CURRICULUM STRUCTURE

THIRD YEAR UG: B.E.

ELECTRONICS AND COMPUTER SCIENCE

REVISION: FRCRCE-1-24

Effective from Academic Year 2024-25
Board of Studies Approval: 9/03/2024
Academic Council Approval: 16/03/2024

Dr. DEEPAK BHOIR	Dr. SAPNA PRABHU	DR. SURENDRA RATHOD
Dean Academics	HoD (ECS)	Principal

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 23rd 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 leaners 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.

SEMESTERWISE CURRICULUM STRUCTURE

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)

THIRD YEAR Electronics and Computer Science Program:

SEM-V									
Course Code	Course Name		Contact Hours	Examination Marks					Credits
				ISE1	MSE	ISE2	ESE	Total	Total
ECC 501	Communication Engineering	TH	3	20	30	20	30	100	3
ECC 502	Computer Organization and Architecture	TH	3	20	30	20	30	100	3
ECC 503	Software Engineering	TH	3	20	30	20	30	100	3
ECC 504	Web Technologies	TH	3	20	30	20	30	100	3
ECCDO501	Department Optional (Course - I)	TH	3	20	30	20	30	100	3
ECL501	Communication Engineering Lab	PR	2	20	--	30	--	50	1
ECL502	Software Engineering and Web Technologies Lab	PR	2	20	--	30	--	50	1
ECL503	Department Optional (Course - I) Lab	PR	2	20	--	30	--	50	1
ECL504	Professional Communication and Ethics-II	PR	4	20	--	30	--	50	2
ECM501	Mini project - 2A	PR	4	20	--	30	--	50	2
		Total	TH:TU:PR 15:0:14			-	-	750	22

Department Level Optional Courses:

Department Level Optional Course -I (DO501)
1. Software Testing & Quality Assurance
2. ASIC Verification
3. Information Theory and Coding
4. Sensors and Applications

SEM-V									
Course Code	Course Name		Contact Hours	Examination Marks					Credits
				ISE1	MSE	ISE2	ESE	Total	Total
ECC 601	Embedded Systems and RTOS	TH	3	20	30	20	30	100	3
ECC 602	Artificial Intelligence	TH	3	20	30	20	30	100	3
ECC 603	Computer Networks	TH	3	20	30	20	30	100	3
ECC 604	Data Warehousing and Mining	TH	3	20	30	20	30	100	3
ECCDO601	Department Level Optional Course -II	TH	3	20	30	20	30	100	3
ECL 601	Embedded Systems Lab	PR	2	20	--	30	--	50	1
ECL602	Artificial Intelligence and Computer Networks Lab	PR	2	20	--	30	--	50	1
ECL603	Data Warehousing and Mining Lab	PR	2	20	--	30	--	50	1
ECL 604	Skill-based Laboratory	TH	2	--	--	--	--	--	--
		PR	2	20	--	30	--	50	2
ECM601	Mini Project 2B	PR	4	20	--	30	--	50	2
		Total	TH:TU:PR 17:0:12			-	-	750	22

Department Level Optional Courses:

Department Level Optional Course -II (DO601)
1. Machine Learning
2. Industrial Automation
3. Digital Signal Processing
4. Electronic Product Design

Honors Degree Offered to ECS 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 ECS 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

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECC 501	Communication Engineering	L	T	P	L	T	P	Total
		03	--	--	03	--	--	03
		Examination Scheme						
			ISE1	MSE	ISE 2	ESE	Total	
		Theory	20	30	20	100 (30% weight-age)	100	

Pre-requisite Course Codes	Engineering Mathematic Digital Electronics Electronic Devices	
Course Outcomes (CO):	At the End of the course students will be able to :	
Course Outcomes	CO1	Analyse various analog modulation methods.
	CO2	Explain various pulse modulation techniques.
	CO3	Evaluate the impact of Inter Symbol Interference in Baseband transmission and methods to mitigate its effect
	CO4	Compare various Digital modulation methods based on spectral efficiency, Euclidean distance etc
	CO5	Analyze the characteristics of radio receivers

Module No.	Unit No.	Topics	Ref.	Hrs.
1. Introduction to Electronic Communication	**1.1**	Electromagnetic Spectrum	[1], [2]	04
	1.2	Block diagram of Analog communication system	[1], [2]	
	1.3	Need for modulation	[1], [2]	
	1.4	Types of Noise, Signal-to-noise ratio, Noise factor, Noise Figure, Noise Temperature	[1], [2]	
2. Analog Modulation Systems	**2.1**	Principle of Amplitude Modulation (AM): Representation of AM wave (Mathematical & Graphical), Frequency spectrum of AM wave, AM Power Distribution, AM for a Complex Modulating Signal	[1], [2]	12
	2.2	Types of AM: Generation of DSB-SC using diode based balanced modulator, Generation of SSB using phase shift method	[1], [2]	
	2.3	Principles of Angle Modulation: Theory of Frequency Modulation (FM) & Phase Modulation (PM) - Basic Concepts, Spectrum Analysis of FM Wave, Noise triangle, Pre-emphasis, De-emphasis	[1], [2]	

	2.4	Comparison of AM, FM and PM	[1], [2]	
3 Radio Transmitters and Receivers	**3.1**	Radio Transmitters: Block diagram of AM & FM transmitters	[1], [2]	04
	3.2	Radio receivers: Receiver Characteristics, Superheterodyne Receiver, diode detector, Automatic gain control (AGC), Automatic frequency control (AFC)	[1], [2]	
4. Pulse Modulation	**4.1**	Sampling theorem and quantization of signals	[1], [2]	05
	4.2	Generation and Detection of Pulse Amplitude Modulation (PAM)	[1], [2]	
	4.3	Pulse Code Modulation (PCM), and Delta Modulation (DM)	[1], [2]	
	4.4	Multiplexing Techniques: Time Division Multiplexing (TDM): T1 carrier system, Frequency Division Multiplexing (FDM)	[1], [2]	
5. Pulse Shaping for Optimum Transmission	**5.1**	Line codes and their desirable properties, PSD of digital data	[1], [2]	04
	5.2	Concept of Inter symbol interference (ISI), Eye diagram: Quality Factor and BER, Nyquist Bandwidth	[1], [2]	
	5.3	Types of equalizers: Linear equalizer	[1], [2]	
	5.4	Correlative coding: Duo-binary encoding and modified duo-binary encoding	[1], [2]	
6 Digital Modulation Techniques	**6.1**	Bandpass digital transmitter and receiver model	[1], [2]	10
	6.2	Generation, detection, signal space diagram, power spectral density and spectrum efficiency analysis of: Binary Phase Shift Keying (BPSK), Quaternary Phase Shift Keying (QPSK), M-ary PSK, Binary Amplitude Shift Keying (BASK), Quadrature Amplitude Modulation (QAM), Binary Frequency Shift Keying (BFSK), Minimum Shift Keying (MSK).	[1], [2]	
			Total	**39**

Course Assessment:

Theory:

ISE-1:

Activity: Quiz 10 Marks
Seminar on Research paper (IEEE /ACM) 10 Marks

ISE-2:

Activity: Technical Report on latest trends in communication Engineering 10 Marks
Assignment 10 Marks

MSE: 30 Marks written examination based on 50% syllabus

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

Recommended Books:

1. Simon Haykin, "Communication System", John Wiley And Sons ,4th Ed
2. Taub Schilling & Saha, "*Principles Of Communication Systems*", Tata Mc-Graw Hill, Third Ed
3. Kennedy and Davis "Electronics Communication System", Tata McGraw Hill
4. T. L. Singal, "Analog and Digital Communication," Tata Mc-Graw Hill, New Delhi, First Edition, 2012.
5. Sklar B, and Ray P. K., "Digital Communication: Fundamentals and Applications," Pearson, Dorling Kindersley (India), Delhi, Second Edition, 2009.
6. Bernad Sklar,- "Digital communication", Pearson Education, 2nd Ed.
7. Simon Haykin, "Digital communication", John Wiley and sons
8. Wayne Tomasi, "Electronics Communication Systems" Pearson Education, Third Edition, 2001
9. R P Singh &S. Sapre, "Analog and Digital Communication", Tata McGraw Hill 2nd Ed.
10. Haykin Simon, "Digital Communication Systems," John Wiley and Sons, New Delhi, Fourth Edition, 2014.
11. Proakis& Salehi, "Communication System Engineering", Pearson Education.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECC 502	Computer Organization and Architecture	L	T	P	L	T	P	Total
		03	--	--	03	--	--	03
		Examination Scheme						
			ISE1	MSE	ISE 2	ESE	Total	
		Theory	20	30	20	100 (30% weight-age)	100	

Pre-requisite Course Codes	Digital Electronics Fundamental concepts of processing Data structures	
Course Outcomes (CO):	At the End of the course students will be able to :	
Course Outcomes	CO1	Define the performance metrics of a Computer
	CO2	Explain the design considerations of Processor, Memory and I/O in Computer systems
	CO3	Interpret the objectives and functions of an Operating System
	CO4	Analyze the concept of process management and evaluate performance of process scheduling algorithms
	CO5	Evaluate the advantages and limitations of Parallelism in systems
	CO6	Discuss the various architectural enhancements in modern processors

Module No.	Unit No.	Topics	Ref.	Hrs.
1. Introduction to Computer Organization	**1.1**	Fundamental Units of a Computer, Basic Measures of Computer Performance - Clock Speed, CPI, MIPs and MFlops	[1], [2]	02
	1.2	Number Representation methods- Integer and Floating-point	[1], [2]	
2. Processor Organization and Architecture	**2.1**	CPU Architecture, Register Organization, Instruction cycle, Instruction Formats	[1], [2]	05
	2.2	Control Unit Design- Hardwired and Micro-programmed Control: Vertical and Horizontal Micro-Instructions, Nano-programming	[1], [2]	
	2.3	Comparison between CISC and RISC architectures	[1], [2]	

3 Memory and I/O Organization	**3.1**	Classification of Memories-Primary and Secondary Memories, ROM and RAM, Memory Inter- leaving	[1], [2]	09
	3.2	Memory Hierarchy, Cache Memory Concepts, Mapping Techniques, Write Policies, Cache Coherency	[1], [2]	
	3.3	Virtual Memory Management-Concept,Segmentation, Paging, Page Replacement policies	[1], [2]	
	3.4	Types of I/O devices and Access methods, Types of Buses, Bus Arbitration	[1], [2]	
4. Operating System concepts	**4.1**	Concept of a Process, Process States, Process Description, Process Control Block	[1], [2]	15
	4.2	Process scheduling -Pre-emptive and Non pre- emptive scheduling algorithms (FCFS, Priority, SJF), Concept of Multi- Threading	[1], [2]	
	4.3	Inter-Process Communication, Process Synchronization, Deadlock and Prevention	[1], [2]	
	4.4	File Management -File Organization and Access	[1], [2]	
	4.5	I/O Management and Disk Scheduling: FCFS, SSTF	[1], [2]	
5. Parallelism	**5.1**	Introduction to Parallel Processing Concepts, Flynn's classification,Amdahl's law	[1], [2]	04
	5.2	Pipelining -Concept, Speedup, Efficiency, Throughput, Types of Pipeline hazards and solutions	[1], [2]	
6 Architectural Enhancements	**6.1**	Superscalar Architectures, Out-of-Order Execution, Multi-core processors, Clusters, GPU	[1], [2]	04
			Total	**39**

Course Assessment:

ISE-1:
Activity: Quiz 10 Marks
Seminar on Research paper (IEEE /ACM) 10 Marks

ISE-2:
Activity: Technical Report on latest Motherboard design 10 Marks
Assignment 10 Marks

MSE: 30 Marks written examination based on 50% syllabus

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

Recommended Books:

1. William Stallings, "*Computer Organization and Architecture: Designing for Performance*", Eighth Edition, Pearson.
2. C. Hamacher, Z. Vranesic and S. Zaky, "Computer Organization", McGraw Hill, 2002.
3. William Stallings, Operating System: Internals and Design Principles, Prentice Hall, 8th Edition
4. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating
5. P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1998.
6. B. Govindarajulu, "*Computer Architecture and Organization: Design Principles and Applications*", Second Edition, Tata McGraw-Hill.
7. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design - The Hardware/Software Interface", Morgan Kaufmann,1998
8. Achyut Godbole and Atul Kahate, Operating Systems, McGraw Hill Education, 3rd Edition
9. Andrew Tannenbaum, Operating System Design and Implementation, Pearson, 3rd Edition

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECC 503	Software Engineering	L	T	P	L	T	P	Total
		03	--	--	03	--	--	03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weight-age)	100	

Pre-requisite Course Codes	Knowledge of Software Application Domains Software Engineering Practices. Knowledge of any Programming Language	
Course Outcomes (CO):	At the End of the course students will be able to :	
Course Outcomes	CO1	Apply software engineering concept and choose process models for a software project development.
	CO2	Analyse and specify software requirement specification (SRS) for software system.
	CO3	Convert requirement model into the design model and demonstrate the use of software and user-interface design principles.
	CO4	Generate the project schedule and estimate the cost of software system.
	CO5	Identify risks and prepare RMMM plan for quality software system.
	CO6	Apply testing strategies and tactics for software system.

