Program Structure for Third Year Electronics Engineering

UNIVERSITY OF MUMBAI

(With Effect from 2021-2022)

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		TH	PR	Tut	TH	Pract.	Tut	Total
ECC 601	Embedded Systems and RTOS	3	-	-	3	-	-	**3**
ECC 602	Artificial Intelligence	3	-	-	3	-	-	**3**
ECC 603	Computer Networks	3	-	-	3	-	-	**3**
ECC 604	Data Warehousing and Mining	3	-	-	3	-	-	**3**
ECC DO601	Department Level Optional Course -II	3	-	-	3	-	-	**3**
ECL 601	Embedded Systems Lab	-	2			1		**1**
ECL602	Artificial Intelligence and Computer Networks Lab	-	2	-	-	1	-	**1**
ECL603	Data Warehousing and Mining Lab	-	2	-	-	1	-	**1**
ECL 604	Skill-based Laboratory	-	4	-	-	2	-	**2**
ECM601	Mini Project 2B	-	4$	-	-	2	-	**2**
Total		**15**	**14**	**-**	**15**	**7**	**-**	**22**

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

Course Code	Course Name	Examination Scheme							
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)	TW	Pract/ Oral	Total
		Test 1	Test 2	Av					
ECC 601	Embedded Systems and RTOS	20	20	20	80	03	-	-	**100**
ECC 602	Artificial Intelligence	20	20	20	80	03	-	-	**100**
ECC 603	Computer Networks	20	20	20	80	03	-	-	**100**
ECC 604	Data Warehousing and Mining	20	20	20	80	03	-	-	**100**
ECC DO601	Department Level Optional Course -II	20	20	20	80	03	-	-	**100**
ECL 601	Embedded Systems Lab	-	-	-	-	-	25	25	**50**
ECL602	Artificial Intelligence and Computer Networks Lab	-	-	-	-	-	25	25	**50**
ECL603	Data Warehousing and Mining Lab	-	-	-	-	-	25	25	**50**
ECL 604	Skill-based Laboratory	-	-	-	-	-	50	-	**50**
ECM601	Mini Project - 2B						25	25	**50**
Total				**100**	**400**	**-**	**150**	**100**	**750**

Department Level Optional Course - II (DO 601):

1. Machine Learning	**3.** Digital Signal Processing
2. Industrial Automation	**4.** Electronic Product Design

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 601	Embedded Systems and RTOS	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC 601	Embedded Systems and RTOS	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

Digital Electronics (**ECC 303)**
Microprocessors and Microcontrollers (**ECC 404)**

Course Objectives:

1. To study concepts involved in Embedded Hardware and Software for System realisation.
2. To learn the concepts of modern microcontroller cores like the ARM-Cortex
3. To learn Real-time programming to design time-constrained embedded systems

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

1. Identify and describe various characteristic features and applications of Embedded systems.
2. Analyse and select hardware for Embedded system implementation.
3. Evaluate various communication protocols for Embedded system implementation.
4. Compare GPOS and RTOS and investigate the concepts of RTOS.
5. Evaluate and use various tools for testing and debugging embedded systems
6. 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	Hrs.
1		**Introduction to Embedded Systems**	03
	1.1	Definition, Characteristics, Classification, Applications	
	1.2	Design metrics of Embedded system and Challenges in optimization of metrics	
2		**Embedded Hardware Elements**	13
	2.1	Features of Embedded cores- µC, ASIC, ASSP, SoC, FPGA, RISC and CISC cores. Types of memories.	
	2.2	Case Study: ARM Cortex-M3 Features, Architecture, Programmer's model, Special Registers, Operating Modes and States, MPU, Memory map and NVIC.	
	2.3	Low power: - Need and techniques. Case study of Low Power modes in Cortex-M3.	
	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)*	
	2.5	Selection criteria of Sensors and Actuators	
3		**Embedded Software**	12
	3.1	Program Modelling concepts: DFG, CDFG, FSM.	
	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.	
4		**Introduction to Free RTOS**	03
		Free RTOS 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		**Testing and Debugging Methodology**	02
	5.1	Testing & Debugging: Hardware testing tools, Boundary-scan/JTAG interface concepts, Emulator.	
	5.2	Software Testing tools, simulator, debugger. White-Box and Black-Box testing.	
6		**System Integration (Case Studies)**	06
	6.1	Embedded Product Design Life-Cycle (EDLC)- Waterfall Model	
	6.2	Hardware-Software Co-design	
	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	
		Total	39

