-VI									
Course Code	Course Name		Contact Hours	Examination Marks					Credits
				ISE1	MSE	ISE2	ESE	Total	Total
CSC 601	System Programming & Compiler Construction	TH	3	20	30	20	30	100	3
CSC 602	Cryptography & System Security	TH	3	20	30	20	30	100	3
CSC 603	Mobile Computing	TH	3	20	30	20	30	100	3
CSC 604	Artificial Intelligence	TH	3	20	30	20	30	100	3
CSDLO601x	Department Level Optional Course- 2	TH	3	20	30	20	30	100	3
CSL 601	System Programming & Compiler Construction Lab	PR	2	25	-	25	--	50	1
CSL 602	Cryptography & System Security Lab	PR	2	10	-	15	--	25	1
CSL 603	Mobile Computing Lab	PR	2	10	-	15	--	25	1
CSL 604	Artificial Intelligence Lab	PR	2	25	-	25	--	50	1
CSL 605	Skill-based Laboratory	PR	4	25	-	50	--	75	2
CSM 601	Mini Project 2B	PR	4	15	-	15	20	50	2
<b>Total</b>			<b>TH:PR 15:16=31</b>					<b>775</b>	<b>23</b>

#### Department Level Optional Courses:

Department Level Optional Course -II	
CSDLO6011	Internet of Things
CSDLO6012	Digital Signal & Image Processing
CSDLO6013	Quantitative Analysis



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**Honors Degree Offered to CE Students from SEM-V to SEM-VIII:**

**A. Name: Internet of Things**

1. SEM-V: HIoTC501: IoT Sensor Technologies
2. SEM VI: HIoTC601: IoT System Design
3. SEM VII: HIoTC701: Dynamic Paradigm in IoT
4. SEM VII: HIoTSBL701: Interfacing & Programming with IoT Lab (SBL)
5. SEM VIII: HIoTC801: Industrial IoT

**B. Name Artificial Intelligence and Machine Learning**

1. SEM-V: HAIMLC501: Mathematics for AI & ML
2. SEM VI: HAIMLC601: Game Theory using AI & ML
3. SEM VII: HAIMLC701: AI & ML in Healthcare
4. SEM VII: HAIMLSBL701: AI & ML in Healthcare: Lab
5. SEM VIII: HAIMLC801: Text, Web and Social Media Analytics

**C. Name: Data Science**

1. SEM-V: HDSC501: Mathematics for Data Science
2. SEM VI: HDSC601: Statistical Learning for Data Science
3. SEM VII: HDSC701: Data Science for Health and Social Care
4. SEM VII: HDSSBL701: Data Science for Health and Social Care Lab
5. SEM VIII: HDSC801: Text, Web and Social Media Analytics

**D. Name: Blockchain**

1. SEM-V: HBCC501: Bit coin and Crypto currency
2. SEM VI: HBCC601: Blockchain Platform
3. SEM VII: HBCC701: Blockchain Development
4. SEM VII: HBCSBL701: Private Blockchain Setup Lab (SBL)
5. SEM VIII: HBCC801: DeFi (Decentralized Finance)

**E. Name: Cyber Security**

1. SEM-V: HCSC501: Ethical Hacking
2. SEM VI: HCSC601: Digital Forensic
3. SEM VII: HCSC701: Security Information Management
4. SEM VII: HCSSBL601: Vulnerability Assessment Penetration Testing (VAPT) Lab
5. SEM VIII: HCSC801: Application Security

**Minors Degree Offered to CE Students from SEM-V to SEM-VIII:**

**A. Name: Robotics**

1. SEM-V: HRC501: Industrial Robotics
2. SEM VI: HRC601: Mechatronics & IoT
3. SEM VII: HRC701: Artificial Intelligence & Data Analysis
4. SEM VII: HRSBL701: Robotics and Automation Lab
5. SEM VIII: HRC801: Autonomous Vehicle Systems

**B. Name: 3D Printing**

1. SEM-V: HC3DP501: Introduction to CAD
2. SEM VI: HC3DP601: 3D Printing: Introduction & Processes
3. SEM VII: HC3DP701: Applications of 3D Printing
4. SEM VIII: H3DPSBL801: Skill Based Lab– Digital Fabrication
5. SEM VIII: HC3DP801: 3D Printing in Medical Technology



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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CSC 501	Theoretical Computer Science	3	1	--	3	1	--	4
		<b>Examination Scheme</b>						
			<b>ISE1</b>	<b>MSE</b>	<b>ISE2</b>	<b>ESE</b>		<b>Total</b>
		<b>TH</b>	<b>20</b>	<b>30</b>	<b>20</b>	<b>100 (30% weightage)</b>		<b>100</b>
	<b>TU</b>	<b>10</b>		<b>15</b>			<b>25</b>	

Pre-requisite Course Codes	CSC301	
<b>Course Outcomes</b>	CO1	Identify the concepts Theoretical Computer Science, difference and equivalence of DFA and NFA, languages described by finite automata.
	CO2	Infer the equivalence of languages described by regular expressions.
	CO3	Devise regular, context free grammars while recognizing the strings and tokens.
	CO4	Design pushdown automata to recognize the language.
	CO5	Develop an understanding of computation through Turing Machine.
	CO6	Acquire fundamental understanding of decidability and undecidability.

Module No.	Unit No.	Topics	Ref.	Hrs.
<b>1</b>	<b>1.0</b>	<b>Basic Concepts and Finite Automata</b>	1,2,3	<b>09</b>
	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 $\epsilon$ -transitions, NFA to DFA Conversion, Minimization of DFA, FSM with output: Moore and Mealy machines, Applications and limitations of FA.		
<b>2</b>	<b>2.0</b>	<b>Regular Expressions and Languages</b>	2,3	<b>07</b>
	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.		



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	<b>3.0</b>	<b>Grammars</b>	1,4	<b>08</b>
<b>3</b>	<b>3.1</b>	Grammars and Chomsky hierarchy		
	<b>3.2</b>	Regular Grammar (RG), Equivalence of Left and Right linear grammar, Equivalence of RG and FA.		
	<b>3.3</b>	<b>Context Free Grammars (CFG)</b> 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.		
<b>4</b>		<b>Pushdown Automata (PDA)</b>	1,2,3	<b>04</b>
	<b>4.1</b>	Definition, Language of PDA, PDA as generator, decider and acceptor of CFG, Deterministic PDA, Non-Deterministic PDA, Application of PDA.		
<b>5</b>		<b>Turing Machine (TM)</b>	4,5	<b>09</b>
	<b>5.2</b>	Definition, Design of TM as generator, decider and acceptor, Variants of TM: Multitrack, Multitape, Universal TM, Applications, Power and Limitations of TMs.		
<b>6</b>		<b>Undecidability</b>	4,5	<b>02</b>
	<b>6.1</b>	Decidability and Undecidability, Recursive and Recursively Enumerable Languages, Halting Problem, Rice's Theorem, Post Correspondence Problem.		
<b>Total</b>				<b>39</b>

**Recommended Books:**

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

**Useful Links:**

1. [www.jflap.org](http://www.jflap.org)
2. <https://nptel.ac.in/courses/106/104/106104028/>
3. <https://nptel.ac.in/courses/106/104/106104148/>

**Course Assessment:**

**Theory:**

**ISE-1:** Activity: Quiz/Assignments 20 Marks

**ISE-2:** Activity: Article Discussion/Quiz/Assignments/Seminar

**MSE:** Two hours 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks (30% weightage) written examination based on entire syllabus

**Tutorials: (6 Nos.)**



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**ISE1:**

15 marks based on first three tutorials as per the predefined rubrics

**ISE2:**

10 marks based on remaining three tutorials as per the predefined rubrics



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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned				
		L	T	P	-	L	T	P	Total
CSC 502	Software Engineering	3	--	--	-	3	--	--	3
		<b>Examination Scheme</b>							
		ISE1		MSE		ISE2	ESE		Total
		20		30		20	100 (30% weightage)		100

Pre-requisite Course Codes	CSL304, CSL405	
<b>Course Outcomes</b>	CO1	Identify requirements of the software & assess the process models.
	CO2	Plan, schedule and track the progress of the projects.
	CO3	Design the software projects.
	CO4	Apply software testing techniques to selected case study.
	CO5	Identify risks, manage the change to assure quality in software projects.

Module No.	Unit No.	Topics	Ref.	Hrs.
<b>1</b>		<b>Introduction To Software Engineering and Process Models</b>	1,2	<b>7</b>
	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		
<b>2</b>		<b>Software Requirements Analysis and Modelling</b>	1,2,5	<b>4</b>
	2.1	Requirement Engineering, Requirement Modelling, Data flow diagram, Scenario based model		
	2.2	Software Requirement Specification document format (IEEE)		
<b>3</b>		<b>Software Estimation Metrics</b>	1,2	<b>7</b>
	3.1	Software Metrics, Software Project Estimation (LOC, FP, COCOMO II)		
	3.2	Project Scheduling & Tracking		
<b>4</b>		<b>Software Design</b>	1,2,6	<b>7</b>
	4.1	Design Principles & Concepts		
	4.2	Effective Modular Design, Cohesion and Coupling, Architectural design		
<b>5</b>		<b>Software Testing</b>	5,6	<b>7</b>
	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		
<b>6</b>		<b>Software Configuration Management, Quality Assurance and Maintenance</b>	1,2,6	<b>7</b>
	6.1	Risk Analysis & Management: Risk Mitigation, Monitoring and Management Plan (RMMM).		