Module No.	Unit No.	Topics	Ref.	Hrs.
1. Introduction to Software Engineering and Process Models	**1.1**	Nature of Software, Software Process framework	[1], [3]	07
	1.2	Prescriptive Models: Waterfall Model, Incremental, RAD Models Evolutionary Process Models: Prototyping, Spiral and Concurrent Development Model. Specialized Models: Component based	[1], [3]	
	1.3	Agile process, Agility Principles, Extreme Programming (XP), Scrum.	[1], [3]	
2. Requirement Engineering and Modelling	**2.1**	Types of Requirements, Requirement Engineering Task, Software Requirement Specification (SRS), Developing Use Cases (UML)	[1], [3]	08
	2.2	Requirement Model: Scenario-based model, Class-based model, Behavioural model.	[1], [3]	
3	**3.1**	Design Concepts, Design Principles	[1], [3]	06

Design Engineering	**3.2**	Architecture Design, Component Level Design, System Level Design, User Interface Design	[1], [3]	
4. Project scheduling & Cost Estimation	**4.1**	Project Scheduling, defining a Task Set for the Software Project, Gantt charts, Program Evaluation Review Techniques (PERT), Tracking the Schedule	[1], [3]	06
	4.2	Software Project Estimation, Decomposition Techniques, LOC based, FP based and Use case-based estimations, Empirical estimation Models. COCOMO II Model.	[1], [3]	
5. Software Risk &Quality Management	**5.1**	Software Risk, Types of Risk, Risk Identification, Risk Assessment, Risk Projection, RMMM.	[1], [3]	06
	5.2	Software Quality Assurance Task and Plan, McCall's Quality Factors, Software Reliability, Formal Technical Review (FTR), Walkthrough	[1], [3]	
6 Software testing Strategies and Tactics	**6.1**	Software Testing Fundamentals, Testing strategies for conventional and Object-Oriented architectures, Unit testing, Integration testing, System Testing, Validation and System Testing.	[1], [3]	06
	6.2	Testing Tactics: White-Box Testing, Basis Path Testing, Control Structure Testing, Black-Box Testing.	[1], [3]	
			Total	**39**

Course Assessment:

Theory:

ISE-1:

Activity: Quiz 10 Marks
Assignment 10 Marks

ISE-2:

Activity: Quiz 10 Marks
Seminar on topics of latest developments in software engineering

MSE: 30 Marks written examination based on 50% syllabus

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

Recommended Books:

1. Roger S Pressman "Software Engineering: A Practitioner's Approach" 8th Edition McGraw-Hill
2. Pankaj Jalote, "An integrated approach to Software Engineering", Springer/Narosa
3. Ian Sommerville, "Software Engineering", Pearson Education (9th edition)
4. Jibitesh Mishra and Ashok Mohanty, "Software Engineering", Pearson edition
5. Rajib Mall, "Fundamentals of Software Engineering", Prentice Hall India
6. Hans Van Vilet "Software Engineering Principles and Practice" 3rd edition Wiley

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECC 504	Web Technologies	L	T	P	L	T	P	Total
		03	--	--	03	--	--	03
		Examination Scheme						
			ISE 1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weightage	100	

Pre-requisite Course Codes	Basics of programming languages, basic knowledge of HTML	
Course Outcomes (CO):	At the End of the course students will be able to :	
Course Outcomes	CO1	Design static web pages using HTML5.
	CO2	Design the layout of web pages using CSS3.
	CO3	Apply the concepts of client-side validation and scripts to static web pages using JavaScript and JQuery.
	CO4	Build responsive web pages using front-end framework Bootstrap.
	CO5	Build dynamic web pages using server -side scripting.
	CO6	Develop a web application using appropriate web development framework.

Module No.	Unit No.	Topics	Ref.	Hrs.
1. Introduction to HTML5	1.1	Basic structure of an HTML5 document, Creating an HTML5 document, Markup Tags, Heading-Paragraphs, line Breaks HTML5 Tags - Introduction to elements of HTML, Working with Text, Lists, Tables and Frames, Hyperlinks, Images and Multimedia, Forms and other HTML5 controls.	[1], [2]	04
	1.2	Self-Learning: HTML5 based game development	[1], [2]	
2. Static Web Page Design	2.1	Concept of CSS, Creating Style Sheet, CSS Properties, CSS Styling (Background, Text Format, Controlling Fonts), Working with block elements and objects, Lists and Tables, CSS Id and Class, Box Model(Introduction, Border properties, Padding Properties, Margin properties) CSS Advanced: (Grouping, Dimension, Display, Positioning, Floating, Align, Pseudo class, Navigation Bar, Image Sprites, Attribute sector)	[1], [2]	04

	2.2	Self-Learning: Creating page Layout and Site Designs	[1], [2]	
3 Client-side scripting	**3.1**	**JavaScript** Introduction to JavaScript, Lexical Structure, Types, Values, Variables, Expressions and Operators, Statements, Objects, Arrays, Functions, Pattern matching with regular expressions, JavaScript in Web Browsers, The Window object, Scripting Documents, Scripting CSS, Handling Events	[1], [2]	06
	3.2	**jQuery** jQuery Basics, jQuery Getters and Setters, Altering Document Structure, Handling events with jQuery, Animated Effects, Utility functions, jQuery Selectors and Selection Methods, Extending jQuery with Plug-ins, The jQuery UI Library	[3]	04
	3.3	Self-Learning: JavaScript Framework -AngularJS	[3]	
4. Bootstrap	**4.1**	Introduction to Bootstrap, downloading and installing Bootstrap. **The Grid System**: Introducing the Grid, Offsetting and Nesting, Responsive Features, Utility Classes, and Supported Devices. **CSS Foundations**: Typography in Bootstrap, Styling Tables, Styling Forms, Styling Buttons, Images, icons, and Thumbnails. **Navigation Systems**: Tabs, Pills, and Lists, Breadcrumbs and Pagination, Navigation Bar, Making the Navigation Bar Responsive. **JavaScript Effects**: Drop-downs, Modal Windows, Tooltips and Popovers, Navigation Aids: Tabs, Collapse, Affix, Carousel.	[5]	06
	4.2	Self-Learning: Bootstrap Customization: Combining Elements in Bootstrap, Customizing by Components, Plugins, and Variables.	[1], [2]	
5. Server side-scripting	**5.1**	Introduction to PHP, PHP Tags, Adding Dynamic content, Accessing form variables, Identifiers, user-declared variables, Data types, Constants, Operators, Control structures, Conditionals, Iteration constructs, Using arrays, string manipulation and regular expressions, reusing code and writing functions, Designing and creating your web database, Accessing MySQL database from the Web with PHP, Session Control in PHP.	[3]	10
	5.2	Self-Learning: PHP-NoSQL Database connectivity e.g. PHP-MongoDB connectivity	[1], [2]	

6 Web Development Framework	**6.1**	MVC architecture - Introduction and applications Server side-scripting – Laravel Framework Managing Your Project Controllers, Layout, Views, and Other Assets, Talking to the Database, Model Relations, Scopes, and Other Advanced Features, Integrating Web Forms, Authenticating and Managing Your Users, Deploying, Optimizing and Maintaining Your Application	[6]	05
	6.2	Self-learning: Django Framework, Interactive web sites, web-based information system, blogs, social networking sites,	[6]	
			Total	**39**

Course Assessment:

Theory:

ISE-1:

Activity: Quiz 20 marks

ISE-2:

Activity: Quiz 10 marks
Assignment 10 marks

MSE: 30 Marks written examination based on 50% syllabus

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

Recommended Books:

1. Ralph Moseley , M.T. Savliya , "Developing Web Applications", Willy India, Second Edition,
2. "Web Technology Black Book", Dreamtech Press, First Edition, 978-7722-997
3. Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5" Third Edition, O'REILLY,2014.(http://www.ebooksbucket.com/uploads/itprogramming/javascript/Learning_PHP_MySQL_Javascript_CSS_HTML5__Robin_Nixon_3e.pdf)
4. Professional Rich Internet Applications: AJAX and Beyond, Dana Moore, Raymond Budd, Edward Benson, Wiley publications. **https://ebooks-it.org/0470082801-ebook.htm**
5. Jennifer Kyrnin, "SAMS Teach Yourself Bootstrap in 24 hours", 1st edition, Pearson Education.
6. Martin Bean, "Laravel 5 Essentials", PACKT Publishing Ltd
7. Harvey & Paul Deitel & Associates, Harvey Deitel and Abbey Deitel, "Internet and World Wide Web - How To Program", Fifth Edition, Pearson Education, 2011.
8. Achyut S Godbole and Atul Kahate, "Web Technologies", Second Edition, Tata McGraw Hill, 2012.

9. Thomas A Powell, Fritz Schneider, "JavaScript: The Complete Reference", Third Edition, Tata McGraw Hill, 2013.
10. David Flanagan, "JavaScript: The Definitive Guide, Sixth Edition", O'Reilly Media, 2011
11. Steven Holzner, "The Complete Reference – PHP", Tata McGraw Hill, 2008
12. Mike Mcgrath, "PHP & MySQL in easy Steps", Tata McGraw Hill, 2012.
13. J. Millman and A. Grabel, "Head First HTML and CSS", 2nd edition, O" Reilly.
14. Ben Frain, "Responsive Web design with HTML5 and CSS3", PACKT Publishing Ltd.
15. L. Welling and L. Thomson, "PHP and MySQL Web Development", 4th edition, Adison Wesley Professional.

Digital Material:

1. www.nptelvideos.in
2. www.w3schools.com
3. http://spoken-tutorial.org

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECCDO501	Software Testing & Quality Assurance	L	T	P	L	T	P	Total
		03	--	--	--	03	--	03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	

Pre-requisite Course Codes	Programming Language (C++, Java), Software Engineering	
Course Outcomes (CO):	At the End of the course students will be able to :	
Course Outcomes	CO1	Investigate the reason for bugs and analyse the principles in software testing to prevent and remove bugs.
	CO2	Understand various software testing methods and strategies.
	CO3	Design test planning
	CO4	Manage the test process.
	CO5	Apply the software testing techniques in the commercial environment
	CO6	Use practical knowledge of a variety of ways to test software and quality attributes

Module No.	Unit No.	Topics	Ref.	Hrs.
1. Testing Methodology	1.1	Introduction to Software Testing: Introduction, Goals of Software Testing, Software Testing Definitions, Model for Software Testing, Effective Software Testing vs Exhaustive Software Testing, Software Failure Case Studies	[1], [2]	08
	1.2	Software Testing Terminology and Methodology: Software Testing Terminology, Software Testing Life Cycle (STLC), Software Testing methodology	[1], [2]	
	1.3	Verification and Validation: Verification, Verification requirements, Validation	[1], [2]	
2. Testing Techniques	2.1	Black Box testing: boundary value analysis, equivalence class testing, state table-based testing, cause-effect graphing based testing, error guessing.	[1], [2]	09
	2.2	White box Testing Techniques: need, logic coverage criteria, basis path testing, graph matrices, loop testing, data flow testing, mutation testing, Static Testing.	[1], [2]	

	2.3	Validation Activities: Unit validation, Integration, Function, System, Acceptance Testing.	[1], [2]	
	2.4	Regression Testing: Progressive vs. Regressive	[1], [2]	
3 Managing the Test Process	**3.1**	Test Management: test organization, structure and of testing group, test planning, detailed test design and test specification.	[1], [2]	07
	3.2	Software Metrics: need, definition and classification of software matrices.	[1], [2]	
	3.3	Efficient Test Suite Management: minimizing the test suite and its benefits	[1], [2]	
4. Test Automation	**4.1**	Automation and Testing Tools: need, categorization, selection and cost in testing tool,	[1], [2]	04
	4.2	Guidelines for testing tools.	[1], [2]	
5. Testing for specialized environment	**5.1**	Agile Testing, Agile Testing Life Cycle, Challenges in Agile Testing	[1], [2]	05
	5.2	Testing Object-Oriented Software: OOT Basics, Object-oriented Testing	[1], [2]	
6 Quality Management	**6.1**	Software Quality Management, McCall's quality factors and Criteria	[1], [2]	06
	6.2	ISO9000:2000, SIX Sigma	[1], [2]	
Total				**39**

Course Assessment:

Theory:

ISE-1:

Activity: Quiz 10 Marks
Seminar on Research paper (IEEE /ACM) 10 Marks

ISE-2:

Activity: Analyze case studies or scenarios related to software testing and QA practices. 10 Marks
Assignment 10 Marks

MSE: 30 Marks written examination based on 50% syllabus

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

Recommended Books:

1. Software Testing Principles and Practices Naresh Chauhan Oxford Higher Education
2. Software Testing and quality assurance theory and practice by Kshirasagar Naik, Priyadarshi Tripathy, Wiley Publication
3. Effective Methods for Software Testing, third edition by Willam E. Perry, Wiley Publication
4. Software Testing Concepts and Tools by Nageswara Rao Pusuluri, Dreamtech press

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ECCDO501	ASIC Verification	03	--	--	03	--	--	03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weightage	100	

Pre-requisite Course Codes	Digital Electronics	
Course Outcomes (CO):	At the End of the course students will be able to :	
Course Outcomes	CO1	Demonstrate an understanding of programmable devices and verification methodologies.
	CO2	Exploit new constructs in System Verilog.
	CO3	Summarize ASIC verification techniques such as Randomization, assertions, coverage etc.
	CO4	Create layered test benches for digital designs in system Verilog.
	CO5	Carry out verification of design successfully using simulators.

Module No.	Unit No.	Topics	Ref.	Hrs.
1. Programmable Devices and Verification Basics	1.1	**Programmable Devices**: Different types of Integrated Circuits- CPLD, FPGA, ASIC, SoC (System-on-Chip), SiP (System-in-Package), MCM (Multi-Chip Module), SoP (System-on-Package), Choices based on application and cost, Architecture of FPGA, CPLD (Xilinx and Altera family devices) , Difference between ASIC, FPGA and CPLD, ASIC flow and overview of types of tools used in each stage of lifecycle	[1], [2]	07
	1.2	**Verification Basics**: Introduction, Verification Process, Verification Plan, Verification Methodology options, Basic Testbench Functionality, Directed Testing, Constrained-Random Stimulus, Functional Coverage, Testbench Components, Layered Testbench, Technology challenges test, Verification languages, Verification IP reuse, Verification approaches.	[1], [2]	

2. Data types, Procedural statements, Connecting the Test bench and Design	**2.1**	Data Types: Built-in Data Types, Logic Data type, Fixed-Size Arrays (Packed and Unpacked arrays), Dynamic Arrays, Queues, associative array, array methods – Reduction, Locator & ordering, Creating New Types with typedef, Creating User-Defined Structures, Enumerated Types, Constants, Strings, Expression width	[1], [2]	08
	2.2	**Procedural statements:** Procedural Statements, Tasks, Functions, and Void Functions, routine arguments, returning from a routine, Time values.	[1], [2]	
	2.3	**Connecting the Test bench and Design:** Separating the testbench and design, The Interface construct, Grouping Signals in an Interface using Modports, Creating Interface Monitor, Stimulus timing with Clocking Block, Testbench design Race Condition, Program Block, Connecting it all together, Top level Scope, Program-Module interactions.	[1], [2]	
3 Basic Object - Oriented Programming	**3.1**	**OOP**: Class, Creating new objects, Where to Define a Class, OOP Terminology, Understanding Dynamic objects, Object Deallocation, using objects, Static vs Global Variables, Class methods, Defining methods outside class, Scoping rules, Using one class inside another, Understanding Dynamic objects, Copying objects, public vs. local, Building a testbench	[1], [2]	06
4. Randomization and Inter-process Communication	**4.1**	**Randomization:** Randomization in system Verilog, Constraint details, Solution probabilities, Controlling multiple constraint blocks, Valid constraints, In-line constraints, The pre-randomize and post-randomize functions, Random number functions, Constraints tips and techniques.	[1], [2]	07
	4.2	**Threads and Inter-process Communication:** Working with threads, disabling threads, inter-process communication, Events, Semaphores, Mailboxes, building a testbench with threads and IPC.	[1], [2]	
5. System Verilog Assertions and Functional Coverage	**5.1**	**SystemVerilog Assertions**: Types of Assertions and examples, Immediate Assertions, Concurrent Assertions, SVA Property and Sequences, Implication (Overlapped & Non-Overlapped) Operator and Repetition Operator, SystemVerilog Assertion built-in methods ($rose, $fell, $stable, $past)	[1], [2]	07

	5.2	**Functional Coverage**: Coverage Types, Functional Coverage Strategies, Simple Functional Coverage Example, anatomy of a cover group, triggering a cover group, data sampling, cross coverage, generic cover groups, Coverage Options, Parameterized Cover Groups, Analysing Coverage Data, Measuring Coverage Statistics During Simulation.	[1], [2]	
6 System Verilog Testbench Case studies	**6.1**	A complete System Verilog Layered TestBench for the simple design of ADDER and Memory module-TestBench Architecture, Transaction Class, Generator Class, Interface, Driver Class, Monitor, Scoreboard, Environment, Test, Test Bench Top	[1], [2]	04
			Total	**39**

Course Assessment:

Theory:

ISE-1:

Activity: Quiz 10 Marks
Assignment 10 Marks

ISE-2:

Activity: Quiz 10 Marks
Assignment 10 Marks

MSE: 30 Marks written examination based on 50% syllabus

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

Recommended Books:

1. Chris Spear, "System Verilog for Verification: A guide to learning the testbench language features", Springer, 3rd Edition
2. Janick Bergeron, "Writing Testbenches Using SystemVerilog", Springer 2006.
3. Stuart Sutherland, Simon Davidmann, and Peter Flake, "System Verilog for Design: A guide to using system verilog for hardware design and modeling", Springer, 2nd Edition.
4. Ben Cohen, Srinivasan Venkataramanan, Ajeetha Kumari and Lisa Piper, "SystemVerilog Assertions Handbook", Vhdl Cohen Publishing, 3rd edition
5. S Prakash Rashinkar, Peter Paterson and Leena Singh, "System on Chip Verification Methodologies and Techniques", Kluwer Academic, 1st Edition
6. System Verilog Language Reference manual
7. Samir Palnitkar, "Verilog HDL: A guide to Digital Design and Synthesis" second edition,Pearson – IEEE 1364-2001 compliant
8. Spartan and Virtex family user manuals from Xilinx

9. Verilog Language Reference manual

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ECCDO501	Information Theory and Coding	03	--	--	03	--	--	03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	

Pre-requisite Course Codes	Engineering Mathematics	
Course Outcomes (CO):	At the End of the course students will be able to :	
Course Outcomes	CO1	Comprehend the significance of this quantitative measure of information in the communication systems.
	CO2	Explain entropy, joint entropy, relative entropy, conditional entropy, and channel capacity of a system.
	CO3	Obtain knowledge in designing various source codes and channel codes.
	CO4	Differentiate between lossy and lossless compression techniques.
	CO5	Analyze an efficient data compression scheme for a given information source.
	CO6	Apply the concepts of multimedia communication.

Module No.	Unit No.	Topics	Ref.	Hrs.
1. Introduction to Information Theory	1.1	Introduction to Probability theory: Axiomatic definition of probability, Bayes Theorem.	[1], [2]	07
	1.2	One random variable: Types of random variable, Discrete & Continuous, PMF, PDF and Cumulative distribution Function, Conditional Probability, Independent Event.	[1], [2]	
	1.3	Two Random Variable: Discrete and Continuous, Joint probability density function, Joint Distribution function, Marginal probabilities, joint conditional probability.	[1], [2]	
	1.4	Concept of amount of information, information units, Entropy: marginal, conditional, joint and relative entropies	[1], [2]	
	1.5	Relation among entropies Mutual information, information rate.	[1], [2]	

2. Source Coding Techniques	**2.1**	Block Diagram of Digital Communication system	[1], [2]	06
	2.2	Encoding techniques, Purpose of encoding, Instantaneous codes, Construction of instantaneous codes, Kraft's inequality, Coding efficiency and redundancy	[1], [2]	
	2.3	Source coding theorem. Construction of basic source codes: Shannon Fano coding.	[1], [2]	
	2.4	Huffman codes, Extended Huffman coding, Arithmetic Coding, Lempel - Ziv Algorithm-LZW	[1], [2]	
3 Information Channels	**3.1**	Information Channels: Communication Channels	[1], [2]	06
	3.2	Channel Models, Channel Matrix, Joint probability Matrix, Binary Symmetric Channel, System Entropies, Mutual Information, Channel Capacity	[1], [2]	
	3.3	Discrete Memoryless channels: Binary Symmetric Channel (BSC), Channel Capacity of BSC, redundancy and efficiency of channels.	[1], [2]	
	3.4	Channel Capacity: Hartley – Shannon law.	[1], [2]	
4. Codes for error detection and correction	**4.1**	Parity check coding, Linear block codes, Error detecting and correcting capabilities	[1], [2]	08
	4.2	Generator and Parity check matrices, Standard array and Syndrome decoding, Hamming codes.	[1], [2]	
	4.3	Cyclic codes: Generator polynomial, Generator and Parity check matrices, Encoding of cyclic codes.	[1], [2]	
	4.4	Syndrome computation and error detection, Decoding of cyclic codes.	[1], [2]	
5. Convolution Codes	**5.1**	Encoding and State, Tree and Trellis diagrams.	[1], [2]	06
	5.2	Maximum likelihood decoding of convolution codes, Viterbi algorithm, Sequential decoding -Stack algorithm	[1], [2]	
	5.3	Interleaving techniques: Block and convolution interleaving.	[1], [2]	
6 Audio and Video Coding	**6.1**	Linear Predictive coding, code excited LPC, Perceptual coding, MPEG audio coders, Dolby audio coders.	[1], [2]	06
	6.2	Video compression: Principles, Introduction to H.265 & MPEG-4 Part 10 Video standards.	[1], [2]	
			Total	**39**

Course Assessment:

Theory:

ISE-1:

Activity: Quiz 10 Marks
Seminar on Research paper (IEEE /ACM) 10 Marks

ISE-2:

Activity: Find out latest algorithm for compression in Information theory 10 Marks
Assignment 10 Marks

MSE: 30 Marks written examination based on 50% syllabus

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

Recommended Books:

1. Simon Haykin, *Communication Systems*, 4th Edition, John Wiley and Sons.
2. Ranjan Bose, Information theory, coding and cryptography, 2nd Edition, Tata McGraw-Hill.
3. R. Togneri, C.J.S deSilva, *Fundamentals of Information Theory and Coding Design*, 1st Edition, Taylor and Francis.
4. Fred Halsall, *Multimedia Communications, Applications Networks Protocols and Standards*, Pearson Education, 1st Edition, Asia.
5. Bernard Sklar, *Digital Communications Fundamentals and Applications*,2nd Edition, Person Education Asia.
6. Taub and Schilling, *Principles of Communication Systems* ,2nd Edition, Tata McGraw-Hill.
7. Glover and Grant, *Digital Communication,* 2ndEdition, Pearson.
8. T. M. Cover, J. A. Thomas, *Elements of Information Theory*, 2nd Edition, Wiley.
9. Mark Nelson, *Data Compression Book*, 2nd Edition, BPB Publication.
10. Watkinson J, *Compression in Video and Audio*, 1st Edition, Focal Press, London.
11. R. J. McEliece, *The Theory of Information and Coding*, 1st Edition, Cambridge University Press.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ECCDO501	Sensors and Applications	03	--	--	03	--	--	03
		Examination Scheme						
			ISE1	MSE	ISE2	ESE		Total
		Theory	20	30	20	100 (30% weightage		100

Pre-requisite Course Codes	Concept of internal characteristics of passive elements like resistor, capacitor inductor etc., Diode and transistor Working, knowledge of basic fundamentals of mechanical terms like position strain, stress etc	
Course Outcomes (CO):	At the End of the course students will be able to :	
Course Outcomes	CO1	Understand the concept of sensors and its characteristics
	CO2	Understand the practical approach in design of technology based on different sensors
	CO3	Learn various sensor materials and technology used in designing sensors
	CO4	Implement a prototype for demonstrating the application of the sensors
	CO5	Demonstrate problem solving & troubleshooting skills in sensor applications

Module No.	Unit No.	Topics	Ref.	Hrs.
1. Sensors Fundamentals and Characteristics Sensors, Signals and Systems	**1.1**	Sensor Classification–Physical, Mechanical, Electrical, Chemical, electrochemical	[1], [2]	06
	1.2	Functional unit of sensor: receptor and transducer; Units of Measurements		
	1.3	Sensor Characteristics, Physical Principles of Sensing Electric Charges, Fields, and Potentials; Capacitance; Magnetism; Induction; Resistance; Piezoelectric Effect; Hall Effect; Temperature and Thermal Properties of Material; Heat Transfer; Light; Dynamic Models of Sensor Elements		
2. Interface	**2.1**	Input Characteristics of Interface Circuits, Amplifiers, Excitation Circuits	[1], [2]	06

Electronic Circuits	**2.2**	Analog to Digital Converters, Direct Digitization and Processing, Bridge Circuits, Data Transmission, Batteries for Low Power Sensors		
	2.3	Analog and digital filtering		
3 Sensors in Different Applications	**3.1**	Area Occupancy and Motion Detectors; Position, Displacement, and Level; Velocity and Acceleration; Force, Strain, and Tactile Sensors; Pressure Sensors	[1], [2]	08
	3.2	Temperature Sensors; Biosensors, Gas sensors, proximity sensor. (Correlation of output with the parameter being measured in engineering terms): Only Working principle of each type of sensors and transduction action (for example: detection of change in temperature and conversion to electrical quantity say resistance and corresponding correlation)		
	3.3	Case study of Applications of sensors in Automotive, Manufacturing plants, digital devices such as mobile phone, house-hold instrument such as washing machine (name of various sensors and their usability in each of these applications).		
4. Sensor Materials and Technologies	**4.1**	MEMS-cantilever based sensors and their types such as, accelerometer, gyroscopes: Structure, material used (polysilicon, Silicon etc), working principle, applications	[1], [2]	07
	4.2	Metal oxide semiconductor (nano-particles) based sensors such as gas sensors, biomedical sensors, chemical sensors (Structure, material used, working principle, applications)		
5. Smart Sensors	**5.1**	4-20 mA Current Loop	[1], [2]	06
	5.2	Types of smart Sensors, Limitations of single sensor and applicability of Array-based sensor technology, Electronic-Nose sensors		
	5.3	HART, Industrial buses such as Profibus, CAN bus, etc.		
6 Industrial standards for the sensors and its calibration	**6.1**	Basic knowledge about IEC 60601-1-1: Medical Electrical Equipment – Part 1-1, ISA S82.01, NEMA standards	[1], [2]	06
	6.2	PCI 6.5 to SOX compliance, HIPAA compliance, and FISMA compliance in software development: Basic introduction about each of these standards, Calibration and compatibility		
			Total	**39**

Course Assessment:

Theory:

ISE-1:

(a) Assignments for 10 marks
(b) Multiple choice questions (MCQ) quiz of 10 marks for a 1 hour duration

ISE-2:

Student seminars based on case study application in practical, real-life domains for 20 marks, 1 hour duration

MSE: 30 Marks written examination based on 50% syllabus

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

Recommended Books:

1. Jacob Fraden, Handbook of Modern Sensors Physics, Designs, and Applications, Fourth Edition, Springer
2. D. Patranabis, Sensors and Transducers, 2nd Edition, PHI Publication, New Delhi
3. Mechatronics- Ganesh S. Hegde, Published by University Science Press, 2nd Edition, An imprint of Laxmi Publication Private Limited
4. Terry Bartelt, Process Control Systems and Instrumentation, Delmar Cengage Learning India Edition New edition
5. www.nptel.ac.in
6. G. Eranna , Metal Oxide Nanostructures as Gas Sensing Devices, Publisher: CRC Press
7. ISA S82.01 - Safety Standard for Electrical & Electronic Test, Measuring, Controlling Related Equipment
8. http://www.ebme.co.uk/arts/safety/part6.htm

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECL 501	Communication Engineering Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes	Engineering Mathematics Digital Electronics Electronic Devices	
At the end of the laboratory course, students will be able to:		
Course Outcomes	CO1	Perform hardware implementation of various analog and digital modulation methods.
	CO2	Illustrate generation and detection of various pulse modulation techniques.
	CO3	Apply techniques to insert Inter Symbol Interference and methods to mitigate its effect.
	CO4	Simulate various analog and digital modulation methods.
	CO5	Demonstrate multiplexing and demultiplexing of signals using multiplexing techniques.
	CO6	Illustrate the effect of sampling frequency on the reconstructed signal.

Experiment No.	Title	Ref.
1	Analog Modulation and demodulation: AM	1,2
2	Analog Modulation and demodulation: FM	1,2
3	Pre-emphasis &De-emphasis	1,2
4	Analog Pulse modulation (PAM/PWM/PPM)	1,2
5	Time division multiplexing	1,2
6	Frequency division multiplexing	1,2
7	Verification of Sampling theorem	1,2
8	Generation of Line codes	1,2
9	Binary modulation and demodulation of BASK	1,2
10	Binary modulation and demodulation of BPSK	1,2
11	Binary modulation and demodulation of BFSK	1,2
	Simulation-based experiments	
12	Simulation of AM and FM	1,2
13	Simulation of PAM, PPM, PWM	1,2
14	Simulation of BPSK/BASK/MSK modulation	1,2
15	Simulation of duobinary encoder, decoder	1,2

Laboratory Assessment:

ISE:

1. **ISE-1** will be conducted for five experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

2. ISE-2

a. Five experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.
b. Activity: Design of Experiment (10 marks)

Recommended Books:

1. Simon Haykin, "Communication System", John Wiley And Sons ,4th Ed
2. Taub Schilling & Saha, "Principles Of Communication Systems", Tata Mc-Graw Hill, Third Ed
3. Kennedy and Davis "Electronics Communication System", Tata McGraw Hill
4. T. L. Singal, "Analog and Digital Communication," Tata Mc-Graw Hill, New Delhi, First Edition, 2012.
5. Sklar B, and Ray P. K., "Digital Communication: Fundamentals and Applications," Pearson, Dorling Kindersley (India), Delhi, Second Edition, 2009.
6. Bernad Sklar,- "Digital communication", Pearson Education, 2nd Ed.
7. Simon Haykin, "Digital communication", John Wiley and sons
8. Wayne Tomasi, "Electronics Communication Systems" Pearson Education, Third Edition, 2001.
9. R P Singh &S. Sapre, "Analog and Digital Communication", Tata McGraw Hill 2nd Ed.
10. Haykin Simon, "Digital Communication Systems," John Wiley and Sons, New Delhi, Fourth Edition, 2014.
11. Proakis& Salehi, "Communication System Engineering", Pearson Education.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECL 502	Software Engineering and Web Technologies Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes	Knowledge of Software Application Domains, Software Engineering Practices. Knowledge of any Programming Language Basics of programming languages, basic knowledge of HTML	
At the end of the laboratory course, students will be able to:		
Course Out-comes	CO1	Identify requirements and apply process model to selected case study.
	CO2	Analyse and design models for the selected case study using UML modeling
	CO3	Use various Software Engineering and Project Management Tools
	CO4	Design static web pages using HTML5, CSS3, Bootstrap.
	CO5	Apply the concepts of Client-side validation and scripts to static web pages using JavaScript and JQuery.
	CO6	Build dynamic web pages using Server-Side Scripting.