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	<b>6.2</b>	Quality Concepts and Software Quality assurance Metrics, Formal Technical Reviews, Software Reliability		
	<b>6.3</b>	The Software Configuration Management (SCM), Version Control and Change Control		
			<b>Total</b>	<b>39</b>

**Recommended Books:**

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

**Useful Links**

1. <https://nptel.ac.in/courses/106/105/106105182/>
2. [https://onlinecourses.nptel.ac.in/noc19\\_cs69/preview](https://onlinecourses.nptel.ac.in/noc19_cs69/preview)
3. <https://www.mooc-list.com/course/software-engineering-introduction-edx>

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Quiz/Assignments 20 Marks

**ISE-2:**

Activity: Article Discussion/Quiz/Assignments/Analyse case studies or scenarios related to the Subject

**MSE:**

Two hours 30 Marks written examination based on 50% syllabus

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Three hours 100 Marks (30% weightage) written examination based on entire syllabus



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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned				
		L	T	P	L	T	P	Total	
CSC 503	Computer Network	3	--	--		3	--	--	3
		<b>Examination Scheme</b>							
		ISE1		MSE		ISE2	ESE		Total
		20		30		20	100 (30% weightage)		100

Pre-requisite Course Codes	None	
<b>Course Outcomes</b>	CO1	Enumerate the functions of the different layers of Network Software Models.
	CO2	Identify the characteristics of network devices and media used to design network.
	CO3	Explore different design issues and protocol of Data link Layer
	CO4	Design a network using IP addressing and subnetting.
	CO5	Explore protocols of transport layer and application layer

Module No.	Unit No.	Topics	Ref.	Hrs.
1		<b>Introduction to Networking</b>	1,2	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		<b>Physical Layer</b>	1,2	3
	2.1	Introduction to Communication Electromagnetic Spectrum		
	2.2	Guided Transmission Media: Twisted pair, Coaxial, Fiber optics.		
3		<b>Data Link Layer</b>	1,2	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)		
	3.2	<b>Medium Access Control sublayer</b> Channel Allocation problem, Multiple access Protocol (Aloha, Carrier Sense Multiple Access (CSMA/CD)		
4		<b>Network layer</b>	1,2	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	<b>Routing algorithms:</b> Shortest Path (Dijkstra's), Link state routing, Distance Vector Routing		
	4.3	<b>Protocols</b> - ARP, RARP, ICMP, IGMP		



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	<b>4.4</b>	<b>Congestion control algorithms:</b> Open loop congestion control, Closed loop congestion control, QoS parameters, Token & Leaky bucket algorithms		
<b>5</b>		<b>Transport Layer</b>	1,2	6
	<b>5.1</b>	<b>The Transport Service:</b> Transport service primitives, Berkeley Sockets, Connection management (Handshake), UDP, TCP, TCP state transition, TCP timers		
	<b>5.2</b>	TCP Flow control (sliding Window), TCP Congestion Control: Slow Start		
<b>6</b>		<b>Application Layer</b>	1,2	6
	<b>6.1</b>	DNS: Name Space, Resource Record and Types of Name Server. HTTP, SMTP, Telnet, FTP, DHCP		
<b>Total</b>				<b>39</b>

**Recommended Books:**

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

**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 Assessment:**

**Theory:**

**ISE-1:**

Activity: Quiz/Assignments 20 Marks

**ISE-2:**

Activity: Article Discussion/Quiz/Assignments/ Analyse case studies or scenarios related to the Subject

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned				
		L	T	P	L	T	P	Total	
CSC 504	Data Warehousing and Mining	3	--	--		3	--	--	3
		<b>Examination Scheme</b>							
		ISE1		MSE		ISE2	ESE		Total
		20		30		20	100 (30% weightage)		100

Pre-requisite Course Codes	CSC403	
<b>Course Outcomes</b>	CO1	Explain the need of Data warehouse and Mining Principles
	CO2	Design a Data-warehouse using Dimension Modelling and apply OLAP operations
	CO3	Select appropriate Data Pre-processing Technique and apply appropriate Data Mining Algorithm to the given Real World Problem.
	CO4	Compare and Evaluate the different Data Mining techniques like Regression, classification, Clustering and Association Rule Mining.
	CO5	Explain the concepts of Web Mining

Module No.	Unit No.	Topics	Ref.	Hrs.
1		<b>Data Warehousing Fundamentals</b>		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.	1,2	
2		<b>Introduction to Data Mining, Data Exploration and Data Pre-processing</b>	1,2	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		<b>Classification</b>	1,2	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		<b>Clustering</b>	1,2	6
		Types of data in Cluster analysis, Partitioning Methods ( <i>k</i> -Means, <i>k</i> -Medoids), Hierarchical Methods (Agglomerative, Divisive).		
5		<b>Mining frequent patterns and associations</b>	1,2	6
		Market Basket Analysis, Frequent Item sets, Closed Item sets, and Association Rule, Frequent Pattern Mining, Apriori Algorithm,		



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		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.		
<b>6</b>		<b>Web Mining</b>	1,2	5
		Introduction, Web Content Mining: Crawlers, Harvest System, Virtual Web View, Personalization, Web Structure Mining: Page Rank, Clever, Web Usage Mining.		
<b>Total</b>			<b>39</b>	

**Recommended Books:**

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

**Useful Links**

1. [https://onlinecourses.nptel.ac.in/noc20\\_cs12/preview](https://onlinecourses.nptel.ac.in/noc20_cs12/preview)
2. <https://www.coursera.org/specializations/data-mining>

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Quiz/Assignments 20 Marks

**ISE-2:**

Activity: Article Discussion/Quiz/Assignments/Analyse case studies or scenarios related to mining Tools

**MSE:**

Two hours 30 Marks written examination based on 50% syllabus

**ESE:**

Three hours 100 Marks (30% weightage) written examination based on entire syllabus



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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned				
		L	T	P	L	T	P	Total	
CSDLO 5011	Probabilistic Graphical Models	3	--	--		3	--	--	3
		<b>Examination Scheme</b>							
		ISE1		MSE		ISE2	ESE		Total
		20		30		20	100 (30% weightage)		100

Pre-requisite Course Codes	CSC301, CSC302	
<b>Course Outcomes</b>	CO1	Understand basic concepts of probabilistic graphical modelling.
	CO2	Model and extract inference from various graphical models like Bayesian Networks, Markov Models
	CO3	Perform learning and take actions and decisions using probabilistic graphical models
	CO4	Represent real world problems using graphical models; design inference algorithms; and learn the structure of the graphical model from data.
	CO5	Design real life applications using probabilistic graphical models.

Module No.	Unit No.	Topics	Ref.	Hrs
1		<b>Introduction to Probabilistic Graphical Modelling</b>	1,4,5	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		<b>Bayesian Network Model and Inference</b>	1,2,3	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.		



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<b>3</b>		<b>Markov Network Model and Inference</b>	1,5	<b>8</b>
	<b>3.1</b>	<b>Undirected Graph Model:</b> 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		
	<b>3.2</b>	Exact inference variable elimination: Graph Theoretic Analysis for Variable Elimination, Conditioning		
<b>4</b>		<b>Hidden Markov Model and Inference</b>	1,4,5	<b>6</b>
	<b>4.1</b>	<b>Template Based Graph Model:</b> HMM- Temporal Models, Template Variables and Template Factors, Directed Probabilistic Models, Undirected Representation, Structural Uncertainty.		
<b>5</b>		<b>Learning and Taking Actions and Decisions</b>	1,2,4	<b>6</b>
	<b>5.1</b>	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		
	<b>5.2</b>	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		
<b>6</b>		<b>Applications</b>	1,3,4	<b>4</b>
	<b>6.1</b>	Application of Bayesian Networks: Classification, Forecasting, Decision Making		
	<b>6.2</b>	Application of Markov Models: Cost Effectiveness Analysis, Relational Markov Model and its Applications, Application in Portfolio Optimization		
	<b>6.3</b>	Application of HMM: Speech Recognition, Part of Speech Tagging, Bioinformatics.		
<b>Total</b>				<b>39</b>

**Recommended Books:**

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, 1st edition, 2011.
3. Finn Jensen and Thomas Nielsen, "Bayesian Networks and Decision Graphs (Information Science and Statistics)", 2nd Edition, Springer, 2007
4. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
5. Martin Wainwright and Michael Jordan, M., "Graphical Models, Exponential Families, and Variational Inference", 2008





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### 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](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](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\\_\(Exercises\)](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](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>
12. <https://web.ece.ucsb.edu/Faculty/Rabiner/ece259/Reprints/tutorial%20on%20hmm%20and%20applications.pdf>
13. [https://mi.eng.cam.ac.uk/~mjfg/mjfg\\_NOW.pdf](https://mi.eng.cam.ac.uk/~mjfg/mjfg_NOW.pdf)
14. <http://bioinfo.au.tsinghua.edu.cn/member/jgu/pgm/materials/Chapter3-LocalProbabilisticModels.pdf>

### Suggested List of Experiments:

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 Assessment:

#### **Theory:**

#### **ISE-1:**

Activity: Quiz/Assignments 20 Marks

#### **ISE-2:**

Activity: Article Discussion/Quiz/Assignments 20 Marks

#### **MSE:**

Two hours 30 Marks written examination based on 50% syllabus

#### **ESE:**

Three hours 100 Marks (30% weightage) written examination based on entire syllabus





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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned				
		L	T	P	L	T	P	Total	
CSDLO 5012	Internet Programming	3	--	--		3	--	--	3
		<b>Examination Scheme</b>							
		ISE1		MSE		ISE2	ESE		Total
		20		30		20	100 (30% weightage)		100

Pre-requisite Course Codes	CSC303, CSL304, CSL405	
<b>Course Outcomes</b>	CO1	Design interactive web pages using HTML and CSS for a given application.
	CO2	Construct a responsive web site using JavaScript and database connectivity through JDBC
	CO3	Construct Rich Internet Applications using Ajax and various web extensions.
	CO4	Develop web applications using ReactJs

Module No.	Unit No.	Topics	Ref.	Hrs.
1		<b>Introduction to Web Technology</b>	1,2,3,6,7	10
	1.1	<b>Web Essentials:</b> Clients, Servers and Communication, The Internet, Basic Internet protocols, World wide web, HTTP Request Message, HTTP Response Message, Web Clients, Web Servers <b>HTML5</b> – fundamental syntax and semantics, Tables, Lists, Image, HTML5 control elements, Semantic elements, Drag and Drop, Audio – Video controls <b>CSS3</b> – Inline, embedded and external style sheets – Rule cascading, Inheritance, Backgrounds, Border Images, Colors, Shadows, Text, Transformations, Transitions, Animation, Basics of Bootstrap.		
2		<b>Front End Development</b>	1,2,3,6,7,8,9	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		<b>Back End Development</b>	1,2,3,6,7	7
	3.1	<b>Servlets:</b> Java Servlet Architecture, Servlet Life Cycle, Form GET and POST actions, Session Handling, Understanding Cookies, Installing and Configuring Apache Tomcat Web Server <b>Database Connectivity:</b> JDBC perspectives, JDBC program example <b>JSP:</b> Understanding Java Server Pages, JSP Standard Tag Library (JSTL), Creating HTML forms by embedding JSP code.		
4		<b>Rich Internet Application (RIA)</b>	1,2,3,4,6,7	4
	4.1	Characteristics of RIA,		



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		<b>Introduction to AJAX:</b> AJAX design basics, AJAX vs Traditional Approach, Rich User Interface using Ajax, jQuery framework with AJAX.		
<b>5</b>		<b>Web Extension: PHP and XML</b>	3,10,11	<b>6</b>
	<b>5.1</b>	XML –DTD (Document Type Definition), XML Schema, Document Object Model, Presenting XML, Using XML Parsers: DOM and SAX, XSL-eXtensible Stylesheet Language		
	<b>5.2</b>	<b>Introduction to PHP-</b> Data types, control structures, built in functions, building web applications using PHP- tracking users, PHP and MySQL database connectivity with example.		
<b>6</b>		<b>React js</b>	5	<b>5</b>
	<b>6.1</b>	Introduction, React features, App “Hello World” Application, Introduction to JSX, Simple Application using JSX		
<b>Total</b>				<b>39</b>

**Recommended Books:**

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](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
6. Harvey & Paul Deitel& Associates, Harvey Deitel and Abbey Deitel, Internet and World Wide Web - How To Program, Fifth Edition, Pearson Education, 2011.
7. Achyut S Godbole and Atul Kahate, —Web Technologies, Second Edition, Tata McGraw Hill, 2012.
8. Thomas A Powell, Fritz Schneider, —JavaScript: The Complete Reference, Third Edition, Tata McGraw Hill, 2013
9. David Flanagan, —JavaScript: The Definitive Guide, Sixth Edition, O'Reilly Media, 2011
10. Steven Holzner —The Complete Reference - PHP, Tata McGraw Hill, 2008
11. Mike McGrath—PHP & MySQL in easy Steps, Tata McGraw Hill, 2012.