Experiment No.	Title	Ref.
	Software Engineering	
1	Prepare detailed statement of problem with feasibility study and identify suitable process model for the same with justification. *	1,2
2	Develop Software Requirement Specification (SRS) document in IEEE format for the project. *	1,2
3	Prepare schedule for the project using any project management tool *	1,2
4	Prepare RMMM plan for the project.	1,2
5	Identify scenarios & develop UML Use case and Class Diagram for the project. *	1,2
6	Develop Activity / State Transition diagram and Sequence diagram for the project. *	1,2
7	Develop test cases for the project using white box testing.	1,2
	Web Technologies	
1	a) Installation and Setting of LAMP / WAMP / XAMP.	1,2
	b) Develop a Prototype of the selected problem statement (UI and UX).	1,2
2	Design and Implement web pages using HTML5 and CSS3 on the selected	1,2

	problem statement.	
3	Design Form using javascript/HTML/JQuery with client-side validations on the selected problem statement.	
4	Design Interactive web pages using PHP (any framework) with database connectivity to MySQL on the selected problem statement.	1,2
5	Design and Implement web pages with PHP and Ajax on the selected problem statement.	1,2
6	Enhance the web page designed in experiment number 2 using bootstrap.	1,2

Laboratory Assessment:

ISE:

1. **ISE-1** will be conducted for **four experiments**. Continuous pre-defined rubrics-based evaluation for 20 marks.

2. ISE-2 will be conducted for **Six experiments**. Continuous pre-defined rubrics-based evaluation for 30 marks.

Recommended Books:

1. "The Unified Modeling Language User Guide" by Grady Booch, James Rumbaugh, Ivar Jacobson, Pearson Publication, ISBN 978-81-7758-372-4
2. UML – Tutorial www.tutorialspoints.com/uml/
3. "Fundamentals of Object-Oriented Design in UML", Meilir Page-Jones, Pearson Education
4. UML Basics— an Introduction to the Unified Modeling Language – IBM "www.ibm.com › Learn › Rational"
5. UML in 24 Hours

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECL 503	Software Testing & Quality Assurance Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		Programming Language (C++, Java), Software Engineering
At the end of the laboratory course, students will be able to:		
Course Outcomes	CO1	Understand the system thoroughly (for requirement, designing and implementation).
	CO2	Recognize failures in the system.
	CO3	Investigate the reason for bugs.
	CO4	Design test plan and test cases.
	CO5	Execute the test cases manually and using automated tools.
	CO6	Manage the testing process.

Experiment No.	Title	Ref.
1	Write programs in C Language to demonstrate the working of the following a. constructs: i) do...while ii) while....do iii) if...else iv) switch	1,2
2	Write a program for any one function of the selected system. Introspect the causes for its failure and write down the possible reasons for its failure.	1,2
3	Study the system, requirement specifications and Designing the system.	1,2
4	Write the brief test plan.	1,2
5	Select the test cases (positive and negative scenarios) for the selected system.	1,2
6	Design Test cases for the system using boundary value analysis or equivalent class partitioning.	1,2
7	Manual execution of test cases and prepare defect reports.	1,2
8	Identify regression scenarios for automation for any one/two test case.	1,2
9	Study of any testing tool (e.g. Selenium).	1,2
10	Automate the scenario in exp 8 with a testing tool. (e.g. Selenium)	1,2
11	Study of any test management tool (e.g. Qase).	1,2

12	Writing down test cases and execution using tools (e.g. Qase).	1,2
13	Study defect management (e.g. JIRA)	1,2
14	Design quality matrix for your system.	1,2

Laboratory Assessment:

ISE:

1. **ISE-1** will be conducted for five experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

2. ISE-2

a. Five experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.
b. Activity: Mini- Project/assign task to automate a specific test scenario using a chosen test automation tool ((10 marks)

Recommended Books:

1. Software Testing Principles and Practices Naresh Chauhan Oxford Higher Education
2. Software Testing and quality assurance theory and practice by Kshirasagar Naik, Priyadarshi Tripathy, Wiley Publication
3. Effective Methods for Software Testing, third edition by Willam E. Perry, Wiley Publication
4. Software Testing Concepts and Tools by Nageswara Rao Pusuluri, Dreamtech press

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECL 503	ASIC Verification	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes	Digital Electronics	
At the end of the laboratory course, students will be able to:		
Course Out-comes	CO1	Create test plan and test cases to verify any digital design.
	CO2	Apply the advanced verification techniques like Randomization on set of inputs.
	CO3	Create a transaction class and apply object -oriented programming for Verification.
	CO4	Carry out simulation of designs using System Verilog hardware verification language.
	CO5	Develop a complete Layered Testbench for any digital design.

Experiment No.	Title	Ref.
1	Write Verilog code for 4:1 MUX using all Verilog modeling styles and simulate the same.	1,2
2	Write Verilog code and testbench for D flip flop and 4 bit counter and simulate the same.	1,2
3	Create a test plan and self-checking test-bench for the ALU.	1,2
4	Create dynamic arrays, associative arrays, and queues using System Verilog.	1,2
5	Write test bench using dynamic arrays, associative arrays with System Verilog to test a synchronous 8-bit x64K (512kBit) RAM.	1,2
6	Create an Interface for a Memory Design. Use Modport to assign direction to signal.	1,2
7	Create class and its objects and perform deep copy and shallow copy.	1,2
8	Create an Interface for a Memory Design. (without modport)	1,2
9	To understand and create Virtual interface and use it in a class.	1,2
10	Given design specifications, draw waveform and write SVA expressions.	1,2
11	Given design specifications, draw waveform and write clock based Sequences	1,2

12	Create IPCs like events, mailbox and semaphores to interact between threads.	1,2
13	Find coverage by writing cover groups for a design.	1,2
14	Implementation of parallel processes using Fork Join/ join_any/ join_none statement.	1,2
15	Create a layered testbench for a simple design like Adder.	1,2

Laboratory Assessment:

ISE:

1. **ISE-1** will be conducted for **four experiments**. Continuous pre-defined rubrics-based evaluation for 20 marks.
2. **ISE-2** will be conducted for **Six experiments**. Continuous pre-defined rubrics-based evaluation for 30 marks.

Recommended Books:

1. Chris Spear, "System Verilog for Verification: A guide to learning the testbench language features", Springer, 3rd Edition
2. Janick Bergeron, "Writing Testbenches Using System Verilog", Springer 2006.
3. Stuart Sutherland, Simon Davidmann, and Peter Flake, "System Verilog for Design: A guide to using system verilog for hardware design and modeling", Springer, 2nd Edition.
4. Ben Cohen, Srinivasan Venkataramanan, Ajeetha Kumari and Lisa Piper, "SystemVerilog Assertions Handbook", Vhdl Cohen Publishing, 3rd edition
5. S Prakash Rashinkar, Peter Paterson and Leena Singh, "System on Chip Verification Methodologies and Techniques", Kluwer Academic, 1st Edition
6. System Verilog Language Reference manual
7. Samir Palnitkar, "Verilog HDL: A guide to Digital Design and Synthesis" second edition,Pearson – IEEE 1364-2001 compliant
8. Spartan and Virtex family user manuals from Xilinx
9. Verilog Language Reference manual

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECL 503	Information Theory and Coding	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes	Engineering Mathematics	
At the end of the laboratory course, students will be able to:		
Course Outcomes	CO1	Understand the basics of information theory, source coding techniques and calculate Entropy of source.
	CO2	Implement Shannon-Hartley equation to find the upper limit on the Channel Capacity.
	CO3	Apply various channel coding schemes & demonstrate their capabilities towards the improvement of the noise performance of communication system.
	CO4	Apply the knowledge of digital electronics and describe the error control codes like block code, cyclic code and convolutional codes.
	CO5	Implement audio and video compression techniques

Experiment No.	Title	Ref.
1	Write a program for determination of entropy and mutual information of a given channel: Noise free channel.	1,2
2	Write a program for determination of entropy and mutual information of a given channel: Binary symmetric channel.	1,2
3	Write a program for Shannon-Hartley equation to find the upper limit on the Channel Capacity	1,2
4	Write a program for generation and evaluation of variable length source coding Shannon – Fano Coding and decoding.	1,2
5	Write a program for generation and evaluation of variable length source coding Huffman Coding and decoding.	1,2
6	Write a program for generation and evaluation of variable length source coding LZW Coding and decoding.	1,2
7	Write a program for Forward error correction system with a given Linear block code.	1,2
8	Write a Program for coding & decoding of Linear block codes.	1,2
9	Write a Program for coding & decoding of Cyclic codes.	1,2

10	Write a program for coding and decoding of Convolutional codes.	1,2
11	Write a program for computing the LPC coefficients.	1,2
12	Write a program for video compression.	1,2

Laboratory Assessment:

ISE:

1. **ISE-1** will be conducted for **four experiments**. Continuous pre-defined rubrics-based evaluation for 20 marks.
2. **ISE-2** will be conducted for **Six experiments**. Continuous pre-defined rubrics-based evaluation for 30 marks.

Recommended Books:

1. Simon Haykin, Communication Systems, 4th Edition, John Wiley and Sons.
2. Ranjan Bose, Information theory, coding and cryptography, 2nd Edition, Tata McGraw-Hill.
3. R. Togneri, C.J.S deSilva, Fundamentals of Information Theory and Coding Design, 1st Edition, Taylor and Francis.
4. Fred Halsall, Multimedia Communications, Applications Networks Protocols and Standards, Pearson Education, 1st Edition, Asia.
5. Bernard Sklar, Digital Communications Fundamentals and Applications,2nd Edition, Person Education Asia.
6. Taub and Schilling, Principles of Communication Systems ,2nd Edition, Tata McGraw-Hill.
7. Glover and Grant, Digital Communication, 2ndEdition, Pearson.
8. T. M. Cover, J. A. Thomas, Elements of Information Theory, 2nd Edition, Wiley.
9. Mark Nelson, Data Compression Book, 2nd Edition, BPB Publication.
10. Watkinson J, Compression in Video and Audio, 1st Edition, Focal Press, London.
11. R. J. McEliece, The Theory of Information and Coding, 1st Edition, Cambridge University Press.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECL 503	Sensors and Applications	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes	Concept of internal characteristics of passive elements like resistor, capacitor, induc tor etc., Diode and transistor Working, knowledge of basic fundamentals of mechanical terms like position, strain stress etc	
At the end of the laboratory course, students will be able to:		
Course Outcomes	CO1	Choose proper sensor with its thorough understanding of the characteristics.
	CO2	Design suitable signal conditioning circuit for the chosen sensors
	CO3	Perform characterization of sensor materials and technology used in different sensors
	CO4	Implement a prototype for demonstrating the application of the sensors
	CO5	Demonstrate problem solving & troubleshooting skills in sensor applications

Experiment No.	Title	Ref.
1	Characteristics of temperature sensors	1,2
2	Characteristics of optical Sensors	1,2
3	I to V and V to I converter	1,2
4	Frequency to voltage converter using Opamp	1,2
5	Inverting and non-inverting amplifier using OpAmp	1,2
6	LVDT Sensor construction and characteristics	1,2
7	Instrumentation Amplifier Design	1,2
8	Filter Design (Analog)	1,2
9	Filter Design (Digital Simulation)	1,2
10	Case study on any house hold appliance	1,2
11	4-20mA Current Loop	1,2
12	Interface with Real word using A/D converters	1,2
13	Simulations of Micro-sensors	1,2
14	Simulations of micro-actuators such as micro-heater/ micromotors	1,2

Laboratory Assessment:

ISE:

1. **ISE-1** will be conducted for **four experiments**. Continuous pre-defined rubrics-based evaluation for 20 marks.
2. **ISE-2** will be conducted for **Six experiments**. Continuous pre-defined rubrics-based evaluation for 30 marks.

Recommended Books:

1. Jacob Fraden, Handbook of Modern Sensors Physics, Designs, and Applications, Fourth Edition, Springer
2. D. Patranabis, Sensors and Transducers, 2nd Edition, PHI Publication, New Delhi
3. Mechatronics- Ganesh S. Hegde, Published by University Science Press, 2nd Edition, An imprint of Laxmi Publication Private Limited
4. Terry Bartelt, Process Control Systems and Instrumentation, Delmar Cengage Learning India Edition New edition
5. www.nptel.ac.in
6. G. Eranna , Metal Oxide Nanostructures as Gas Sensing Devices, Publisher: CRC Press
7. ISA S82.01 - Safety Standard for Electrical & Electronic Test, Measuring, Controlling Related Equipment
8. http://www.ebme.co.uk/arts/safety/part6.htm

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ECL 504	Professional Communication and Ethics-II	--	--	2*+2 Batch wise	--	--	2	2
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes	–	
At the end of the laboratory course, students will be able to:		
Course Outcomes	CO1	Plan and prepare effective business/ technical documents which will in turn provide a 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. ADVANCED TECHNICAL WRITING: PROJECT/PROBLEM BASED LEARNING (PBL)	1.1	**Purpose and Classification of Reports** Classification on the basis of: Subject Matter (Technology, Accounting, Finance, Marketing, etc.), Time Interval (Periodic, One-time, Special), Function (Informational, Analytical, etc.), Physical Factors (Memorandum, Letter, Short & Long)	[1], [2]	06
	1.2	**Parts of a Long Formal Report** Prefatory Parts (Front Matter), Report Proper (Main Body), Appended Parts (Back Matter)	[1], [2]	

	1.3	**Language and Style of Reports** Tense, Person & Voice of Reports, Numbering Style of Chapters, Sections, Figures, Tables and Equations, Referencing Styles in APA & MLA Format, Proof-reading through Plagiarism Checkers	[1], [2]	
	1.4	**Definition, Purpose & Types of Proposals** Solicited (in conformance with RFP) & Unsolicited Proposals, Types (Short and Long proposals)	[1], [2]	
	1.5	**Parts of a Proposal** Elements, Scope and Limitations, Conclusion	[1], [2]	
	1.6	**Technical Paper Writing** Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References), Language and Formatting, Referencing in IEEE Format	[1], [2]	
2. EMPLOYMENT SKILLS	**2.1**	**Cover Letter & Resume** Parts and Content of a Cover Letter, Difference between Bio-data, Resume & CV, Essential Parts of a Resume, Types of Resume (Chronological, Functional & Combination)	[1], [2]	06
	2.2	**Statement of Purpose** Importance of SOP, Tips for Writing an Effective SOP	[1], [2]	
	2.3	**Verbal Aptitude Test** Modelled on CAT, GRE, GMAT exams	[1], [2]	
	2.4	**Group Discussions** Purpose of a GD, Parameters of Evaluating a GD, Types of GDs (Normal, Case-based & Role Plays), GD Etiquette	[1], [2]	
	2.5	**Personal Interviews** Planning and Preparation, Types of Questions, Types of Interviews (Structured, Stress, Behavioral, Problem Solving & Case-based), Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual	[1], [2]	
3 BUSINESS MEETINGS	**3.1**	**Conducting Business Meetings** Types of Meetings, Roles and Responsibilities of Chairperson, Secretary and Members, Meeting Etiquette	[1], [2]	02

	3.2	**Documentation** Notice, Agenda, Minutes	[1], [2]	
4. TECHNICAL/ BUSINESS PRESENTATIONS	**4.1**	**Effective Presentation Strategies** Defining Purpose, Analyzing Audience, Location and Event, Gathering, Selecting And Arranging Material, Structuring a Presentation, Making Effective Slides, Types of Presentations Aids, Closing a Presentation, Platform Skills	[1], [2]	02
	4.2	**Group Presentations** Sharing Responsibility in a Team, Building the contents and visuals together, Transition Phases	[1], [2]	
5. INTERPERSONAL SKILLS	**5.1**	**Interpersonal Skills** Emotional Intelligence, Leadership & Motivation, Conflict Management & Negotiation, Time Management, Assertiveness, Decision Making	[1], [2]	08
	5.2	**Start-up Skills** Financial Literacy, Risk Assessment, Data Analysis (e.g. Consumer Behavior, Market Trends, etc.)	[1], [2]	
6 CORPORATE ETHICS	**6.1**	**Intellectual Property Rights** Copyrights, Trademarks, Patents, Industrial Designs, Geographical Indications Integrated Circuits, Trade Secrets (Undisclosed Information)	[1], [2]	02
	6.2	**Case Studies** Cases related to Business/ Corporate Ethics	[1], [2]	
			Total	**26**

INTERNAL 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. Activities: 1)Meeting Documentation (Notice, Agenda and Minutes) 2)Role Play/ Case Study Documentation 3) Technical Paper and GD 4) Quiz on IPR
Continuous pre-defined rubrics-based evaluation for 10 marks.

b. Report Presentation : 10 Marks
c. Group Discussion : 10 Marks

Recommended 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.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECM501	Mini project - 2A	L	T	P	L	T	P	Total
		--	--	4$	--	--	2	2
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes	–	
At the end of the laboratory course, students will be able to:		
Course Out-comes	CO1	Identify problems based on societal /research needs
	CO2	Apply knowledge and skill to solve societal problems in a group
	CO3	Develop interpersonal skills to work as member of a group or leader.
	CO4	Draw the proper inferences from available results through theoretical/ experimental/simulations.
	CO5	Analyze the impact of solutions in societal and environmental context for sustainable development
	CO6	Use standard norms of engineering practices
	CO7	Excel in written and oral communication.
	CO8	Demonstrate capabilities of self-learning in a group, which leads to life-long learning.
	CO9	Demonstrate project management principles during project work.

Guidelines for Mini Project

- 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.
- 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.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.

A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.

- Faculty supervisor may give inputs to students during mini project activity; however, focus should be on self- learning.
- Students in a group shall understand problem effectively, propose multiple solution and

select best possible solution in consultation with guide/ supervisor.

- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- 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 case-by-case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;

Marks awarded by guide/supervisor based on log book	:10
Marks awarded by review committee	:10
Quality of Project report	:05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

In **first semester** entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.

First shall be for finalization of problem

Second shall be on finalization of proposed solution of problem.

In **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 last month of the said semester.

Half-year project:
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

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.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria:

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual as member or leader
13. Clarity in written and oral communication

In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:
Report should be prepared as per the guidelines issued by the University of Mumbai.
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 head of Institution Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual as member or leader
8. Clarity in written and oral communication

Laboratory Assessment:

ISE:

1. **ISE-1** will be conducted in mid semester for 20 marks

2. **ISE-2**
   a. will be conducted by the end of the semester for 20 marks.
   b. Activity: Oral and presentation 10 marks

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECC 601	Embedded Systems and RTOS	L	T	P	L	T	P	Total
		3	--	--	3	--	--	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	

Pre-requisite Course Codes	Digital Electronics Microprocessors and Microcontrollers	
Course Outcomes (CO):	At the End of the course students will be able to :	
Course Outcomes	CO1	Identify and describe various characteristic features and applications of Embedded systems.
	CO2	Analyze and select hardware for Embedded system implementation.
	CO3	Evaluate various communication protocols for Embedded system implementation.
	CO4	Compare GPOS and RTOS and investigate the concepts of RTOS
	CO5	Evaluate and use various tools for testing and debugging embedded systems.
	CO6	Design a system for different requirements based on life-cycle for the embedded system, keeping oneself aware of ethics and environmental issues.

Module No.	Unit No.	Contents	Ref	Hrs.
1 Introduction to Embedded Systems	1.1	Definition, Characteristics, Classification, Applications	[1],[2]	03
	1.2	Design metrics of Embedded system and Challenges in optimization of metrics	[1],[2]	
2 Embedded Hardware Elements	2.1	Features of Embedded cores- µC, ASIC, ASSP, SoC, FPGA, RISC and CISC cores. Types of memories.	[1],[2]	13
	2.2	Case Study: ARM Cortex-M3 Features, Architecture, Programmer's model, Special Registers, Operating Modes and States, MPU, Memory map and NVIC.	[4],[8]	
	2.3	Low power: - Need and techniques. Case study of Low Power modes in Cortex-M3.	[4],[8]	

	2.4	Communication Interfaces: Comparative study of Serial communication Interfaces (RS-232, RS-485), SPI, I2C, CAN, USB (v2.0), Bluetooth, Zig-Bee. **(Frame formats of above protocols are not expected)**	[1],[2],[7]	
	2.5	Selection criteria of Sensors and Actuators	[1],[2],[7]	
3 Embedded Software	**3.1**	Program Modelling concepts: DFG, CDFG, FSM.	[1][2]	**12**
	3.2	Real-time Operating system:- Need of RTOS in Embedded system software and comparison with GPOS, Task, Task states, Multi-tasking, Task scheduling, and algorithms- Preemptive SJF, Round-Robin, Priority, Rate Monotonic Scheduling, Earliest Deadline First . Inter-process communication: Message queues, Mailbox, Event timers. Task synchronization: Need, Issues - Deadlock, Race condition, live Lock, Solutions using Mutex, Semaphores. Shared data problem, Priority inversion.	[2][3]	
4 Introduction to FreeRTOS		FreeRTOS Task Management features, Resource Management features, Task Synchronization features, Event Management features, Calculate the CPU Utilization of an RTOS, Interrupt Management features, Time Management features.	[5]	**03**
5 Testing and Debugging Methodology	**5.1**	Testing & Debugging: Hardware testing tools, Boundary-scan/JTAG interface concepts, Emulator.	[2]	**02**
	5.2	Software Testing tools, simulator, debugger. White-Box and Black-Box testing.	[2]	
6 System Integration (Case Studies)	**6.1**	Embedded Product Design Life-Cycle (EDLC)- Waterfall Model	[1][2]	**06**
	6.2	Hardware-Software Co-design	[1][2]	
	6.3	Case studies for Automatic Chocolate Vending Machine, Washing Machine, Smart Card, highlighting i) Specification requirements (choice of components), ii) Hardware architecture iii) Software architecture	[2]	
		Total		**39**

Course Assessment:

Theory:

ISE-1:

Activity: Quiz- 10 Marks
Think pair share -10 marks

ISE-2: Activity: Case study Seminar -10 Marks
Assignment -10 Marks

MSE: 30 Marks written examination based on 50% syllabus

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

Recommended Books:

1. Dr. K.V. K. K. Prasad, "Embedded Real Time System: Concepts, Design and Programming", Dreamtech, New Delhi, Edition 2014.
2. Rajkamal, "Embedded Systems: Architecture, Programming and Design", McGraw Hill Education (India) Private Limited, New Delhi, 2015, Edition 3rd.
3. Sriram Iyer, Pankaj Gupta, " Embedded Real Time Systems Programming", Tata McGraw Hill Publishing Company ltd., 2003.
4. Joseph Yiu, "The Definitive guide to ARM CORTEX-M3 & CORTEX-M4 Processors", Elsevier, 2014, 3rd Edition.
5. www.freertos.org
6. David Simon, "An Embedded Software Primer", Pearson, 2009.
7. Jonathan W. Valvano, "Embedded Microcomputer Systems – Real Time Interfacing", Publisher - Cengage Learning, 2012 Edition 3rd.
8. AndrewSloss, Domnic Symes, Chris Wright, "ARM System Developers Guide Designing and Optimising System Software", Elsevier, 2004
9. FrankVahid, Tony Givargis, "Embedded System Design – A Unified Hardware/Software Introduction", John Wiley & Sons Inc., 2002.
10. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, New Delhi, 2009

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECC 602	Artificial Intelligence	L	T	P	L	T	P	To-tal
		3	--	--	3	--	--	3
		Examination Scheme						
			ISE 1	MSE	ISE 2	ESE	Total	
		Theory	20	30	20	100 (30% weight-age)	100	

Pre-requisite Course Codes	Data structures and algorithms Discrete mathematics Basic Mathematics	
Course Outcomes (CO):	At the End of the course students will be able to :	
Course Outcomes	CO1	Identify the characteristics of the environment and differentiate be-tween various agent architectures
	CO2	Apply the most suitable search strategy to design problem solving agents.
	CO3	Represent a natural language description of statements in logic and apply the inference rules to design Knowledge Based agents.
	CO4	Apply a probabilistic model for reasoning under uncertainty.
	CO5	Comprehend various learning techniques.
	CO6	Describe the various building blocks of an expert system for a given real world problem.

Module No.	Unit No.	Contents	Ref.	Hrs.
1 Introduction to Artificial Intelligence	1.1	Artificial Intelligence (AI), AI Perspectives: Acting and Thinking humanly, Acting and Thinking rationally	[1]	3
	1.2	History of AI, Applications of AI, The present state of AI, Eth-ics in AI	[1]	
2 Intelligent Agents	2.1	Introduction of agents, Structure of Intelligent Agent, Char-acteristics of Intelligent Agents	[1]	4
	2.2	Types of Agents, Simple Reflex, Model Based, Goal Based, Utility Based Agents.	[1]	
	2.3	Environment Types, Deterministic, Stochastic, Static, Dy-namic, Observable, Semi-observable, Single Agent, Multi Agent	[1]	

3 Solving Problems by Searching	**3.1**	Definition, State space representation, Problem as a state space search, Problem formulation, Well-defined problems	[1]	12
	3.2	Solving Problems by Searching, Performance evaluation of search strategies, Time Complexity, Space Complexity, Completeness, Optimality	[1]	
	3.3	Uninformed Search, Depth First Search, Breadth First Search, Depth Limited Search, Iterative Deepening Search, Uniform Cost Search, Bidirectional Search	[1]	
	3.4	Informed Search, Heuristic Function, Admissible Heuristic, Informed Search Technique, Greedy Best First Search, A* Search, Local Search, Hill Climbing Search, Simulated Annealing Search, Optimization, Genetic Algorithm	[1]	
	3.5	Game Playing, Adversarial Search Techniques, Mini-max Search, Alpha-Beta Pruning	[1]	
4 Knowledge and Reasoning	**4.1**	Definition and importance of Knowledge, Issues in Knowledge Representation, Knowledge Representation Systems, Properties of Knowledge Representation Systems	[1]	10
	4.2	Propositional Logic (PL), Syntax, Semantics, Formal logic-connectives, truth tables, tautology, validity, well-formed-formula,	[1]	
	4.3	Predicate Logic, FOPL, Syntax, Semantics, Quantification, Inference rules in FOPL, Introduction to logic programming (PROLOG)	[1]	
	4.4	Forward Chaining, Backward Chaining and Resolution in FOPL	[1]	
5 Reasoning Under Uncertainty	**5.1**	Handling Uncertain Knowledge, Random Variables, Prior and Posterior Probability, Inference using Full Joint Distribution	[1]	5
	5.2	Bayes' Rule and its use, Bayesian Belief Networks, Reasoning in Belief Networks	[1]	
6 Planning and Learning	**6.1**	The planning problem, Partial order planning, total order planning.	[1]	
	6.2	Learning in AI, Learning Agent, Concepts of Supervised, Unsupervised, Semi -Supervised Learning, Reinforcement Learning, Ensemble Learning.	[1]	5
	6.3	Expert Systems, Components of Expert System: Knowledge base, Inference engine, user interface, working memory, Development of Expert Systems	[1]	
		Total		**39**

Course Assessment:

Theory:

ISE-1:

Activity: Quiz 05 Marks
Technical Debate Activity 05 Marks
Assignment 10 Marks

ISE-2:
Activity: Seminar on Research paper (IEEE /ACM) 10 Marks
Assignment 10 Marks

MSE: 30 Marks written examination based on 50% syllabus

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

Recommended Books:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach —Second Edition" Pearson Education.
2. Elaine Rich and Kevin Knight —Artificial Intelligence‖ Third Edition, Tata McGraw-Hill Education Pvt. Ltd., 2008.
3. George F Luger "Artificial Intelligence" Low Price Edition, Pearson Education., Fourth edition.
4. Ivan Bratko "PROLOG Programming for Artificial Intelligence", Pearson Education, Third Edition.
5. D. W. Patterson, Artificial Intelligence and Expert Systems, Prentice Hall.
6. Saroj Kaushik "Artificial Intelligence", Cengage Learning.
7. Davis E. Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
8. Patrick Henry Winston, "Artificial Intelligence", Addison-Wesley, Third Edition.
9. N. P. Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECC 603	Computer Networks	L	T	P	L	T	P	Total
		3	--	--	3	--	--	3
		Examination Scheme						
			ISE 1	MSE	ISE 2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	

Pre-requisite Course Codes	Communication Engineering	
Course Outcomes (CO):	At the End of the course students will be able to :	
Course Outcomes	CO1	Enumerate the layers of OSI model and TCP/IP model and describe their functions.
	CO2	Identify the characteristics of network devices and media used to design networks.
	CO3	Demonstrate the knowledge of networking protocols at various layers of TCP/IP model.
	CO4	Classify the routing protocols and analyse how to assign the IP addresses for a given network
	CO5	Design and configure the networks using IP addressing and subnetting / supernetting schemes.
	CO6	Explain the functions of Application layer and Presentation layers, their paradigms and Protocols

Module No.	Unit No.	Contents	Ref	Hrs.
1 Introduction to Data Communications and Networking	1.1	Introduction to computer networks, Network software, Layers and services, Network topologies, protocol hierarchies, design issues for the layers, connection oriented and connectionless services	[1],[2]	05
	1.2	Reference models: Layer details of OSI, TCP/IP models. Communication between layers. Internet	[1],[2]	
2 Physical Layer	2.1	Guided Transmission Media: Twisted pair, Coaxial, Fiber optics.	[1],[2]	06