**Useful Links**

1. <https://books.goalkicker.com/ReactJSBook/>
2. <https://www.guru99.com/reactjs-tutorial.html>
3. [www.nptelvideos.in](http://www.nptelvideos.in)
4. [www.w3schools.com](http://www.w3schools.com)
5. <https://spoken-tutorial.org/>
6. [www.coursera.org](http://www.coursera.org)

**The following list can be used as a guideline for mini project:**



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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 Assessment:**

**Theory:**

**ISE-1:**

Activity: Quiz/Assignments 20 Marks

**ISE-2:**

Activity: Article Discussion/Quiz/Assignments

**MSE:**

Two hours 30 Marks written examination based on 50% syllabus

**ESE:**

Three hours 100 Marks (30% weightage) written examination based on entire syllabus



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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned				
		L	T	P	L	T	P	Total	
CSDLO 5013	Advance Database Management System	3	--	--		3	--	--	3
		<b>Examination Scheme</b>							
		ISE1		MSE		ISE2	ESE		Total
		20		30		20	100 (30% weightage)		100

Pre-requisite Course Codes	CSC403	
<b>Course Outcomes</b>	CO1	Design distributed database using the various techniques for query processing
	CO2	Measure query cost and perform distributed transaction management
	CO3	Organize the data using XML and JSON database for better interoperability
	CO4	Compare different types of NoSQL databases
	CO5	Formulate NoSQL queries using MongoDB
	CO6	Describe various trends in advance databases through temporal, graph based and spatial based databases

Module No.	Unit No.	Topics	Ref.	Hrs.
1		<b>Distributed Databases</b>	3	3
	1.1	Introduction, Distributed DBMS Architecture, Data Fragmentation, Replication and Allocation Techniques for Distributed Database Design.		
2		<b>Distributed Database Handling</b>	1,2,3	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		<b>Data interoperability – XML and JSON</b>	1,5	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		<b>NoSQL Distribution Model</b>	4,8	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.		



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<b>5</b>		<b>NoSQL using MongoDB</b>	4,8,11	6
	<b>5.1</b>	NoSQL using MongoDB: Introduction to MongoDB Shell, Running the MongoDB shell, MongoDB client, Basic operations with MongoDB shell, Basic Data Types, Arrays, Embedded Documents		
	<b>5.2</b>	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		
<b>6</b>		<b>Trends in advance databases</b>	1,2	6
	6.1	<b>Temporal database:</b> Concepts, time representation, time dimension, incorporating time in relational databases.		
	6.2	<b>Graph Database:</b> Introduction, Features, Transactions, consistency, Availability, Querying, Case Study Neo4J		
	6.3	<b>Spatial database:</b> Introduction, data types, models, operators and queries		
<b>Total</b>				<b>39</b>

**Recommended Books:**

1. Korth, Siberchatz, Sudarshan, "Database System Concepts", 6thEdition, McGraw Hill
2. Elmasri and Navathe, "Fundamentals of Database Systems", 5thEdition, Pearson Education
3. Ozsu, M. Tamer, Valduriez, Patrick, "Principles of distributed database systems", 3rd 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, après Inc.
6. Peter Rob and Carlos Coronel, Database Systems Design, Implementation and Management, Thomson Learning, 5thEdition.
7. Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.
8. Adam Fowler, NoSQL for dummies, John Wiley & Sons, Inc.
9. Shashank Tiwari, Professional NOSQL, John Willy & Sons. Inc
10. Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH
11. MongoDB Manual: <https://docs.mongodb.com/manual>

**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>

**Course Assessment:**

**Theory:**

**ISE-1:**Activity: Quiz/Assignments 20 Marks

**ISE-2:** Activity: Article Discussion/Quiz/Assignments

**MSE:** Two hours 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks (30% weightage) written examination based on entire syllabus



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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CSL 501	Software Engineering Lab	--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	25	--	25	--	50	

<b>Pre-requisite Course Codes</b>	CSL304, CSL405	
<b>Course Outcomes</b>	CO1	Identify requirements and apply software process model to selected case study.
	CO2	Develop architectural models for the selected case study.
	CO3	Use computer-aided software engineering (CASE) tools.

Module No.	Unit No.	Topics
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.

**Course Assessment:**

**Lab:**

**ISE:**

- ISE-1** Quizzes/Assignments/Paper Presentation/Article Discussion  
Quizzes/Assignments based on 50% experiments
- ISE-2** Quizzes/Assignments/Paper Presentation/Article Discussion  
Quizzes/Assignments based on 50% experiments



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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CSL 502	Computer Network Lab	--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	25	--	25	--	50	

Pre-requisite Course Codes	None	
Course Outcomes	CO1	Enumerate the functions of the different layers of Network Software Models.
	CO2	Identify the characteristics of network devices and media used to design network.
	CO3	Explore different design issues and protocol of Data link Layer
	CO4	Design a network using IP addressing and subnetting.
	CO5	Explore protocols of transport layer and application layer

Module No.	Unit No.	Topics
1		Study of RJ45 and CAT6 Cabling and connection using crimping tool.
2		Use basic networking commands in Linux (ping, tracer, 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: 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		Set up multiple IP addresses on a single LAN. Using nstat and route commands of Linux, do the following: View current routing table Add and delete routes Change default gateway 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

**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>





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**Course Assessment:**

**Lab:**

**ISE:**

**ISE-1** Quizzes/Assignments/Paper Presentation/Article Discussion  
Quizzes/Assignments based on 50% experiments

**ISE-2** Quizzes/Assignments/Paper Presentation/Article Discussion  
Quizzes/Assignments based on 50% experiments





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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CSL 503	Data Warehousing and Mining Lab	--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	25	--	25	--	50	

<b>Pre-requisite Course Codes</b>	CSL304, CSL405	
<b>Course Outcomes</b>	CO1	Design data warehouse and perform various OLAP operations.
	CO2	Implement data mining algorithms like classification.
	CO3	Implement clustering algorithms on a given set of data sample.
	CO4	Implement Association rule mining & web mining algorithm.

Module No.	Unit No.	Topics
1		One case study on building Data warehouse/Data Mart 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

**Course Assessment:**

**Lab:**

**ISE:**

**ISE-1** Quizzes/Assignments/Paper Presentation/Article Discussion  
 Quizzes/Assignments based on 50% experiments

**ISE-2** Quizzes/Assignments/Paper Presentation/Article Discussion  
 Quizzes/Assignments based on 50% experiments



**Society of St. Francis Xavier, Pilar's**  
**Fr. Conceicao Rodrigues College of Engineering**  
 Fr. Agnel Ashram, Bandstand, Bandra (W), Mumbai – 400 050  
 (Autonomous College affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CSL 504	Professional Communication & Ethics II	2	--	1	--	1	1	2
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		
Course Outcomes	CO1	Plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles.
	CO2	Strategize their personal and professional skills to build a professional image and meet the demands of the industry.
	CO3	Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.
	CO4	Deliver persuasive and professional presentations.
	CO5	Develop creative thinking and interpersonal skills required for effective professional communication.
	CO6	Apply codes of ethical conduct, personal integrity and norms of organizational behaviour.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		<b>Advanced technical writing: project/Problem Based Learning (PBL)</b>		
		<b>Purpose and Classification of Reports:</b> <b>Classification on the basis of:</b> Subject Matter (Technology, Accounting, Finance, Marketing, etc.), Time Interval (Periodic, One-time, Special), Function (Informational, Analytical, etc.), Physical Factors (Memorandum, Letter, Short & Long) <b>Parts of a Long Formal Report:</b> Prefatory Parts (Front Matter), Report Proper (Main Body), Appended Parts (Back Matter) <b>Language and Style of Reports:</b> Tense, Person & Voice of Reports, Numbering Style of Chapters, Sections, Figures, Tables and Equations, Referencing Styles in APA & MLA Format, Proofreading through Plagiarism Checkers <b>Definition, Purpose &amp; Types of Proposals:</b> Solicited (in conformance with RFP) & Unsolicited Proposals, Types (Short and Long proposals) <b>Parts of a Proposal:</b> Elements, Scope and Limitations, Conclusion <b>Technical Paper Writing:</b> 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	1,2	<b>06</b>
2		<b>Employment skills</b>	1,2	<b>06</b>



**Society of St. Francis Xavier, Pilar's**  
**Fr. Conceicao Rodrigues College of Engineering**  
**Fr. Agnel Ashram, Bandstand, Bandra (W), Mumbai – 400 050**  
**(Autonomous College affiliated to University of Mumbai)**

		<p><b>Cover Letter &amp; Resume:</b> Parts and Content of a Cover Letter, Difference between Bio-data, Resume &amp; CV, Essential Parts of a Resume, Types of Resume (Chronological, Functional &amp; Combination)</p> <p><b>Statement of Purpose:</b> Importance of SOP, Tips for Writing an Effective SOP</p> <p><b>Verbal Aptitude Test:</b> Modelled on CAT, GRE, GMAT exams</p> <p><b>Group Discussions:</b> Purpose of a GD, Parameters of Evaluating a GD, Types of GDs (Normal, Case-based &amp; Role Plays), GD Etiquettes</p> <p><b>Personal Interviews:</b> Planning and Preparation, Types of Questions, Types of Interviews (Structured, Stress, Behavioural, Problem Solving &amp; Case-based), Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual</p>		
<b>3</b>		<b>Business meetings</b>	1,2	<b>02</b>
		<p><b>Conducting Business Meetings:</b> Types of Meetings, Roles and Responsibilities of Chairperson, Secretary and Members, Meeting Etiquette</p> <p><b>Documentation:</b> Notice, Agenda, Minutes</p>		
<b>4</b>		<b>Technical/ business presentations</b>	1,2	<b>02</b>
		<p><b>Effective Presentation Strategies:</b> Defining Purpose, Analyzing Audience, Location and Event, Gathering, Selecting &amp; Arranging Material, structuring a Presentation, Making Effective Slides, Types of Presentations Aids, Closing a Presentation, Platform skills</p> <p><b>Group Presentations:</b> Sharing Responsibility in a Team, Building the contents and visuals together, Transition Phases</p>		
<b>5</b>		<b>Interpersonal skills</b>	1,2	<b>08</b>
		<p><b>Interpersonal Skills:</b> Emotional Intelligence, Leadership &amp; Motivation, Conflict Management &amp; Negotiation, Time Management, Assertiveness, Decision Making</p> <p><b>Start-up Skills:</b> Financial Literacy, Risk Assessment, Data Analysis (e.g. Consumer Behaviour, Market Trends, etc.)</p>		
<b>6</b>		<b>Corporate ethics</b>	1,2	<b>02</b>
		<p><b>Intellectual Property Rights:</b> Copyrights, Trademarks, Patents, Industrial Designs, Geographical Indications, Integrated Circuits, Trade Secrets (Undisclosed Information)</p> <p><b>Case Studies:</b> Cases related to Business/ Corporate Ethics</p>		
<b>Total</b>				<b>26</b>

**Course Assessment:**

**ISE:**

**ISE-1: Activities to be carried out**

(1) Report/Proposal Writing (2) Movie Analysis to learn interpersonal skills (3) Reading & Understanding Statement of Purpose (4) Cover Letter and Resume - Continuous pre-defined rubrics-based evaluation for 20 marks.

**ISE-2: Activities to be carried out**

- a. Meeting Documentation (Notice, Agenda and Minutes) 2) Role Play/ Case Study Documentation 3) Technical Paper and GD 4) Quiz on IPR
- b. Continuous pre-defined rubrics-based evaluation for 10 marks.
- c. Report Presentation: 10 Marks



**Society of St. Francis Xavier, Pilar's**  
**Fr. Conceicao Rodrigues College of Engineering**  
**Fr. Agnel Ashram, Bandstand, Bandra (W), Mumbai – 400 050**  
**(Autonomous College affiliated to University of Mumbai)**

d. Group Discussion: 10 Marks

**Books Recommended: Textbooks and Reference books**

1. Arms, V. M. (2005). Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition. Boston, MA: McGraw-Hill.
2. Bovée, C. L., & Thill, J. V. (2021). Business communication today. Upper Saddle River, NJ: Pearson.
3. Butterfield, J. (2017). Verbal communication: Soft skills for a digital workplace. Boston, MA: Cengage Learning.
4. Masters, L. A., Wallace, H. R., & Harwood, L. (2011). Personal development for life and work. Mason: South-Western Cengage Learning.
5. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). Organizational behaviour. Harlow, England: Pearson.
6. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
7. Archana Ram (2018) Place Mentor, Tests of Aptitude for Placement Readiness. Oxford University Press
8. Sanjay Kumar & PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press



**Society of St. Francis Xavier, Pilar's**  
**Fr. Conceicao Rodrigues College of Engineering**  
 Fr. Agnel Ashram, Bandstand, Bandra (W), Mumbai – 400 050  
 (Autonomous College affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CSM 501	Mini Project 2A	--	--	4	--	--	2	2
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	15	--	15	20	50	

Pre-requisite Course Codes	CSL304, CSL405	
Course Outcomes	CO1	Identify societal/research/innovation/entrepreneurship problems through appropriate literature survey
	CO2	Identify Methodology for solving above problem and apply engineering knowledge and skills to solve it
	CO3	Validate, Verify the results using test cases/benchmark data/theoretical/ inferences/experiments/simulations
	CO4	Use standard norms of engineering practices and project management principles during project work
	CO5	Demonstrate the capability of self learning leading to lifelong learning
	CO6	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.



**Society of St. Francis Xavier, Pilar's**  
**Fr. Conceicao Rodrigues College of Engineering**  
**Fr. Agnel Ashram, Bandstand, Bandra (W), Mumbai – 400 050**  
**(Autonomous College affiliated to University of Mumbai)**

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.

**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.
  - First shall be for finalization of problem
  - 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.
  - First review is based on readiness of building working prototype to be conducted
  - 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,
  - Identification of need/problem
  - Proposed final solution
  - Procurement of components/systems Building
  - prototype and testing
2. Two reviews will be conducted for continuous assessment
  - First shall be for finalization of problem and proposed solution
  - Second shall be for implementation and testing of solution

**Course Assessment:**

**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



**Society of St. Francis Xavier, Pilar's**  
**Fr. Conceicao Rodrigues College of Engineering**  
**Fr. Agnel Ashram, Bandstand, Bandra (W), Mumbai – 400 050**  
**(Autonomous College affiliated to University of Mumbai)**

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.

**Course Assessment:**

**ISE:**

1. **ISE-1**  
Midterm presentation will be carried out and evaluation is based on rubrics decided by the department.
2. **ISE-2**  
Midterm presentation will be carried out and evaluation is based on rubrics decided by the department.
3. **ESE -**  
Oral examination will be carried out at the end of the semester by the panel of the department.





**Society of St. Francis Xavier, Pilar's**  
**Fr. Conceicao Rodrigues College of Engineering**  
 Fr. Agnel Ashram, Bandstand, Bandra (W), Mumbai – 400 050  
 (Autonomous College affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CSC 601	System Programming and Compiler Construction	3	--	--	3	--	--	3
		<b>Examination Scheme</b>						
		ISE1	MSE	ISE2	ESE	Total		
		20	30	20	100 (30% weightage)	100		

<b>Pre-requisite Course Codes</b>	CSC501, CSC404, CSC304
<b>Course Outcomes</b>	CO1 Explain the design of two pass assembler.
	CO2 Explain the design of two pass macroprocessor.
	CO3 Distinguish between different loaders and linkers schemes.
	CO4 Explore analysis phase of the compiler.
	CO5 Describe synthesis phase of compiler.

Module No.	Unit No.	Topics	Ref.	Hrs.
<b>1</b>		<b>Introduction to System Software</b>	1,3	<b>2</b>
	1.1	Concept of System Software, Goals of system software, system program and system programming, Introduction to various system programs such as Assembler, Macro processor, Loader, Linker, Compiler, Interpreter, Device Drivers, Operating system, Editors, Debuggers.		
<b>2</b>		<b>Assemblers</b>	1,3	<b>7</b>
	2.1	Elements of Assembly Language programming, Assembly scheme, pass structure of assembler, Assembler Design: Two pass assembler Design and single pass Assembler Design for X86 processor, data structures used.		
<b>3</b>		<b>Macros and Macro Processor</b>	1,3	<b>6</b>
	3.1	Introduction, Macro definition and call, Features of Macro facility: Simple, parameterized, conditional and nested. Design of Two pass macro processor, data structures used.		
<b>4</b>		<b>Loaders and Linkers</b>	1,3	<b>6</b>
	4.1	Introduction, functions of loaders, Relocation and Linking concept, Different loading schemes: Relocating loader, Direct Linking Loader, Dynamic linking and loading.		
<b>5</b>		<b>Compilers: Analysis Phase</b>	1,2,3,4	<b>10</b>
	5.1	Introduction to compilers, Phases of compilers: <b>Lexical Analysis</b> - Role of Finite State Automata in Lexical Analysis, Design of Lexical analyzer, data structures used. <b>Syntax Analysis</b> - Role of Context Free Grammar in Syntax analysis, Types of Parsers: Top down parser- LL(1), Bottom up parser- SR Parser, Operator precedence parser, SLR. <b>Semantic Analysis</b> , Syntax directed definitions.		
<b>6</b>		<b>Compilers: Synthesis phase</b>	1,2,3,4	<b>8</b>
	6.1	<b>Intermediate Code Generation:</b> Types of Intermediate codes: Syntax tree, Postfix notation, three address codes: Triples and		





**Society of St. Francis Xavier, Pilar's**  
**Fr. Conceicao Rodrigues College of Engineering**  
**Fr. Agnel Ashram, Bandstand, Bandra (W), Mumbai – 400 050**  
**(Autonomous College affiliated to University of Mumbai)**

	Quadruples, indirect triple. <b>Code Optimization:</b> Need and sources of optimization, Code optimization techniques: Machine Dependent and Machine Independent. <b>Code Generation:</b> Issues in the design of code generator, code generation algorithm. Basic block and flow graph.		
<b>Total</b>			<b>39</b>

**Recommended Books:**

1. D. M Dhamdhare: Systems programming and Operating Systems, Tata McGraw Hill, Revised Second Edition
2. A. V. Aho, R. Shethi, Monica Lam, J.D. Ulman: Compilers Principles, Techniques and Tools, Pearson Education, Second Edition.
3. J. J. Donovan: Systems Programming Tata McGraw Hill, Edition 1991
4. John R. Levine, Tony Mason & Doug Brown, Lex & YACC, O 'Reilly publication, second Edition
5. D, M. Dhamdhare, Compiler construction 2e, Macmillan publication, second edition.
6. Kenneth C. Louden, Compiler construction: principles and practices, Cengage Learning
7. Leland L. Beck, System software: An introduction to system programming, Pearson publication, Third Edition

**Useful Links for E-resources:**

1. <http://www.nptelvideos.in/2012/11/compiler-design.html>
2. <https://www.coursera.org/lecture/nand2tetris2/unit-4-1-syntax-analysis-5pC2Z>

**Course Assessment:**

**Theory:**

**ISE-1:** Activity: Quiz/Assignments 20 Marks

**ISE-2:** Activity: Article Discussion/Quiz/Assignments

**MSE:** Two hours 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks (30% weightage) written examination based on entire syllabus



**Society of St. Francis Xavier, Pilar's**  
**Fr. Conceicao Rodrigues College of Engineering**  
 Fr. Agnel Ashram, Bandstand, Bandra (W), Mumbai – 400 050  
 (Autonomous College affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CSC 602	Cryptography & System Security	3	--	--	3	--	--	3
		<b>Examination Scheme</b>						
		ISE1	MSE	ISE2	ESE	Total		
		20	30	20	100 (30% weightage)	100		

Pre-requisite Course Codes	CSC503	
<b>Course Outcomes</b>	CO1	Apply concepts of modular arithmetic and number theory to classical encryption techniques to achieve system security goals.
	CO2	Discuss and apply modern cryptographic techniques to a given problem.
	CO3	Analyze various hash functions and digital signature algorithms to authenticate and verify integrity.
	CO4	Analyze various attacks on network security, and different security protocols.
	CO5	Differentiate between various malicious programs.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		<b>Introduction - Number Theory and Basic Cryptography</b>	1,2,3	8
	1.1	Security Goals, Attacks, Services and Mechanisms, Techniques. Modular Arithmetic: Euclidean Algorithm, Fermat's and Euler's theorem		
	1.2	Classical Encryption techniques, Symmetric cipher model, mono-alphabetic and polyalphabetic substitution techniques: Vigenere cipher, playfair cipher, Hill cipher, transposition techniques: keyed and keyless transposition ciphers		
2		<b>Symmetric and Asymmetric key Cryptography and key Management</b>	1,2,3	11
	2.1	Block cipher principles, block cipher modes of operation, DES, Double DES, Triple DES, Advanced Encryption Standard (AES), Stream Ciphers: RC4 algorithm.		
	2.2	Public key cryptography: Principles of public key cryptosystems- The RSA Cryptosystem, The knapsack cryptosystem		
	2.3	Symmetric Key Distribution: KDC, Needham-schroeder protocol. Kerberos: Kerberos Authentication protocol, Symmetric key agreement: Diffie Hellman, Public key Distribution: Digital Certificate: X.509, PKI		
3		<b>Cryptographic Hash Functions</b>	2,3,5	3
	3.1	Cryptographic hash functions, Properties of secure hash function, MD5, SHA-1, MAC, HMAC, CMAC.		
4		<b>Authentication Protocols &amp; Digital Signature Schemes</b>	2,3	5



**Society of St. Francis Xavier, Pilar's**  
**Fr. Conceicao Rodrigues College of Engineering**  
**Fr. Agnel Ashram, Bandstand, Bandra (W), Mumbai – 400 050**  
**(Autonomous College affiliated to University of Mumbai)**