	2.2	Unguided media (Wireless Transmission): Radio Waves, Microwave, Bluetooth, Infrared, Circuit and Packet Switching	[1],[2]	
	2.3	Network Devices: Repeaters, Hubs, Switches, Routers and Gateways	[1],[2]	
3 Data Link Layer	**3.1**	DLL Design Issues - Services, Framing, Error Control, Flow Control, Error Detection and Correction Elementary Data Link protocols, Stop and Wait, Sliding Window - Go Back N, Selective Repeat.	[1],[2]	08
	3.2	Medium Access Control sublayer: Channel Allocation problem, Multiple access Protocol (Aloha, Carrier Sense Multiple Access (CSMA/CD), Local Area Networks - Ethernet (802.3), Introduction to wireless LAN: 802.11x	[1],[2]	
4 Network layer	**4.1**	Network Layer design issues, Communication Primitives: Unicast, Multicast, Broadcast. Network Layer Protocols: IPv4 Datagram Format, IPv4 Addresses, IPv4 Addressing (classful and classless), Subnetting and Supernetting design problems, IPv4 Protocol, IPv6 Packet Format, IPv6 Addressing, Transition from IPv4 to IPv6	[1],[2]	08
	4.2	Routing algorithms: Intradomain Routing -Shortest Path, Distance Vector Algorithms, Link State Routing, Interdomain Routing Protocols.	[1],[2]	
	4.3	Congestion control algorithms: Open loop congestion control, Closed loop congestion control, QoS parameters.	[1],[2]	
5 Transport Layer	**5.1**	The Transport Service: Transport service primitives, Berkeley Sockets, Connection management (Handshake), UDP, TCP, TCP state transition, TCP timers	[1],[2]	07
	5.2	TCP Flow control (sliding Window), TCP Congestion Control: Slow Start	[1],[2]	
6 Application layer	**6.1**	Application layer Paradigms, Client-Server Paradigm: Application Programming Interface	[1],[2]	05
	6.2	Standard Client Server applications: World Wide Web and HTTP, FTP, Electronic Mail, TELNET, Secure Shell (SSH), Domain Name System (DNS)	[1],[2]	
		Total		**39**

Course Assessment:
Theory:

ISE-1:
Activity: Quiz 10 Marks
Assignment 10 Marks

ISE-2:
Activity: Quiz 10 Marks
Create a network with routing protocols using packet tracer 10 Marks

MSE: 30 Marks written examination based on 50% syllabus

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

Recommended Books:

1. Andrew S Tanenbaum, Computer Networks -, 4th Edition, Pearson Education
2. Behrouz A. Forouzan, Forouzan Mosharrat, Computer Networks A Top down Approach, McGraw Hill education
3. Ranjan Bose, Information Theory, Coding and Cryptography, Ranjan Bose, Tata McGraw Hill, Second Edition.
4. 1.James F. Kurose, K. W. Ross, Computer Networking: A Top-Down Approach Featuring the Internet, 3rd Edition, Pearson Education.
5. 2. S. Keshav, An Engineering Approach to Computer Networks, 2nd Edition, Pearson Education.
6. 3. W. A. Shay, Understanding communications and Networks, 3rd Edition, W. A. Shay, Cengage Learning.
7. L. L. Peterson and B. S. Davie, Computer Networks: A Systems Approach, 4th Ed, Elsevier India

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECC604	Data Warehousing and Mining	L	T	P	L	T	P	Total
		3	--	--	3	--	--	3
		Examination Scheme						
			ISE 1	MSE	ISE 2	ESE	Total	
		Theory	20	30	20	100 (30% weight-age)	100	

Pre-requisite Course Codes	Database Concepts Algorithm Design and Analysis Concepts Data Structures	
Course Outcomes (CO):	At the End of the course students will be able to :	
Course Outcomes	CO1	Understand Data Warehousing fundamentals and Dimensionality modelling principles.
	CO2	Understand the use of ETL techniques and apply OLAP operations
	CO3	Perceive the importance of data pre-processing and basics of data mining techniques
	CO4	Relate to the concepts of market basket analysis in real world applica-tions.
	CO5	Apply classification algorithms in real world dataset for classification and prediction.
	CO6	Visualize the concept of clustering and its applications.

Module No.	Unit No.	Contents	Ref	Hrs.
1 Data Warehous-ing and Di-mension Modelling	1.1	Introduction to Data Warehouse, Characteristics of Data Ware-house	[1]	8
	1.2	Components of Data warehouse Architecture, Data warehouse ar-chitecture	[1]	
	1.3	Data warehouses versus Data Marts,	[1]	
	1.4	E-R Modelling versus Dimensional Modelling,	[1]	
	1.5	Data Warehouse Schemas; Star Schema, Snowflake Schema, Fact Less Fact Table, Fact Constellation Schema.	[1]	
	1.6	Inside Dimensional Table, Inside Fact Table,	[1]	
	1.7	Update to the dimension tables. OLTP Systems versus OLAP	[1]	

2 **ETL and OLAP**	**2.2**	Data Transformation; Basic Tasks in Transformation, Major Data Transformation Types	[1]	6
	2.3	Data Loading Techniques	[1]	
	2.4	What is Multidimensional Data, OLAP Models: MOLAP, ROLAP.	[1]	
	2.5	OLAP operations: Slice, Dice, Rollup, Drilldown and Pivot.	[1]	
3 Data Mining and Data pre-processing	**3.2**	KDD process, Data Mining Functionalities, Interestingness Measures,	[1]	6
	3.3	Classification of data mining system, major issues in data mining.	[1]	
	3.4	Data Summarization, Data Cleaning, Data Integration and Transformation,	[1]	
	3.5	Data Reduction, Data Discretization And Concept Hierarchy Generalization.	[1]	
4 Mining frequent patterns and associations	**4.1**	Market Basket Analysis, Frequent Item sets, Closed Item sets, and Association Rule	[1]	7
	4.2	Frequent Pattern Mining, Efficient and Scalable Frequent Item set Mining Methods: Apriori Algorithm, Association Rule Generation, Improving the Efficiency of Apriori,	[1]	
	4.3	FP growth	[1]	
	4.4	Mining various kinds of association rules – Multilevel and Multidimensional	[1]	
5 Classification and Prediction	**5.1**	Definition, Decision tree induction	[1]	5
	5.2	Bayesian classification	[1]	
	5.3	Introduction to prediction, Linear and logistic regression techniques	[1]	
	5.4	Accuracy and error measures.	[1]	
6 Cluster analysis	**6.1**	Definition, Distance Measures,	[1]	7
	6.2	Clustering Algorithms: Partitioning- K means and K-medoids,	[1]	
	6.3	Hierarchical clustering- Agglomerative clustering and Divisive clustering	[1]	
		Total		**39**

Course Assessment:

Theory:

ISE-1:

Activity: Quiz 10 Marks
Assignment 10 marks

ISE-2:

Activity: Quiz 10 marks
Assignment 10 marks

MSE: 30 Marks written examination based on 50% syllabus

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

Recommended Books:

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

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECC DO601	Machine Learning	L	T	P	L	T	P	Total
		3	--	--	3	--	--	3
		Examination Scheme						
			ISE 1	MSE	ISE 2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	

Pre-requisite Course Codes	Data Structures Basic Probability and Statistics Algorithms	
Course Outcomes (CO):	At the End of the course students will be able to :	
Course Outcomes	CO1	Comprehend basics of Machine Learning.
	CO2	Build Mathematical foundation for machine learning.
	CO3	Understand various Machine learning models.
	CO4	Select suitable Machine learning models for a given problem.
	CO5	Build Neural Network based models.
	CO6	Apply Dimensionality Reduction techniques

Module No.	Unit No.	Contents	Ref	Hrs.
1 Introduction to Machine Learning	**1.1**	Introduction to Machine Learning, Issues in Machine Learning, Application of Machine Learning, Steps of developing a Machine Learning Application.	[1]	6
	1.2	Supervised and Unsupervised Learning: Concepts of Classification, Clustering and prediction, Training, Testing and validation dataset, cross validation, overfitting and underfitting of model	[1]	
	1.3	Performance Measures: Measuring Quality of model- Confusion Matrix, Accuracy, Recall, Precision, Specificity, F1 Score, RMSE	[1]	
2 **Mathematical**	**2.1**	System of Linear equations, Norms, Inner products, Length of Vector, Distance between vectors, Orthogonal vectors	[1]	5

Foundation for ML	**2.2**	Symmetric Positive Definite Matrices, Determinant, Trace, Eigenvalues and vectors, Orthogonal Projections, Diagonalization, SVD and its applications.	[1]	
3 Liner models	**3.1**	The least-squares method, Multivariate Linear Regression, Regularised Regression, Using Least-Squares Regression for classification	[1]	7
	3.2	Support Vector Machines	[1]	
4 Clustering	**4.1**	Hebbian Learning rule	[1]	4
	4.2	Expectation -Maximization algorithm for clustering	[1]	
5 Classification models	**5.1**	Introduction, Fundamental concept, Evolution of Neural Networks, Biological Neuron, Artificial Neural Networks, NN architecture, McCulloch-Pitts Model. Designing a simple network, Non-separable patterns, Perceptron model with Bias. Activation functions, Binary, Bipolar, continuous, Ramp. Limitations of Perceptron.	[1]	12
	5.2	Perceptron Learning Rule. Delta Learning Rule (LMS-Widrow Hoff), Multi-layer perceptron network. Adjusting weights of hidden layers. Error back propagation algorithm.	[1]	
	5.3	Logistic regression	[1]	
6 Dimensionality Reduction	**6.1**	Curse of Dimensionality.	[1]	5
	6.2	Feature Selection and Feature Extraction	[1]	
	6.3	Dimensionality Reduction Techniques, Principal Component Analysis.	[1]	
		Total		**39**

Course Assessment:

Theory:

ISE-1:

Activity: Two Quiz 10 Marks
Seminar on Research paper (IEEE /ACM) 10 Marks

ISE-2:

Activity: Debate activity 10 Marks
Assignment 10 Marks

MSE: 30 Marks written examination based on 50% syllabus

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

Recommended Books:

1. Nathalie Japkowicz & Mohak Shah, "Evaluating Learning Algorithms: A Classification Perspective", Cambridge.

2. Marc Peter Deisenroth, Aldo Faisal, Cheng Soon Ong, "Mathematics for machine learning",
3. Samir Roy and Chakraborty, "Introduction to soft computing", Pearson Edition.
4. Ethem Alpaydın, "Introduction to Machine Learning", MIT Press
5. Peter Flach, "Machine Learning", Cambridge University Press
6. Tom M. Mitchell, "Machine Learning", McGraw Hill
7. Kevin P. Murphy, "Machine Learning — A Probabilistic Perspective", MIT Press
8. Stephen Marsland, "Machine Learning an Algorithmic Perspective", CRC Press
9. Shai Shalev-Shwartz, Shai Ben-David, "Understanding Machine Learning", Cambridge University Press
10. Peter Harrington, "Machine Learning in Action", DreamTech Press.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECC DO601	Industrial Automation	L	T	P	L	T	P	Total
		3	--	--	3	--	--	3
		Examination Scheme						
			ISE 1	MSE	ISE 2	ESE	Total	
		Theory	20	30	20	100 (30% weight-age)	100	

Pre-requisite Course Codes	Knowledge of Basic Electrical Engineering, Basic Electronics, Digital Electronics, Electronics Measurement and Instruments	
Course Outcomes (CO):	At the End of the course students will be able to :	
Course Outcomes	CO1	Understand and draw block diagram of industrial automation and control system.
	CO2	Understand various automation components and systems.
	CO3	Explain architecture of industrial automation system.
	CO4	Demonstrate working of PLC and SCADA and interface the same.
	CO5	Demonstrate the use of IOT and robotics in Automation.
	CO6	Distinguish between the usage of custom embedded systems, FPGAs and PLCs.

Course Assessment:

Module No.	Unit No.	Contents	Ref	Hrs.
1 **Introduction**	**1.1**	Automation overview, Requirement of automation systems,	[1]	06
	1.2	Architecture of Industrial Automation system, Parameters of Industrial Revolution 4.0	[1]	
	1.3	Introduction of PLC and supervisory control and data acquisition (SCADA)	[1]	
	1.4	Industrial bus systems: Mod bus & Profi-bus & Ether CAT	[1]	
2 **Automation components**	**2.1**	Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement.	[1]	07
	2.2	Actuators, process control valves, Introduction of DC and AC servo drives for motion control. Use of Contactors, Isolators, MCB, MCCB, Earth Breakers etc	[1]	
3 Computer aided measurement and control systems	**3.1**	Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques	[1]	08
	3.2	Computer aided process control software, Computer based data acquisition system	[1]	
	3.3	Internet of things (IoT) for plant automation	[1]	
4 Programmable logic controllers	**4.1**	Programmable controllers, Programmable logic controllers, Analog digital input and output modules	[1]	06
	4.2	PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking	[1]	
	4.3	PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.	[1]	
5 Distributed Control System	**5.1**	Overview of DCS, DCS software configuration,	[1]	06
	5.2	DCS communication, DCS Supervisory Computer Tasks,	[1]	
	5.3	DCS integration with PLC and Computers, Features of DCS, Advantages of DCS	[1]	
6 Overview of Industrial automation using robots	**6.1**	Basic construction and configuration of robot Pick and place robot	[1]	06
	6.2	Welding robot.	[1]	
	6.3	Robots in the medical field	[1]	
		Total		**39**

Theory:

ISE-1:

(a) Assignments for 10 marks
(b) Multiple choice questions (MCQ) quiz of 10 marks for a 1 hour duration

ISE-2:

Student seminars based on case study application in practical, real-life domains for 20 marks, 1 hour duration

MSE: 30 Marks written examination based on 50% syllabus

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

Recommended Books:

1. S.K. Singh, Industrial Instrumentation and Control The McGraw Hill Companies
2. By. C.D. Johnson, Process Control Instrumentation Technology, PHI
3. E. Andrew Parr, Industrial control handbook, Newnem publication
4. Garry Dunning, Introduction to Programmable logic controller, Delmar Thomson Learning,
5. Norman A. Anderson, Instrumentation and Process measurements and Control 2nd Edition. CRC Press.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECC DO601	Digital Signal Processing	L	T	P	L	T	P	Total
		3	--	--	3	--	--	3
		Examination Scheme						
			ISE 1	MSE	ISE 2	ESE	Total	
		Theory	20	30	20	100 (30% weight-age)	100	

Pre-requisite Course Codes	Engineering Mathematics	
Course Outcomes (CO):	At the End of the course students will be able to :	
Course Outcomes	CO1	Apply the concept of DT Signal and DT Systems.
	CO2	Classify and analyse discrete time signals and systems.
	CO3	Implement Digital Signal Transform techniques DTFT, DFT and FFT.
	CO4	Design FIR and IIR digital filters to meet arbitrary specifications and Develop algorithms for implementation.
	CO5	Use signal processing techniques and digital signal processors in various applications.

Module No.	Unit No.	Contents	Ref	Hrs.
1 Discrete-Time Signal and Discrete-Time Systems	1.1	Introduction to Digital Signal Processing, Sampling and Recon-struction, Standard DT Signals, Concept of Digital Frequency, Representation of DT signal using Standard DT Signals, Signal Manipulations-shifting, reversal, scaling, addition, multiplica-tion.	[1]	08
	1.2	Classification of Discrete-Time Signals, Classification of Dis-crete-Systems, LTI system, Impulse Response.	[1]	
	1.3	Linear Convolution, Circular Convolution- Emphasis on graph-ical method, linear convolution using Circular Convolution. Soft-ware simulation - Impulse Response, Step Response, convolution, Correlation.	[1]	
2 Frequency Domain Analysis	2.1	Introduction to DTFT. Properties of DTFT.	[1]	07
	2.2	Z transform - definition, properties of unilateral and bilateral Z Transform, Z transform of standard signals, ROC, poles and zeros of transfer function, Inverse Z transform	[1]	

using DTFT and Z Transform	**2.3**	Analysis and characterization of LTI system using Z transform, impulse and step response, causality, stability, stability of causal system	[1]	
3 Discrete Fourier Transform and Fast Fourier Transform	**3.1**	DFT, Relation between DFT and DTFT, IDFT	[1]	06
	3.2	Properties of DFT, circular convolution of sequences using DFT	[1]	
	3.3	Fast Fourier transforms (FFT), Radix-2 decimation in time and decimation in frequency FFT algorithms, inverse FFT	[1]	
4 IIR Digital Filters	**4.1**	Comparison of IIR and FIR filters, Types of IIR Filters, Analog filter approximations: Butterworth, Chebyshev I and II	[1]	09
	4.2	Mapping of S-plane to Z-plane, impulse invariance method, bilinear transformation method, Design of IIR digital filters from analog filters with examples, Software simulation – Design of IIR Filters	[1]	
	4.3	Analog and digital frequency transformations	[1]	
5 FIR Digital Filters	**5.1**	Characteristics of FIR digital filters, Minimum Phase, Maximum Phase, Mixed Phase and Linear Phase Filters Frequency response, location of the zero of linear phase FIR filters	[1]	05
	5.2	Design of FIR filters using window techniques -Rectangular, Hamming, Hanning, Blackman, Bartlett, Software simulation – Design of FIR Filters.	[1]	
6 DSP Processors and Applications	**6.1**	General purpose digital signal processors, DSP processor architecture, Selecting digital signal processors, Special purpose DSP hardware	[1]	04
	6.2	Applications of DSP: Radar Signal Processing and Speech Processing	[1]	
		Total		**39**

Course Assessment:

Theory:

ISE-1: will be conducted for **four experiments**. Continuous pre-defined rubrics-based evaluation for 20 marks.

ISE-2: will be conducted for **Six experiments**. Continuous pre-defined rubrics-based evaluation for 30 marks.

MSE : 30 Marks written examination based on 50% syllabus

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

Recommended Books:

1. Emmanuel C. Ifeachor, Barrie W. Jervis, "*Digital Signal Processing"*, A Practical Approach by, Pearson Education – Second edition
2. Tarun Kumar Rawat, "*Digital Signal Processing"*, Oxford University Press, 2015
3. S Salivahanan, A Vallavaraj, C Gnanapriya. "Digital Signal Processing" – TMH, 2007
4. Proakis J., Manolakis D., "*Digital Signal Processing*", 4th Edition, Pearson Education
5. Sanjit K. Mitra, Digital Signal Processing – A Computer Based Approach – edition 4e McGraw Hill Education (India) Private Limited
6. Oppenheim A, Schafer R, BuckJ.,"*DiscreteTimeSignalProcessing*",3rd Edition, Pearson Education.
7. B. Venkata Ramani and, M. Bhaskar, "*Digital Signal Processors, Architecture, Programming and Applications*", Tata McGraw Hill, 2nd edition 2017.
8. L.R.Rabiner and B.Gold," *Theory and Applications of Digital Signal Processi*ng", Prentice-Hall of India, 2015.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECC DO601	Electronic Product Design	L	T	P	L	T	P	Total
		3	--	--	3	--	--	3
		Examination Scheme						
			ISE 1	MSE	ISE 2	ESE	Total	
		Theory	20	30	20	100 (30% weightage)	100	

Pre-requisite Course Codes	Electronic Circuits Controls and Instrumentation	
Course Outcomes (CO):	At the End of the course students will be able to :	
Course Outcomes	CO1	Importance of customer-centric approach in the electronic product development process.
	CO2	Electronic product development stages and challenges
	CO3	Implement learning for meeting a prototype as per industry standard/specification
	CO4	Demonstrate problem-solving & troubleshooting skills in electronic product design
	CO5	Prepare the relevant set of design documentation & present it as a case study

Module No.	Unit No.	Contents	Ref	Hrs.
1 Customer Centric Approach For Product Development	**1.1**	Prototype, MVP, commercial product and related terminologies	[1]	08
	1.2	Basics of customer discovery process, customer and value proposition	[1]	
	1.3	Understand product market fit, product failure, internal challenges for product development.	[1]	
	1.4	Identify the available market place for the product.	[1]	
2 Product Development Challenges	**2.1**	Idea segmentation, product features, lab to market journey, Product development stages, product development challenges.	[1]	06
	2.2	Electronic product classification and certifications requirement. Indian and international standard for product compliance.	[1]	
3 Hardware Design & Testing Methods	**3.1**	Design process, identifying the requirements, formulating specifications, design specifications, system partitioning, functional design, architectural design,	[1]	07
	3.2	Component selection criteria	[1]	
	3.3	Functional model v/s architectural model, prototyping, performance & efficiency measures, formulating a test plan, writing all the specifications, test procedures & test cases, design reviews, module debug & testing – black box testing, white box testing, grey box testing	[1]	
4 Software Design & Testing Methods	**4.1**	Types of software, the waterfall model of software development, models, metrics & software limitations, risk abatement & failure prevention	[1]	06
	4.2	Software bugs & testing	[1]	
	4.3	Good programming practice, user interface, embedded & real-time software	[1]	
5 Product Debugging & Testing	**5.1**	Steps of debugging, the techniques for troubleshooting	[1]	06
	5.2	Characterization, electromechanical components, passive components, active components, active devices, operational amplifier, analog-to-digital conversion, digital components,	[1]	
	5.3	Inspection & testing of components, process of simulation, prototyping & testing, integration, validation & verification, EMI & EMC issues	[1]	
6 The Documentation Process	**6.1**	Definition, needs & types of documentation, records, accountability & liability, audience, steps in preparation, presentation & preservation of documents	[1]	06
	6.2	Methods of documentation, visual techniques, layout of documentation, bills of materials, manuals – instructional or operating manual, service and maintenance manual,	[1]	
	6.3	Fault finding tree, software documentation practices	[1]	
		Total		**39**

Course Assessment:

Theory:

ISE-1:

Students will be assigned topic in domain and follow the activities given as follows
Activity: Conceptual Design Presentation 10 Marks
Prototype Development and Demonstration: 10 Marks

ISE-2:

Activity: Design Documentation and Report Writing:: 10 Marks
User Experience (UX) Evaluation 10 Marks

MSE: 30 Marks written examination based on 50% syllabus

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

Recommended Books:

1. Phillip Kotler, Kevin Lane keller, Abraham Koshi, Mithieshwar Zha, Marketing management 13th edition
2. Alexander Osterwalder & Yves Pigneur, Business model generation
3. Alex Osterwalder, Yves Pigneur, Greg Bernarda, Alan Smith, Value Proposition design
4. G. C. Loveday, Electronic Testing & Fault Diagnosis, 4th edition, A. H. Wheeler Publishing
5. James K. Peckol, Embedded Systems – A Contemporary Design Tool, 1st edition, Wiley Publication
6. J. C. Whitaker, The Electronics Handbook, CRC Press
7. GIFF CONSTABLE, Talking to humans
8. R. G. Kaduskar & V. B. Baru, Electronic Product Design, 3rd edition, Wiley India
9. Kim Fowler, Electronic Instrument Design, 2nd edition, Oxford University Press
10. Robert J. Herrick, PCB Design Techniques for EMC Compliance, 2nd edition, IEEE Press

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECL 601	Embedded Systems Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE 1	MSE	ISE 2	ESE	Total	
		Lab	20	–	30	–	50	

Pre-requisite Course Codes	Basics of Microcontroller programming C programming	
Course Outcomes (CO):	At the End of the course students will be able to :	
Course Outcomes	CO1	Interface various sensors and actuators to embedded cores.
	CO2	Write code using RTOS for multi-tasking Embedded systems
	CO3	Design applications using different embedded cores

Suggested List of Experiments

Experiment No.	Title	Ref
1	Interfacing of LEDs /switches with any embedded core. (8051/ARM/STM32, etc)	[1]
2	Interfacing of Temperature sensor with any embedded core. (8051/ARM/STM32, etc)	[1]
3	Interfacing of LCD/ Seven segment display with any embedded core. (8051/ARM/STM32,etc)	[1]
4	Interfacing of Ultrasonic/Humidity sensor with any embedded core. (8051/ARM/STM32,etc)	[1]
5	Interfacing of a relay with any embedded core. (8051/ARM/STM32,etc)	[1]
6	Interfacing of a DC motor (speed and Direction control) with any embedded core.(8051/ARM/STM32,etc)	[1]
7	Interfacing of a stepper motor (to move by a particular angle) with any embedded core. (8051/ARM/STM32, etc)	[1]
8	Implement power management in any embedded core of your choice	[2]
9	Implement the I2C communication to connect to DS1307 RTC	[2]
10	Porting of FreeRTOS to Arduino/STM32.	[2][4] [9]
11	Write a Program to Create Multiple Tasks and understand the Multitasking capabilities of RTOS(FreeRTOS).	[2][4] [9]

12	Write a Program to illustrate the Queue Management Features of Fre-eRTOS.	[2][4] [9]
13	Write a Program to illustrate the Event Management Features of Fre-eRTOS.	[2][4] [9]
14	Write a Program to illustrate the use of Binary and Counting Semaphore for Task Synchronisation using FreeRTOS.	[2][4] [9]
15	Build a Multitasking Real-Time Applications using the above IPC Mechanisms (Message Queue, EventGroup, Semaphores) with FreeRTOS on Arduino/STM32.	[2][4] [9]

Laboratory Assessment:

ISE-1:
Activity: Assessment on first 4 experiments-20 marks

ISE-2:
Activity: Assessment on next 4 experiments-20 marks
Mini-project-10 Marks

Recommended Books:

1. M. A. Mazidi, J. C. Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems Using Assembly and C ", Pearson Education, 2nd Edition.
2. Rajkamal, "Embedded Systems: Architecture, Programming and Design", McGraw Hill Education (India) Private Limited, New Delhi, 2015, Edition 3rd.
3. Joseph Yiu, "The Definitive guide to ARM CORTEX-M3 & CORTEX-M4 Processors", Elsevier, 2014, 3rd Edition.
4. www.freertos.org
5. David Simon, "An Embedded Software Primer", Pearson, 2009.
6. Jonathan W. Valvano, "Embedded Microcomputer Systems – Real Time Interfacing", Publisher - Cengage Learning, 2012 Edition 3rd.
7. Andrew Sloss, Domnic Symes, Chris Wright, "ARM System Developer's Guide Designing and Optimising System Software", Elsevier, 2004
8. https://www.keil.com
9. https://www.arduino.cc

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECL602	Artificial Intelligence and Computer Networks Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE 1	MSE	ISE 2	ESE	Total	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes	Data structures and algorithms, Discrete mathematics, Basic Mathematics Communication Engineering	
Course Outcomes (CO):	At the End of the course students will be able to :	
Course Outcomes	CO1	Identify suitable Agent Architecture for a given real world AI problem.
	CO2	Implement various search techniques for a Problem-Solving Agent.
	CO3	Implement various search techniques for a Problem-Solving Agent.
	CO4	Represent natural language description as statements in Logic and apply inference rules to it.
	CO5	Construct a Bayesian Belief Network for a given problem and draw probabilistic inferences from it.
	CO6	Design and implement various network applications such as data transmission between client and server, file transfer etc. using Socket Programming.
	CO7	Determine how to assign the IP addresses and configure a network on different operating environments.
	CO8	Configure the networks using IP addressing and subnetting / supernetting schemes using various OS commands.

Suggested List of Experiments

Experiment No.	Title	Ref
	Artificial Intelligence	
1	Provide the PEAS description and TASK Environment for a given AI problem. Identify suitable Agent Architecture for the problem	[1]
2	Write simple programs using PROLOG as an AI programming Language	[1]
3	Implement any one of the Uninformed search techniques	[1]
4	Implement any one of the Informed search techniques E.g. A-Star algorithm for 8 puzzle problem	[1]
5	Implement adversarial search using min-max algorithm.	[1]

6	Write a program to implement genetic algorithm.	[1]
7	Prove the goal sentence from the following set of statements in FOPL by applying forward, backward and resolution inference algorithms.	[1]
8	Create a Bayesian Network for the given Problem Statement and draw inferences from it. (You can use any Belief and Decision Networks Tool for modeling Bayesian Networks)	[1]
	Computer Networks	
1	Use a tool (Eg. NS2) to implement a specific Network topology with respect to the given number of nodes and physical configuration and do: • Graphical simulation of network with Routing Protocols and traffic consideration (TCP, UDP) • Analysis of network performance for quality parameters such as packet-delivery-ratio, delay, and throughput	[1]
2	Socket programming using TCP and/or UDP	[1]
3	Use basic networking commands in Linux (ping, tracert, nslookup, netstat, ARP, RARP, ip, ifconfig, dig, route, etc) and set up a network environment with multiple IP addresses and configuration of ARP tables. Set up a network environment in Windows platform also	[1]
4	Working with routing in Linux/windows: • View the current routing table • Add and delete routes • Change default gateway Perform IPTables for IP forwarding	[1]
5	Set up and configuration of firewalls in Linux/windows (Use IPTables)	[1]
6	Packet Sniffing using Wireshark	[1]

Course Assessment:

ISE:

1. **ISE-1** will be conducted for four experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

2. ISE-2

a. Four experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

b. Activity: Quiz and Viva 10 Marks

Recommended Books:

Artificial Intelligence

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach —Second Edition" Pearson Education.
2. Elaine Rich and Kevin Knight —Artificial Intelligence‖ Third Edition, Tata McGraw-Hill Education Pvt. Ltd., 2008.
3. George F Luger "Artificial Intelligence" Low Price Edition, Pearson Education., Fourth edition.