	4.1	User Authentication, Entity Authentication: Password Base, Challenge Response Based		
	4.2	Digital Signature, Attacks on Digital Signature, Digital Signature Scheme: RSA		
<b>5</b>		<b>Network Security and Applications</b>	2,3,6	<b>9</b>
	5.1	Network security basics: TCP/IP vulnerabilities (Layer wise), Network Attacks: Packet Sniffing, ARP spoofing, port scanning, IP spoofing		
	5.2	Denial of Service: DOS attacks, ICMP flood, SYN flood, UDP flood, Distributed Denial of Service		
	5.3	Internet Security Protocols: PGP, SSL, IPSEC. Network security: IDS, Firewalls		
<b>6</b>		<b>System Security</b>	2,3,6	<b>3</b>
	6.1	Buffer Overflow, malicious Programs: Worms and Viruses, SQL injection		
<b>Total</b>				<b>39</b>

**Recommended Books:**

1. William Stallings, "Cryptography and Network Security, Principles and Practice", 6<sup>th</sup> Edition, Pearson Education, March 2013
2. Behrouz A. Ferouzan, "Cryptography & Network Security", Tata McGraw Hill
3. Behrouz A. Forouzan & Debdeep Mukhopadhyay, "Cryptography and Network Security" 3rd Edition, McGraw Hill
4. Bruce Schneier, "*Applied Cryptography, Protocols Algorithms and Source Code in C*", Second Edition, Wiley.
5. Atul Kahate, "Cryptography and Network Security", Tata McGraw-Hill Education, 2003.
6. Eric Cole, "Network Security Bible", Second Edition, Wiley, 2011 edition, Wiley

**Useful Links**

1. <https://github.com/cmin764/cmiN/blob/master/FII/L3/SI/book/W.Stallings%20-%20Cryptography%20and%20Network%20Security%206th%20ed.pdf>
2. <https://docs.google.com/file/d/0B5F6yMKYDUbrYXE4X1ZCUHpLNnc/view>

**Course Assessment:**

**Theory:**

**ISE-1:**Activity: Quiz/Assignments 20 Marks

**ISE-2:** Activity: Article Discussion/Quiz/Assignments

**MSE:** Two hours 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks (30% weightage) written examination based on entire syllabus



**Society of St. Francis Xavier, Pilar's**  
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 Fr. Agnel Ashram, Bandstand, Bandra (W), Mumbai – 400 050  
 (Autonomous College affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned				
		L	T	P	L	T	P	Total	
CSC 603	Mobile Computing	3	--	--		3	--	--	3
		<b>Examination Scheme</b>							
		ISE1		MSE		ISE2	ESE		Total
		20		30		20	100 (30% weightage)		100

Pre-requisite Course Codes	CSC503	
<b>Course Outcomes</b>	CO1	Identify basic concepts and principles in computing, cellular architecture.
	CO2	Describe the components and functioning of mobile networking.
	CO3	Classify variety of security techniques in mobile network.
	CO4	Apply the concepts of WLAN for local as well as remote applications.
	CO5	Describe Long Term Evolution (LTE) architecture and its interfaces.

Module No.	Unit No.	Topics	Ref.	Hrs.
<b>1</b>		<b>Introduction to Mobile Computing</b>	1,2	<b>4</b>
	1.1	Introduction to Mobile Computing, Telecommunication Generations, Cellular systems,		
	1.2	Electromagnetic Spectrum, Antenna, Signal Propagation, Signal Characteristics, Multiplexing, Spread Spectrum: DSSS & FHSS, Co-channel interference		
<b>2</b>		<b>GSM Mobile services</b>	1,4	<b>8</b>
	2.1	GSM Mobile services, System Architecture, Radio interface, Protocols, Localization and Calling, Handover, security (A3, A5 & A8)		
	2.2	GPRS system and protocol architecture		
	2.3	UTRAN, UMTS core network; Improvements on Core Network,		
<b>3</b>		<b>Mobile Networking</b>	1,2,6	<b>8</b>
	3.1	Medium Access Protocol, Internet Protocol and Transport layer		
	3.2	Mobile IP: IP Packet Delivery, Agent Advertisement and Discovery, Registration, Tunnelling and Encapsulation, Reverse Tunnelling.		
	3.3	Mobile TCP: Traditional TCP, Classical TCP Improvements like Indirect TCP, Snooping TCP & Mobile TCP, Fast Retransmit/ Fast Recovery, Transmission/Timeout Freezing, Selective Retransmission		
<b>4</b>		<b>Wireless Local Area Networks</b>	1,2,9	<b>6</b>
	4.1	<b>Wireless Local Area Networks:</b> Introduction, Infrastructure and ad-hoc network		
	4.2	<b>IEEE 802.11:</b> System architecture, Protocol architecture, Physical layer, Medium Access Control layer, MAC management, 802.11a, 802.11b standard		
	4.3	<b>Wi-Fi security:</b> WEP, WPA, Wireless LAN Threats, Securing Wireless Networks		
	4.4	<b>Bluetooth:</b> Introduction, User Scenario, Architecture, protocol stack		
<b>5</b>		<b>Mobility Management</b>	1,2,6	<b>6</b>



**Society of St. Francis Xavier, Pilar's**  
**Fr. Conceicao Rodrigues College of Engineering**  
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**(Autonomous College affiliated to University of Mumbai)**

	<b>5.1</b>	<b>Mobility Management:</b> Introduction, IP Mobility, optimization, IPv6		
	<b>5.2</b>	<b>Macro Mobility:</b> MIPv6, FMIPv6		
	<b>5.3</b>	<b>Micro Mobility:</b> CellularIP, HAWAII, HMIPv6		
<b>6</b>		<b>Long-Term Evolution (LTE) of 3GPP</b>	<b>3,5</b>	<b>7</b>
	6.1	<b>Long-Term Evolution (LTE) of 3GPP:</b> LTE System Overview, Evolution from UMTS to LTE		
	6.2	LTE/SAE Requirements, SAE Architecture		
	6.3	<b>EPS:</b> Evolved Packet System, E-UTRAN, Voice over LTE (VoLTE), Introduction to LTE-Advanced		
	6.4	Self Organizing Network (SON-LTE), SON for Heterogeneous Networks (HetNet), Comparison between Different Generations (2G, 3G, 4G and 5G), Introduction to 5G		
<b>Total</b>				<b>39</b>

### Recommended Books:

1. Jochen Schiller, "Mobile Communication", Addison Wesley, Pearson Education
2. William Stallings "Wireless Communications & Networks", Second Edition, Pearson Education
3. Christopher Cox, "An Introduction to LTE: LTE, LTE-Advanced, SAE and 4G Mobile Communications", Wiley publications
4. Raj Kamal, "Mobile Computing", 2/e, Oxford University Press-New
5. Seppo Hamalainen, Henning Sanneck, Cinzia Sartori, "LTE Self-Organizing Networks (SON): Network Management Automation for Operational Efficiency", Wiley publications
6. Ashutosh Dutta, Henning Schulzrinne "Mobility Protocols and Handover Optimization: Design, Evaluation and Application", IEEE Press, Wiley Publication
7. Michael Gregg, "Build your own security lab", Wiley India edition
8. Dipankar Raychaudhuri, Mario Gerla, "Emerging Wireless Technologies and the Future Mobile Internet", Cambridge
9. Andreas F. Molisch, "Wireless Communications", Second Edition, Wiley Publication, "Mobile Communication", Addison Wesley, Pearson Education

### Useful Links

1. <https://www.coursera.org/learn/smart-device-mobile-emerging-technologies>
2. <https://nptel.ac.in/courses/106/106/106106167/>

### Course Assessment:

#### Theory:

**ISE-1:** Activity: Quiz/Assignments 20 Marks

**ISE-2:** Activity: Article Discussion/Quiz/Assignments

**MSE:** Two hours 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks (30% weightage) written examination based on entire syllabus



**Society of St. Francis Xavier, Pilar's**  
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 (Autonomous College affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned				
		L	T	P	L	T	P	Total	
CSC 604	Artificial Intelligence	3	--	--	3	--	--	3	
		<b>Examination Scheme</b>							
		ISE1		MSE		ISE2	ESE		Total
		20		30		20	100 (30% weightage)		100

Pre-requisite Course Codes	CSC301, CSC401, CSC303	
<b>Course Outcomes</b>	CO1	Ability to develop a basic understanding of AI building blocks presented in intelligent agents.
	CO2	Ability to choose an appropriate problem solving method and knowledge representation technique.
	CO3	Ability to analyze the strength and weaknesses of AI approaches to knowledge– intensive problem solving.
	CO4	Ability to design models for reasoning with uncertainty as well as the use of unreliable information.
	CO5	Ability to design and develop AI applications in real world scenarios.

Module No.	Unit No.	Topics	Ref.	Hrs.
<b>1</b>		<b>Introduction to Artificial Intelligence</b>	1,2	<b>4</b>
	1.1	Introduction, History of Artificial Intelligence, Intelligent Systems: Categorization of Intelligent System, Components of AI Program, Foundations of AI, Sub-areas of AI, Applications of AI, Current trends in AI.		
<b>2</b>		<b>Intelligent Agents</b>	2,5	<b>4</b>
	2.1	Agents and Environments, The concept of rationality, The nature of environment, The structure of Agents, Types of Agents, Learning Agent.		
	2.2	Solving problem by Searching: Problem Solving Agent, Formulating Problems, Example Problems.		
<b>3</b>		<b>Problem solving</b>	1,2,4,7	<b>10</b>
	3.1	Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS), Depth Limited Search, Depth First Iterative Deepening (DFID), Informed Search Methods: Greedy best first Search, A* Search, Memory bounded heuristic Search.		
	3.2	Local Search Algorithms and Optimization Problems: Hill climbing search Simulated annealing, Genetic algorithms.		
	3.3	<b>Adversarial Search:</b> Game Playing, Min-Max Search, Alpha Beta Pruning		
<b>4</b>		<b>Knowledge and Reasoning</b>	4,7	<b>12</b>
	4.1	Knowledge based Agents, Brief Overview of propositional logic, First Order Logic: Syntax and Semantic, Inference in FOL, Forward chaining, backward Chaining.		
	4.2	Knowledge Engineering in First-Order Logic, Unification, Resolution		



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	4.3	Uncertain Knowledge and Reasoning: Uncertainty, Representing knowledge in an uncertain domain, The semantics of belief network, Simple Inference in belief network		
<b>5</b>		<b>Planning and Learning</b>	2,7	<b>5</b>
	5.1	The planning problem, Planning with state space search, Partial order planning, Hierarchical planning, Conditional Planning.		
	5.2	Learning: Forms of Learning, Theory of Learning, PAC learning. Introduction to statistical learning (Introduction only) Introduction to reinforcement learning: Learning from Rewards, Passive Reinforcement Learning, Active reinforcement Learning		
<b>6</b>		<b>AI Applications</b>		<b>4</b>
		Introduction to NLP- Language models, Grammars, Parsing Robotics - Robots, Robot hardware, Problems Robotics can solve AI applications in Healthcare, Retail, Banking		
<b>Total</b>			<b>39</b>	

**Recommended Books:**

1. Stuart J. Russell and Peter Norvig, "*Artificial Intelligence: A Modern Approach*", Fourth Edition" Pearson Education, 2020
2. Saroj Kaushik, "*Artificial Intelligence*", Cengage Learning, First edition, 2011
3. George F Luger, "*Artificial Intelligence*" Low Price Edition, Fourth edition, Pearson Education.,2005
4. Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication
5. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication
6. Patrick H. Winston, Artificial Intelligence, 3rd edition, Pearson Education
7. Elaine Rich and Kevin Knight, "*Artificial Intelligence*", Third Edition, McGraw Hill Education,2017

**Useful Links**

1. <https://nptel.ac.in/courses/106/105/106105078/>
2. <https://thetempedia.com/blog/simple-ai-and-machine-learning-projects-for-students-and-beginners/>
3. <https://nptel.ac.in/courses/106/105/106105079/>

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Quiz/Assignments 20 Marks

**ISE-2:**

Activity: Article Discussion/Quiz/Assignments

**MSE:**

Two hours 30 Marks written examination based on 50% syllabus

**ESE:**

Three hours 100 Marks (30% weightage) written examination based on entire syllabus





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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned				
		L	T	P	L	T	P	Total	
CSDLO 6011	Internet of Things	3	--	--		3	--	--	3
		<b>Examination Scheme</b>							
		ISE1		MSE		ISE2	ESE		Total
		20		30		20	100 (30% weightage)		100

Pre-requisite Course Codes	FEC205, CSC304, CSC405, CSC503	
<b>Course Outcomes</b>	CO1	Understand the concepts of IoT and the Things in IoT.
	CO2	Emphasize core IoT functional Stack and understand application protocols for IoT.
	CO3	Apply IoT knowledge to key industries that IoT is revolutionizing.
	CO4	Examines various IoT hardware items and software platforms used in projects.

Module No.	Unit No.	Topics	Ref.	Hrs.
<b>1</b>		<b>Introduction to Internet of Things (IoT)</b>	1,4	7
	1.1	What is IoT? - IoT and Digitization		
	1.2	IoT Impact – Connected Roadways, Connected Factory, Smart Connected Buildings, Smart Creatures		
	1.3	Convergence of IT and OT, IoT Challenges		
	1.4	The oneM2M IoT Standardized Architecture		
	1.5	The IoT World Forum (IoTWF) Standardized Architecture		
	1.6	IoT Data Management and Compute Stack – Design considerations and Data related problems, Fog Computing, Edge Computing, The Hierarchy of Edge, Fog and Cloud		
<b>2</b>		<b>Things in IoT</b>	1,4	7
	2.1	Sensors/Transducers – Definition, Principles, Classifications, Types, Characteristics and Specifications		
	2.2	Actuators – Definition, Principles, Classifications, Types, Characteristics and Specifications		
	2.3	Smart Object – Definition, Characteristics and Trends		
	2.4	Sensor Networks – Architecture of Wireless Sensor Network, Network Topologies		
	2.5	Enabling IoT Technologies - Radio Frequency Identification Technology, Micro- Electro-Mechanical Systems (MEMS), NFC (Near Field Communication), Bluetooth Low Energy (BLE), LTE-A (LTE Advanced), IEEE 802.15.4– Standardization and Alliances, ZigBee		
<b>3</b>		<b>The Core IoT Functional Stack</b>	1,2	6
	3.1	Layer 1 – Things: Sensors and Actuators Layer		
	3.2	Layer 2 – Communications Network Layer, Access Network Sublayer, Gateways and Backhaul Sublayer, Network Transport Sublayer, IoT Network Management Sublayer		





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	3.3	Layer 3 – Applications and Analytics Layer, Analytics Vs. Control Applications, Data Vs. Network Analytics, Data Analytics Vs. Business Benefits, Smart Services		
<b>4</b>		<b>Application Protocols for IoT</b>	1,4	7
	4.1	The Transport Layer		
	4.2	IoT Application Transport Methods		
	4.3	Application Layer Protocol Not Present		
	4.4	SCADA - Background on SCADA, Adapting SCADA for IP, Tunneling Legacy SCADA over IP Networks, SCADA Protocol Translation, SCADA Transport over LLNs with MAP-T,		
	4.5	Generic Web-Based Protocols		
	4.6	IoT Application Layer Protocols – CoAP and MQTT		
<b>5</b>		<b>Domain Specific IoTs</b>		6
	5.1	Home Automation – Smart Lighting, Smart Appliances, Intrusion Detection, Smoke/Gas Detectors	1,2	
	5.2	Cities – Smart Parking, Smart Lighting, Smart Roads, Structural Health Monitoring, Surveillance		
	5.3	Environment – Weather Monitoring, Air Pollution Monitoring, Noise Pollution Monitoring, Forest Fire Detection, River Floods Detection		
	5.4	Energy – Smart Grids, Renewable Energy Systems, Prognostics		
	5.5	Retail – Inventory Management, Smart Payments, Smart Vending Machines		
	5.6	Logistics – Route Generation & Scheduling, Fleet Tracking, Shipment Monitoring		
	5.7	Agriculture – Smart Irrigation, Green House Control		
	5.8	Industry – Machine Diagnostics & Prognosis, Indoor Air Quality Monitoring		
	5.9	Health & Lifestyle – Health & Fitness Monitoring, Wearable Electronics		
<b>6</b>		<b>Create your own IoT</b>	1,2,4	6
	6.1	IoT Hardware - Arduino, Raspberry Pi, ESP32, Cloudbit/Littlebits, Particle Photon, Beaglebone Black.		
	6.2	IoT Software - languages for programming IoT hardware, for middleware applications and API development, for making front ends, REST and JSON-LD		
	6.3	A comparison of IoT boards and platforms in terms of computing		
	6.4	A comparison of IoT boards and platforms in terms of development environments and communication standards		
	6.5	A comparison of boards and platforms in terms of connectivity		
	6.6	A comparison of IoT software platforms		
<b>Total</b>			<b>39</b>	

**Recommended Books:**

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry, *“IoT Fundamentals – Networking Technologies, Protocols, and Use Cases for the Internet of Things”*, 1<sup>st</sup> Edition, Published by Pearson Education, Inc, publishing as Cisco Press, 2017
2. Hakima Chaouchi, *“The Internet of Things - Connecting Objects to the Web”*, 1<sup>st</sup> Edition, Wiley, 2010
3. Perry Lea, *“Internet of things For Architects”*, 1<sup>st</sup> Edition, Packt Publication, 2018
4. Arshdeep Bahga, Vijay Madiseti, *“Internet of Things – Hands-On Approach”*, 2<sup>nd</sup> Edition, Universities Press, 2016



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5. Adrian McEwen & Hakim Cassimally, *“Designing the Internet of Things”*, 1<sup>st</sup> Edition, Wiley, 2014
6. Donald Norris, *“Raspberry Pi – Projects for the Evil Genius”*, 2<sup>nd</sup> Edition, McGraw Hill, 2014.
7. Anand Tamboli, *“Build Your Own IoT Platform”*, 1<sup>st</sup> Edition, Apress, 2019

**Useful Links**

1. <https://nptel.ac.in/courses/106/105/106105166/>
2. <https://nptel.ac.in/courses/108/108/108108098/>
3. <https://nptel.ac.in/courses/106/105/106105195/>
4. <https://www.coursera.org/specializations/iot>

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Quiz/Assignments 20 Marks

**ISE-2:**

Activity: Article Discussion/Quiz/Assignments

**MSE:**

Two hours 30 Marks written examination based on 50% syllabus

**ESE:**

Three hours 100 Marks (30% weightage) written examination based on entire syllabus



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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned				
		L	T	P	L	T	P	Total	
CSDLO 6012	Digital Signal & Image Processing	3	--	--		3	--	--	3
		<b>Examination Scheme</b>							
		ISE1		MSE		ISE2	ESE		Total
		20		30		20	100 (30% weightage)		100

Pre-requisite Course Codes	CSC401	
<b>Course Outcomes</b>	CO1	Understand the concept of DT Signal and DT Systems
	CO2	Classify and analyze discrete time signals and systems
	CO3	Implement Digital Signal Transform techniques DFT and FFT
	CO4	Use the enhancement techniques for digital Image Processing
	CO5	Apply image segmentation techniques

Module No.	Unit No.	Topics	Ref.	Hrs.
1		<b>Discrete-Time Signal and Discrete-Time System</b>	1,2	10
	1.1	Introduction to Digital Signal Processing, Sampling and Reconstruction, Standard DT Signals, Concept of Digital Frequency, Representation of DT signal using Standard DT Signals, Signal Manipulations (shifting, reversal, scaling, addition, multiplication).		
	1.2	Classification of Discrete-Time Signals, Classification of Discrete-Systems		
	1.3	Linear Convolution formulation for 1-D signal (without mathematical proof), Circular Convolution (without mathematical proof), Linear convolution using Circular Convolution. Auto and Cross Correlation formula evaluation, Concept of LTI system, Output of DT system using Time Domain Linear Convolution.		
2.0		<b>Discrete Fourier Transform</b>	1,2	05
	2.1	Introduction to DTFT, DFT, Relation between DFT and DTFT, IDFT		
	2.2	Properties of DFT without mathematical proof (Scaling and Linearity, Periodicity, Time Shift and Frequency Shift, Time Reversal, Convolution Property and Parseval's Energy Theorem). DFT computation using DFT properties. Convolution of long sequences, Introduction to 2-D DFT		
	2.3	Convolution of long sequences, Introduction to 2-D DFT		
3		<b>Fast Fourier Transform</b>	1,2	04
	3.1	Need of FFT, Radix-2 DIT-FFT algorithm,		
	3.2	DIT-FFT Flow graph for N=4 and 8, Inverse FFT algorithm.		
	3.3	Spectral Analysis using FFT		
4		<b>Digital Image Fundamentals</b>	3,4,7,8	05
	4.1	Introduction to Digital Image, Digital Image Processing System, Sampling and Quantization		
	4.2	Representation of Digital Image, Connectivity		
	4.3	Image File Formats: BMP, TIFF and JPEG.		
5.0		<b>Image Enhancement in Spatial domain</b>	3,4,7,8	09



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	<b>5.1</b>	Gray Level Transformations, Zero Memory Point Operations		
	<b>5.2</b>	Histogram Processing, Histogram equalization.		
	<b>5.3</b>	Neighbourhood processing, Image averaging, Image Subtraction, Smoothing Filters - Low pass averaging, Sharpening Filters-High Pass Filter, High Boost Filter, Median Filter for reduction of noise		
<b>6.0</b>		<b>Image Segmentation</b>	3,4,7,8	06
	<b>6.1</b>	Fundamentals, Segmentation based on Discontinuities and Similarities		
	<b>6.2</b>	Point, line and Edge Detection, Image edge detection using Robert, Prewitt and Sobel masks, Image edge Detection using Laplacian mask		
	<b>6.3</b>	Region based segmentation: Region Growing, Region Splitting and Merging		
<b>Total</b>				<b>39</b>