Computer networks

1. Andrew S Tanenbaum, Computer Networks -, 4th Edition, Pearson Education
2. Behrouz A. Forouzan, Forouzan Mosharrat, Computer Networks A Top down Approach, McGraw Hill education
3. Ranjan Bose, Information Theory, Coding and Cryptography, Ranjan Bose, Tata McGraw Hill, Second Edition.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECL603	Data Warehousing and Mining Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE 1	MSE	ISE 2	ESE	Total	
		Lab	20		30		50	

Pre-requisite Course Codes	Database Concepts, Algorithm Design and Analysis Concepts, Data Structures	
Course Outcomes (CO):	At the End of the course students will be able to :	
Course Outcomes	CO1	Design data warehouse using dimensional modelling.
	CO2	Perform different OLAP operations.
	CO3	Differentiate among different data mining techniques and decide the applicability for each.
	CO4	Demonstrate classifications, prediction, etc. on datasets using open source tools.
	CO5	Perform Market basket analysis in real world data using data mining tools.
	CO6	Appreciate and visualize clustering techniques.

Suggested List of Experiments

Experiment No.	Title	Ref
1	One case study on building Data warehouse/Data Mart • Write Detailed Problem statement and design dimensional modelling (creation of star and snowflake schema) • Implementation of all dimension table and fact table	[1]
2	Implementation of OLAP operations: Slice, Dice, Rollup, Drilldown and Pivot for the above problem statement (experiment 1)	[1]
3	Implementation of Classification algorithm (Decision Tree/Naive Bayes)	[1]
4	Implementation of Clustering algorithm (K-means/Agglomerative)	[1]
5	Implementation of Association Rule Mining algorithm (Apriori)	[1]
6	Implementation of prediction algorithm (Linear regression)	[1]
7	Perform data Pre-processing task and Demonstrate Classification algorithm on data sets using data mining tool (WEKA, R tool, XL Miner, Orange etc.)	[1]

8	Perform data Pre-processing task and Demonstrate Clustering algorithm on data sets using data mining tool (WEKA, R tool, XL Miner, Orange etc.).	[1]
9	Perform data Pre-processing task and Demonstrate Association algorithm on data sets using data mining tool (WEKA, R tool, XL Miner, Orange etc.).	[1]
10	Demo on any cloud-based data warehousing process (an end to end process) which gives a holistic view of Data Warehouse	[1]

References :

1. Oracle database SQL reference
2. Oracle warehouse builder
3. Weka tutorial
4. Python tutorial for classification and clustering
5. Tutorial on orange "https://orangedatamining.com/getting-started/"
6. https://www.coursera.org/specializations/data-mining
7. https://www.udemy.com/course/data-mining-python/
8. https://onlinecourses.nptel.ac.in/noc21_cs06/preview

Data sets available for download

1. Datasets for data mining "http://www.inf.ed.ac.uk/teaching/courses/dme/html/datasets0405.html"
2. Datasets for data mining "https://www.kdnuggets.com/datasets/index.html"
3. Datasets from UCI repository
4. Kaggle datasets

Course Assessment:

Lab:

ISE-1:

Activity: Five experiments 20 marks

ISE-2:

Activity: Five experiments 20 marks

Seminar on latest technologies of data mining 10 marks

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECL 604	Skill-based Lab: Linux Server Administration Lab	L	T	P	L	T	P	Total
		2	--	2	--	--	2	2
		Examination Scheme						
			ISE 1	MSE	ISE 2	ESE	Total	
		Lab	20	–	30	–	50	

Pre-requisite Course Codes	–	
Course Outcomes (CO):	At the End of the course students will be able to :	
Course Outcomes	CO1	Understand the concept of Open-source technology and basics of Linux operating system.
	CO2	Learn various Linux Command Line administration tasks and perform file, user, group and process management tasks.
	CO3	Learn various Linux Command Line utilities to perform storage and network management tasks.
	CO4	Learn Linux Server administration tasks and configure servers for front and backend services.
	CO5	Analyse a given problem and apply requisite facets of SHELL programming in order to devise a SHELL script to solve the problem.
	CO6	Apply security measures to protect the operating environment and explain virtualization and their role in elastic computing.

Module No		Topics	Hours	CO Mapping	BTL Level
1		**Introduction to Open-Source Software**	06	CO1	L2, L3
	1.1	Need of Open Sources, Advantages and applications of Open sources, FOSS – FOSS usage, Free Software Movement, Open-Source Software Development Model, comparison with close source / Proprietary software, widely used open-source software license: Apache License 2.0, BSD license, GNU General Public License, MIT License, Mozilla Public License 2.0			
	1.2	**Installation of Linux (Redhat-CentOS-Fedora-Ubuntu):** Linux Architecture, Kernel and shells, Boot Process, bootloader, understanding FHS of Linux, Understanding the different types of run-levels, understanding different types of shutdown commands,			

2		**Open-Source Operating System: System Administration Task**	**08**	**CO2**	**L3**
	2.1	**Basic Command Line:** Working with the Bash Shell, Getting the Best of Bash, Useful Bash Key Sequences, Working with Bash History, Performing Basic File System Management Tasks, Working with Files and Directories, Piping and Redirection, Finding Files, Working with Links			
	2.2	**Process management Task:** Performing Job Management Tasks, System and Process Monitoring and Management, Managing Process Niceness, Scheduling Jobs using CRON, Creating Backups,			
	2.3	**Users, Groups, and Permissions:** Managing Users and Groups, Commands for User Management, Managing Passwords, Modifying and Deleting User Accounts, Configuration Files, Creating Groups, Managing Permissions, the Role of Ownership, Basic Permissions: Read, Write, and Execute, Advanced Permissions, Working with Access Control Lists, Setting Default Permissions with umask, Working with Attributes			
3		**Open-Source Operating System: Storage and Network Management**	**08**	**CO3**	**L3**
	3.1	**Storage Configuration and Management:** Understanding Partitions and Logical Volumes, Creating Partitions, File Systems Overview, Creating File Systems, Mounting and Unmounting File systems, Mounting File Systems Automatically Through fstab, Working with Logical Volumes, Creating Logical Volumes, Resizing Logical Volumes, Creating Swap Space, Working with Encrypted Volumes			
	3.2	**Network Management:** Understanding Network Manager, Network Manager Configuration Files, Network Service Scripts, Networking from the Command Line, Troubleshooting Networking, Setting Up IPv4 and IPv6, Configuring SSH, Enabling the SSH Server, Using the SSH Client, Using PuTTY on Windows Machines, Configuring Key-Based SSH Authentication, Using Graphical Applications with SSH, Using SSH Port Forwarding, Configuring VNC Server Access			
4		**Open-Source Operating System: Server Administration Task**		**CO4**	**L3**

	4.1	**Configuring Server for File Sharing:** What is NFS? Advantages and Disadvantages of NFS, Configuring NFS4, Setting Up NFSv4, Mounting an NFS Share, Making NFS Mounts Persistent, Configuring Automount, Configuring Samba, Setting Up a Samba File Server, Samba Advanced Authentication Options, Accessing Samba Shares, Understanding the features and advantages of FTP server, Configuring FTP server and FTP clients, Understanding FTP Basic Commands	**08**		
	4.2	**Configuring LAMP stack:** Configuring the Apache Web Server, creating a Basic Website, Understanding the Apache Configuration Files, Apache Log Files, Working with Virtual Hosts, Securing the Web Server with TLS Certificates, Setting Up MySQL and PhpMyAdmin.			
5		**Bash Shell Scripting**	**10**	**CO5**	**L3, L4, L6**
	5.1	**Introducing Bash Shell Scripting:** Introduction to Shells, Executing the Script, Working with Variables and Input, Understanding Variables, Working with Script Arguments, reading user input, Using Command Substitution, Substitution Operators, Changing Variable Content with Pattern Matching, Performing Calculations, Using Control Structures, using if…then…else, using case, using while, using until, using for.			
	5.2	**Advanced Shell Scripting:** Using I/O Redirections, Functions, Arrays, Process substitution, Commands Chaining, AWK, GAWK, SED, CUT and REGEX. Working with web using shell script: Downloading web page as formatted text file and parsing for data, working CURL etc.			
6		**Open-Source Operating System: Advanced security & Virtualization**	**08**	**CO6**	**L3**
	6.1	**SELinux and FirewallD:** SELinux Overview, SELinux Tools, SELinux Contexts, SELinux Booleans, Use SELinux port labeling to allow services to use non-standard ports, Diagnose and address SELinux policy violations, Configure FirewallD, Understand Firewalld Components, Setting Default Firewalld Zone, Creating Own Services in Firewalld, Assigning Services to Firewalld Zones, Adding Rich Rules for Network Range			
	6.2	**Virtualization:** Introduction to virtualization and its types, need of virtualization, Benefits of Virtualization, Virtualization Implementation, Kernel based Virtual Machines (KVM) and XEN			

Recommended Books:

1. Linux: The Complete Reference, Sixth Edition by Richard Petersen, McGraw Hill Education; 6th edition (1 July 2017)
2. Linux Command Line and Shell Scripting Bible by Richard Blum Wiley; 3rd edition (17 March 2015)
3. Red hat Linux Networking and System Administration, by Terry Collings and Kurt Wall, Wiley 3rd edition 2005
4. Linux Administration: A Beginner's Guide by Wale Soyinka, McGraw-Hill Education; 8th edition (28 April 2020)
5. Red Hat Enterprise Linux 6 Administration, Real World Skills for Red Hat Administrators by Sander van Vugt, John Wiley and Sons 2013
6. Rhcsa Red Hat Enterprise Linux 8: Training and Exam Preparation Guide, Asghar Ghori, Endeavor Technologies (10 January 2020)

Software Resources:

1. https://www.virtualbox.org/wiki/Downloads
2. https://getfedora.org/
3. https://www.centos.org/download/
4. https://ubuntu.com/download/desktop
5. https://developers.redhat.com/products/rhel/download

Online Resources: (browser-based terminals)

1. https://distrotest.net/
2. https://bellard.org/jslinux/
3. http://www.webminal.org/terminal/
4. https://www.tutorialspoint.com/unix_terminal_online.php

Online Resources: (Study Resources)

1. https://training.linuxfoundation.org/training/introduction-to-linux/
2. https://www.netacad.com/courses/os-it/ndg-linux-unhatched
3. https://www.netacad.com/courses/os-it/ndg-linux-essentials
4. https://www.edx.org/course/fundamentals-of-red-hat-enterprise-linux
5. https://linuxhandbook.com/tag/bash-beginner/
6. https://www.learnshell.org/
7. https://itsfoss.com/shell-scripting-resources/

Suggested List of Experiments

Experiment no	Experiment Title
1	Installation of Red HAT/Centos/Fedora Linux operating system. a. Partitioning drives b. Configuring boot loader (GRUB/LILO)

	c. Updating and upgrading the system d. Shutting down and reboot
2	Learning and executing Linux commands for a. Interacting with BASH shell and built-in shell variables b. Navigation c. File and directory management d. Working with links e. Searching files
3	Learning and executing Linux commands for Process management tasks like a. Executing a process b. Getting process info c. Killing a process d. Changing process attributes e. Managing foreground and background processes f. Scheduling automated jobs using CRON jobs
4	Learning and executing Linux commands for managing Users, Groups, and Permissions a. Creating, modifying and deleting users b. Creating, modifying and deleting groups c. Managing file permissions, attributes and ownerships d. Setting Default Permissions with umask e. Setting up access control list for files and directories
5	Learning and executing Linux commands for managing Storage drives in Linux environment a. Create partitions b. Install file system c. Mount and unmount partitions manually from CLI d. Automated mounting using fstab e. Encrypt volumes
6	Learning and executing Linux commands for managing networking in Linux environment a. Enable networking services from command line b. Configure IP and other network settings from command line. c. Configure IP and other network settings from configuration files. d. Configure SSH based services for CLI and GUI access on remote machines.
7	Install and configure an NFS server and mount NFS shares on Linux Environment
8	Install and configure files sharing services using FTP server
9	Install and configure Samba file server and share files across local network.

10	Install and configure a LAMP stack and deploy a full stack web application on it with SSL/TLS security.
11	Shell Scripting: **a.** Write a shell script program to display list of user currently logged in. **b.** Write a shell script program to display "HELLO WORLD". **c.** Write a shell script program to develop a scientific calculator. **d.** Write a shell Script program to check whether the given number is even or odd. **e.** Shell script Program to search whether element is present is in the list or no **f.** Shell script program to check whether given file is a directory or not. **g.** Shell script program to count number of files in a Directory. **h.** Shell script program to copy contents of one file to another. **i.** Create directory, write contents on that and Copy to a suitable location in your home directory. **j.** Use a pipeline and command substitution to set the length of a line in file to a variable. **k.** Write a program using sed command to print duplicated lines of Input. **l.** Write a grep/egrep script to find the number of words character, words and lines in a file. **m.** Write an awk script to develop a Fibonacci series. **n.** Write an awk script to display the pattern of given string or number. **o.** Write a shell script program to check variable attributes of file and processes. **p.** Write a shell script program to check and list attributes of processes. **q.** Shell Script program to implement read, write, and execute permissions. **r.** Shell Script program for changing process priority.
12	Configuring security for the Linux Server environment using SELinux and FirewallD
13	Install and set up KVM to run isolated instances of other operating systems inside a Linux host system

Assessment:

1. **ISE- 1**
   a. Five experiments 20 marks
2. **ISE - 2**

a. Five experiments 20 marks
b. Quiz 10 marks

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
ECM601	Mini project – 2B	L	T	P	L	T	P	Total
		--	--	4$	--	--	2	2
		Examination Scheme						
			ISE1	MSE	ISE 2	ESE	Total	
		Lab	20	--	30	--	50	

$ indicates workload of learner(Not faculty), for mini-project

Pre-requisite Course Codes	–	
At the end of the laboratory course, students will be able to:		
Course Out-comes	CO1	Identify problems based on societal /research needs
	CO2	Apply knowledge and skill to solve societal problems in a group
	CO3	Develop interpersonal skills to work as member of a group or leader.
	CO4	Draw the proper inferences from available results through theoretical/ experimental/simulations.
	CO5	Analyze the impact of solutions in societal and environmental context for sustainable development
	CO6	Use standard norms of engineering practices
	CO7	Excel in written and oral communication.
	CO8	Demonstrate capabilities of self-learning in a group, which leads to life-long learning.
	CO9	Demonstrate project management principles during project work.

Guidelines for Mini Project

- 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.
- Students should do survey and identify needs, which shall be converted into problem statemer mini project in consultation with faculty supervisor/head of department/internal committee of ulties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus sh on
  self- learning.

- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- 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 case-by-case basis.

Mini-project 2-B can be based on the Department-Level Optional subject
Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;

Marks awarded by guide/supervisor based on log book	:10
Marks awarded by review committee	:10
Quality of Project report	:05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:
In **first semester** entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
First shall be for finalization of problem

Second shall be on finalization of proposed solution of problem.

In **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 last month of the said semester.

Half-year project:
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

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.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria:

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovative solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovation
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual as member or leader
13. Clarity in written and oral communication

In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- 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 head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovative solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual as member or leader
8. Clarity in written and oral communication

Laboratory Assessment:

ISE:

1. **ISE-1** will be conducted in mid semester for 20 marks

2. **ISE-2**
   a. will be conducted by the end of the semester for 20 marks.
   b. Activity: Oral and presentation 10 marks