**Recommended Books:**

1. John G. Proakis, Dimitris and G. Manolakis, “**Digital Signal Processing: Principles, Algorithms, and Applications**”, 4th Edition, Pearson Education, 2007
2. Anand Kumar, “**Digital Signal Processing**”, 2nd Edition, PHI Learning Pvt. Ltd. 2014
3. Rafel C. Gonzalez and Richard E. Woods, “**Digital Image Processing**”, Pearson Education Asia, 4th Edition, 2018
4. S. Sridhar, “**Digital Image Processing**”, 2nd Edition, Oxford University Press, 2012
5. Sanjit Mitra, “**Digital Signal Processing: A Computer Based Approach**”, 4th Edition, Tata McGraw Hill, 2013
6. S. Salivahanan, A. Vallavaraj, and C. Gnanapriya, “**Digital Signal Processing**”, 2<sup>nd</sup> Edition, Tata McGraw Hill Publication, 2011
7. S. Jayaraman, E. Esakkirajan and T. Veerkumar, “**Digital Image Processing**”, 3<sup>rd</sup> Edition, Tata McGraw Hill Education Private Ltd, 2009
8. Anil K. Jain, “**Fundamentals of Digital Image Processing**”, 4th Edition, Prentice Hall of India Private Ltd.,1989

**Useful Links**

1. <https://nptel.ac.in/courses/>
2. <https://swayam.gov.in>

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Quiz/Assignments 20 Marks

**ISE-2:**

Activity: Article Discussion/Quiz/Assignments

**MSE:**

Two hours 30 Marks written examination based on 50% syllabus

**ESE:**

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned				
		L	T	P	L	T	P	Total	
CSDLO 6013	Quantitative Analysis	3	--	--		3	--	--	3
		Examination Scheme							
		ISE1		MSE		ISE2	ESE		Total
		20		30		20	100 (30% weightage)		100

<b>Pre-requisite Course Codes</b>	CSC301, CSC401	
<b>Course Outcomes</b>	CO1	Recognize the need of Statistics and Quantitative Analysis
	CO2	Apply the data collection and the sampling methods.
	CO3	Analyze using concepts of Regression, Multiple Linear Regression
	CO4	Formulate Statistical inference drawing methods.
	CO5	Apply Testing of hypotheses

Module No.	Topics	Ref.	Hrs.
1	<b>Introduction to Statistics</b>		6
	Functions – Importance – Uses and Limitations of Statistics. Statistical data– Classification, Tabulation, Diagrammatic & Graphic representation of data	1,2	
2	<b>Data Collection &amp; Sampling Methods</b>	1,2	6
	Primary & Secondary data, Sources of data, Methods of collecting data. Sampling – Census & Sample methods –Methods of sampling, Probability Sampling and Non-Probability Sampling.		
3	<b>Introduction to Regression</b>	1,2	8
	Mathematical and Statistical Equation – Meaning of Intercept and Slope – Error term – Measure for Model Fit –R <sup>2</sup> – MAE – MAPE.		
4	<b>Introduction to Multiple Linear Regression</b>	1,2	8
	Multiple Linear Regression Model, Partial Regression Coefficients, Testing Significance overall significance of Overall fit of the model, Testing for Individual Regression Coefficients		
5	<b>Statistical inference</b>	1,2,3	6
	Random sample -Parametric point estimation unbiasedness and consistence - method of moments and method of maximum likelihood.		
6	<b>Tests of hypotheses</b>	1,2,3	5
	Null and Alternative hypotheses. Types of errors. Neyman-Pearson lemma- MP and UMP tests.		
<b>Total</b>			39

**Recommended Books:**

1. Agarwal, B.L. (2006):-Basic Statistics. Wiley Eastern Ltd., New Delhi
2. Gupta, S. P. (2011):-Statistical Methods. Sultanchand & Sons, New Delhi
3. Sivathanupillai, M & Rajagopal, K. R. (1979):-Statistics for Economics Students.
4. Hogg, R.V. and Craig, A. T. (2006), An introduction to mathematical statistics, Amerind publications.
5. Arora, P.N., Sumeet Arora, S. Arora (2007):- Comprehensive Statistical Methods. Sultan Chand,



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New Delhi

6. Montgomery, D. C., Peck E.A, & Vining G.G.(2003). Introduction to Linear Regression Analysis. John Wiley and Sons, Inc. NY
7. Mood AM, Graybill FA, and Boes, D.C.(1985), Introduction to the theory of statistics, McGrawhill Book Company, New Delhi.
8. Kapur, J.N. and Saxena,H.C.(1970), Mathematical statistics, Sultan Chand & company, New Delhi.

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Quiz/Assignments 20 Marks

**ISE-2:**

Activity: Article Discussion/Quiz/Assignments

**MSE:**

Two hours 30 Marks written examination based on 50% syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CSL 601	System Programming and Compiler Construction Lab	--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	25	--	25	--	50	

Pre-requisite Course Codes	CSC501, CSC404, CSC304	
Course Outcomes	CO1	Generate machine code by implementing two pass assemblers.
	CO2	Implement Two pass macro processor.
	CO3	Implement scanner and parser of compiler.
	CO4	Implement scanner and parser of compiler.
	CO5	Explore LEX & YACC tools.

Module No.	Topic
1	Implementations of two pass Assembler.
2	Implementation of Two pass Macro Processor.
3	Implementation of Lexical Analyzer.
4	Implementation of Parser (Any one).
5	Implementation of Intermediate code generation phase of compiler.
6	Implementation of code generation phase of compiler.
7	Study and implement experiments on LEX, YACC.

**Reference Books:**

- Andrew W. Appel Princeton University. Jens Palsberg Modern Compiler. Implementation in Java, Second Edition. Purdue University. CAMBRIDGE University press @2002.
- Charles N. Fischer, Richard J. LeBlanc Crafting a compiler with C , Pearson Education 2007

**Lab:**

**ISE:**

- ISE-1** Quizzes/Assignments/Paper Presentation/Article Discussion  
Quizzes/Assignments based on 50% experiments
- ISE-2** Quizzes/Assignments/Paper Presentation/Article Discussion  
Quizzes/Assignments based on 50% experiments





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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CSL 602	Cryptography & System Security Lab	--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	10	--	15	--	25	

Pre-requisite Course Codes	CSC503	
Course Outcomes	CO1	Apply knowledge of cryptographic techniques to implement simple cipher.
	CO2	Explore different network reconnaissance, and packet sniffing tools to gather information about networks, and packets, respectively.
	CO3	Explore various attacks on the system security.
	CO4	Set up firewalls and implement email security.

Module No.	Topic
1	Design and Implementation of a product cipher using Substitution and Transposition ciphers.
2	Implementation and analysis of RSA crypto system.
3	Implementation of Diffie Hellman Key exchange algorithm
4	For varying message sizes, test integrity of message using MD-5, SHA-1, and analyse the performance of the two protocols. Use crypt APIs.
5	Study the use of network reconnaissance tools like WHOIS, dig, traceroute, ns lookup to gather information about networks and domain registrars.
6	Study of packet sniffer tools: wireshark,: 1. Download and install wireshark and capture icmp, tcp, and http packets in promiscuous mode. 2. Explore how the packets can be traced based on different filters.
7	Download and install nmap. Use it with different options to scan open ports, perform OS fingerprinting, do a ping scan, tcp port scan, udp port scan, xmas scan etc.
8	Detect ARP spoofing using nmap and/or open-source tool ARPWATCH and wireshark. Use arping tool to generate gratuitous arps and monitor using wireshark
9	Simulate DOS attack using Hping, hping3 and other tools
10	Simulate buffer overflow attack using Ollydbg, Splint, Cpp check etc
11	1. Set up IPSEC under LINUX. 2. Set up Snort and study the logs.
12	Setting up personal Firewall using iptables
13	Explore the GPG tool of linux to implement email security



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14	SQL injection attack, Cross-Cite Scripting attack simulation
15	Case Study /Seminar: Topic beyond syllabus related to topics covered.

**Lab:**

**ISE:**

1. **ISE-1** Quizzes/Assignments/Paper Presentation/Article Discussion  
Quizzes/Assignments based on 50% experiments
2. **ISE-2** Quizzes/Assignments/Paper Presentation/Article Discussion  
Quizzes/Assignments based on 50% experiments



**Society of St. Francis Xavier, Pilar's**  
**Fr. Conceicao Rodrigues College of Engineering**  
 Fr. Agnel Ashram, Bandstand, Bandra (W), Mumbai – 400 050  
 (Autonomous College affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CSL 603	Mobile Computing Lab	--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	10	--	15	--	25	

Pre-requisite Course Codes	CSC503	
<b>Course Outcomes</b>	CO1	Develop and demonstrate mobile applications using various tools
	CO2	Articulate the knowledge of GSM, CDMA & Bluetooth technologies and demonstrate it.
	CO3	Students will able to carry out simulation of frequency reuse, hidden/exposed terminal Problem
	CO4	Implement security algorithms for mobile communication network
	CO5	Demonstrate simulation and compare the performance of Wireless LAN

The softwares like Android Studio, J2ME, NS2, NS3 and any other software which is suitable are recommended for performing the practical.

Module No.	Topic
1	Implementation a Bluetooth network with application as transfer of a file from one device to another.
2	To implement a basic function of Code Division Multiple Access (CDMA).
3	Implementation of GSM security algorithms (A3/A5/A8)
4	Illustration of Hidden Terminal/Exposed terminal Problem. Consider two Wi-fi base stations (STA) and an access point (AP) located along the x-axis. All the nodes are fixed. The AP is situated at the middle of the two STA, the distance of separation being 150 m. [variable]. Node #0 and node #1 are the hidden terminals. Both are transmitting some data to the AP (almost at same rate) at the same time. The loss across the wireless link between each STA and the AP is fixed at 50 dB irrespective of the distance of separation. To study how RTS/CTS helps in wireless networks, 1. No RTS/CTS is being sent. 2. Nodes do exchange RTS/CTS packets. <b>Compare the no. of packet retransmissions required in both the cases (as obtained in the output) and compare the results.</b>
5	To setup & configuration of Wireless Access Point (AP). Analyze the Wi-Fi communication range in the presence of the access point (AP) and the base station (BS). Consider BS and AP are static. Find out the maximum distance to which two way communications is possible. Try multiple iterations by adjusting its distance in the code and test it.
6	Study of security tools (like Kismet, Netstumbler)
7	Develop an application that uses GUI components.
8	Write an application that draws basic graphical primitives on the screen.



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9	Develop an application that makes use of database.
10	Develop a native application that uses GPS location information.
11	Implement an application that creates an alert upon receiving a message.
12	Implementation of income tax/loan EMI calculator and deploy the same on real devices (Implementation of any real time application)

### Useful Links

1. <https://nptel.ac.in/courses/106/106/106106147/>
2. <https://www.coursera.org/learn/smart-device-mobile-emerging-technologies>

### Lab:

#### ISE:

1. **ISE-1** Quizzes/Assignments/Paper Presentation/Article Discussion  
Quizzes/Assignments based on 50% experiments
2. **ISE-2** Quizzes/Assignments/Paper Presentation/Article Discussion  
Quizzes/Assignments based on 50% experiments



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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CSL 604	Artificial Intelligence Lab	--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	25	--	25	--	50	

Pre-requisite Course Codes	CSC301, CSC401, CSC303	
Course Outcomes	CO1	Identify languages and technologies for Artificial Intelligence
	CO2	Understand and implement uninformed and informed searching techniques for real world problems.
	CO3	Create a knowledge base using any AI language.
	CO4	Design and implement expert systems for real world problems.

Module No.	Topic
1	One case study on AI applications published in IEEE/ACM/Springer or any prominent journal.
2	Assignments on State space formulation and PEAS representation for various AI applications
3	Program on uninformed search methods.
4	Program on informed search methods.
5	Program on Game playing algorithms.
6	Program for first order Logic
7	Planning Programming
8	Implementation for Bayes Belief Network

Note: Any other practical covering the syllabus topics and subtopics can be conducted.  
 The programming assignment for First order logics could be in the form of a mini project

**Course Assessment:**

**Lab:**

**ISE:**

1. **ISE-1** Quizzes/Assignments/Paper Presentation/Article Discussion  
Quizzes/Assignments based on 50% experiments
2. **ISE-2** Quizzes/Assignments/Paper Presentation/Article Discussion  
Quizzes/Assignments based on 50% experiments



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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CSL 605	Cloud Computing	--	--	4	--	--	2	2
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	25	--	50	--	75	

Pre-requisite Course Codes	CSC503	
<b>Course Outcomes</b>	CO1	Implement different types of virtualization techniques.
	CO2	Analyze various cloud computing service models and implement them to solve the given problems.
	CO3	Design and develop real world web applications and deploy them on commercial cloud(s).
	CO4	Explain major security issues in the cloud and mechanisms to address them.
	CO5	Explore various commercially available cloud services and recommend the appropriate one for the given application.
	CO6	Implement the concept of containerization

Module	Detailed Contents	Hours	LO
01	<b>Title:</b> Introduction and overview of cloud computing. <b>Objective:</b> To understand the origin of cloud computing, cloud cube model, NIST model, characteristics of cloud, different deployment models, service models, advantages and disadvantages.	2	2
02	<b>Title:</b> To study and implement Hosted Virtualization using VirtualBox & KVM. <b>Objective:</b> To know the concept of Virtualization along with their types, structures and mechanisms. This experiment should have demonstration of creating and running Virtual machines inside hosted hypervisors like VirtualBox and KVM with their comparison based on various virtualization parameters.	2	1
03	<b>Title:</b> To study and Implement Bare-metal Virtualization using Xen, HyperV or VMware Esxi. <b>Objective:</b> To understand the functionality of Bare-metal hypervisors and their relevance in cloud computing platforms. This experiment should have demonstration of install, configure and manage Bare Metal hypervisor along with instructions to create and run virtual machines inside it. It should also emphasize on accessing VMs in different environments along with additional services provided by them like Load balancing, Auto-Scaling, Security etc.	4	1



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04	<p>Title: To study and Implement Infrastructure as a Service using AWS/Microsoft Azure.</p> <p>Objective: To demonstrate the steps to create and run virtual machines inside Public cloud platform. This experiment should emphasize on creating and running Linux/Windows Virtual machine inside Amazon EC2 or Microsoft Azure Compute and accessing them using RDP or VNC tools.</p>	4	2
05	<p>Title: To study and Implement Platform as a Service using AWS Elastic Beanstalk/ Microsoft Azure App Service.</p> <p>Objective: To demonstrate the steps to deploy Web applications or Web services written in different languages on AWS Elastic Beanstalk/ Microsoft Azure App Service.</p>	4	2
06	<p>Title: To study and Implement Storage as a Service using Own Cloud/ AWS S3, Glaciers/ Azure Storage.</p> <p>Objective: To understand the concept of Cloud storage and to demonstrate the different types of storages like object storage, block level storages etc. supported by Cloud Platforms like Own Cloud/ AWS S3, Glaciers/ Azure Storage.</p>	4	2
07	<p>Title: To study and Implement Database as a Service on SQL/NOSQL databases like AWS RDS, AZURE SQL/ MongoDB Lab/ Firebase.</p> <p>Objective: To know the concept of Database as a Service running on cloud and to demonstrate the CRUD operations on different SQL and NOSQL databases running on cloud like AWS RDS, AZURE SQL/ Mongo Lab/ Firebase.</p>	2	2
08	<p>Title: To study and Implement Security as a Service on AWS/Azure</p> <p>Objective: To understand the Security practices available in public cloud platforms and to demonstrate various Threat detection, Data protection and Infrastructure protection services in AWS and Azure.</p>	3	4
09	<p>Title: To study and implement Identity and Access Management (IAM) practices on AWS/Azure cloud.</p> <p>Objective: To understand the working of Identity and Access Management IAM in cloud computing and to demonstrate the case study based on Identity and Access Management (IAM) on AWS/Azure cloud platform.</p>	2	2
10	<p>Title: To study and Implement Containerization using Docker Objective: To know the basic differences between Virtual machine and Container. It involves demonstration of creating, finding, building, installing, and running Linux/Windows application containers inside local machine or cloud platform.</p>	4	6





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11	Title: To study and implement container orchestration using Kubernetes  Objective: To understand the steps to deploy Kubernetes Cluster on local systems, deploy applications on Kubernetes, creating a Service in Kubernetes, develop Kubernetes configuration files in YAML and creating a deployment in Kubernetes using YAML	4	6
12	Mini-project: Design a Web Application hosted on public cloud platform [It should cover the concept of IaaS, PaaS, DBaaS, Storage as a Service, Security as a Service etc.]	4	3, 5

Sr. No.	Suggested Assignment List (Any two)	LO
1	Assignment based on selection of suitable cloud platform solution based on requirement analysis considering given problem statement	5
2	Assignment on recent trends in cloud computing and related technologies	5
3	Assignment on comparative study of different computing technologies [Parallel, Distributed, Cluster, Grid, Quantum]	5
4	Comparative study of different hosted and bare metal Hypervisors with suitable parameters along with their use in public/private cloud platform	1
5	Assignment on explore and compare the similar type of services provided by AWS and Azure [Any ten services]	5

<b>Digital Material:</b>		
Sr. No.	Topic	Link
1	Introduction and overview of cloud computing	<a href="https://www.nist.gov/system/files/documents/itl/cloud/NIST_SP-500-291_Version-2_2013_June18_FINAL.pdf">https://www.nist.gov/system/files/documents/itl/cloud/NIST_SP-500-291_Version-2_2013_June18_FINAL.pdf</a>
2	Hosted Virtualization using KVM	<a href="https://phoenixnap.com/kb/ubuntu-install-kvm/">https://phoenixnap.com/kb/ubuntu-install-kvm/</a>
3	Baremetal Virtualization using Xen	<a href="https://docs.citrix.com/en-us/xenserver/7-1/install.html">https://docs.citrix.com/en-us/xenserver/7-1/install.html</a>
4	IaaS, PaaS, STaaS, DbaaS, IAM and Security as a Service on AWS and Azure	1) AWS <a href="https://docs.aws.amazon.com/">https://docs.aws.amazon.com/</a> 2) MS Azure <a href="https://docs.microsoft.com/en-us/azure">https://docs.microsoft.com/en-us/azure</a>
5	Docker	<a href="https://docs.docker.com/get-started/">https://docs.docker.com/get-started/</a>
6	Kubernetes	<a href="https://kubernetes.io/docs/home/">https://kubernetes.io/docs/home/</a>



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**Textbooks:**

1. Bernard Golden, “Amazon Web Services for Dummies”, John Wiley & Sons, Inc.
2. Michael Collier, Robin Shahan, “Fundamentals of Azure, Microsoft Azure Essentials”,
3. Microsoft Press.
4. RajkumarBuyya, Christian Vecchiola, S ThamaraiSelvi, “Mastering Cloud Computing”,
5. Tata McGraw-Hill Education.
6. Barrie Sosinsky, “Cloud Computing Bible”, Wiley publishing
7. John Paul Mueller, “AWS for Admins for Developers”, John Wiley & Sons, Inc.
8. Ken Cochrane, Jeeva S. Chelladhurai, NeependraKhare , “Docker Cookbook - Second
9. Edition”, Packt publication
10. Jonathan Baier, “Getting Started with Kubernetes-Second Edition”, Packt Publication

**Course Assessment:**

**Lab:**

**ISE:**

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- **ISE-2** Quizzes/Assignments/Paper Presentation/Article Discussion  
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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CSM 601	Mini Project 2B	--	--	4	--	--	2	2
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	15	--	15	20	50	

Pre-requisite Course Codes	CSC301, CSC401, CSC303	
<b>Course Outcomes</b>	CO1	Identify Methodology for solving above problem and apply engineering knowledge and skills to solve it
	CO2	Validate, Verify the results using test cases
	CO3	Analyze and evaluate the impact of solution
	CO4	Use standard norms of engineering practices and project management principles during project work
	CO5	Communicate through technical report writing and oral presentation
	CO6	Gain technical competency towards participation in Competitions, Hackathons, etc.
	CO7	Demonstrate capabilities of self-learning, leading to lifelong learning.
	CO8	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/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.



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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.

**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 the 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"> <li>• First shall be for finalization of problem</li> <li>• Second shall be on finalization of proposed solution of problem</li> </ul>
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"> <li>• First review is based on readiness of building working prototype to be conducted.</li> <li>• Second review shall be based on poster presentation cum demonstration of working model in the last month of the said semester.</li> </ul>

**Half-year project:**

1	In this case in one semester students' group shall complete project in all aspects including, Identification of need/problem <ul style="list-style-type: none"> <li>• Proposed final solution</li> <li>• Procurement of components/systems</li> <li>• Building prototype and testing</li> </ul>
2	Two reviews will be conducted for continuous assessment, <ul style="list-style-type: none"> <li>• First shall be for finalization of problem and proposed solution</li> <li>• Second shall be for implementation and testing of solution.</li> </ul>

**Mini Project** shall be assessed based on following points

- Clarity of problem and quality of literature Survey for problem identification
- Requirement gathering via SRS/ Feasibility Study
- Completeness of methodology implemented
- Design, Analysis and Further Plan
- Novelty, Originality or Innovativeness of project
- Societal / Research impact
- Effective use of skill set: Standard engineering practices and Project management standard
- Contribution of an individual's as member or leader
- Clarity in written and oral communication
- Verification and validation of the solution/ Test Cases
- Full functioning of working model as per stated requirements
- Technical writing /competition/hackathon outcome being met



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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 VI sem) all criteria in generic may be considered for evaluation of performance of students in mini projects.

<b>Guidelines for Assessment of Mini Project End Semester Examination (ESE):</b>	
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 Examiners approved by the head of the Institution.
3	Students shall be motivated to publish a paper/participate in competition based on the work in Conferences/students competitions.

**Course Assessment:**

**Lab:**

**ISE:**

ISE-1 midterm presentation will be carried out and evaluation is based on rubrics decided by the department.

ISE-2 midterm presentation will be carried out and evaluation is based on rubrics decided by the department.

ESE -Oral examination will be carried out at the end of the semester by the panel of the department.