Note: *- Referring to data sheets while selecting hardware components must be encouraged.*

Text Books:

1. Dr. K. V. K. K. Prasad, "Embedded Real Time System: Concepts, Design and Programming", Dreamtech, New Delhi, Edition2014.
2. Rajkamal, "Embedded Systems: Architecture, Programming and Design", McGraw Hill Education (India) Private Limited, New Delhi, 2015, 3rd Edition.
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

Reference Books:

1. David Simon, "An Embedded Software Primer", Pearson,2009.
2. Jonathan W. Valvano, "Embedded Microcomputer Systems – Real Time Interfacing", Publisher - Cengage Learning, 2012 3rd Edition.
3. Andrew Sloss, Domnic Symes, Chris Wright, "ARM System Developers Guide Designing and Optimising System Software", Elsevier, 2004.
4. FrankVahid, Tony Givargis, "Embedded System Design – A Unified Hardware/SoftwareIntroduction", John Wiley & Sons Inc., 2002.
5. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, New Delhi,2009

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the module

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC602	Artificial Intelligence	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC602	Artificial Intelligence	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

Data structures and algorithms,
Discrete mathematics,
Basic Mathematics

Course Objectives:

1. To gain perspective of AI and its foundations.
2. To study different agent architectures and properties of the environment.
3. To understand the basic principles of AI towards problem solving, inference, perception, knowledge representation, and learning.
4. To investigate probabilistic reasoning under uncertain and incomplete information.
5. To explore the current scope, potential, limitations, and implications of intelligent systems.

Course Outcomes:

After successful completion of the course students will be able to:

1. Identify the characteristics of the environment and differentiate between various agent architectures.
2. Apply the most suitable search strategy to design problem solving agents.
3. Represent a natural language description of statements in logic and apply the inference rules to design Knowledge Based agents.
4. Apply a probabilistic model for reasoning under uncertainty.
5. Comprehend various learning techniques.
6. Describe the various building blocks of an expert system for a given real world problem.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Artificial Intelligence**	3
	1.1	Artificial Intelligence (AI), AI Perspectives: Acting and Thinking humanly, Acting and Thinking rationally	
	1.2	History of AI, Applications of AI, The present state of AI, Ethics in AI	
2		**Intelligent Agents**	4
	2.1	Introduction of agents, Structure of Intelligent Agent, Characteristics of Intelligent Agents	
	2.2	Types of Agents, Simple Reflex, Model Based, Goal Based, Utility Based Agents.	
	2.3	Environment Types, Deterministic, Stochastic, Static, Dynamic, Observable, Semi-observable, Single Agent, Multi Agent	
3		**Solving Problems by Searching**	12
	3.1	Definition, State space representation, Problem as a state space search, Problem formulation, Well-defined problems	
	3.2	Solving Problems by Searching, Performance evaluation of search strategies, Time Complexity, Space Complexity, Completeness, Optimality	
	3.3	Uninformed Search, Depth First Search, Breadth First Search, Depth Limited Search, Iterative Deepening Search, Uniform Cost Search, Bidirectional Search	
	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	
	3.5	Game Playing, Adversarial Search Techniques, Mini-max Search, Alpha-Beta Pruning	
4		**Knowledge and Reasoning**	10
	4.1	Definition and importance of Knowledge, Issues in Knowledge Representation, Knowledge Representation Systems, Properties of Knowledge Representation Systems	
	4.2	Propositional Logic (PL), Syntax, Semantics, Formal logic-connectives, truth tables, tautology, validity, well-formed-formula,	
	4.3	Predicate Logic, FOPL, Syntax, Semantics, Quantification, Inference rules in FOPL, Introduction to logic programming (PROLOG)	
	4.4	Forward Chaining, Backward Chaining and Resolution in FOPL	
5		**Reasoning Under Uncertainty**	5
	5.1	Handling Uncertain Knowledge, Random Variables, Prior and Posterior Probability, Inference using Full Joint Distribution	
	5.2	Bayes' Rule and its use, Bayesian Belief Networks, Reasoning in Belief Networks	
6		**Planning and Learning**	5
	6.1	The planning problem, Partial order planning, total order planning.	
	6.2	Learning in AI, Learning Agent, Concepts of Supervised, Unsupervised, Semi -Supervised Learning, Reinforcement Learning, Ensemble Learning.	

	6.3	Expert Systems, Components of Expert System: Knowledge base, Inference engine, user interface, working memory, Development of Expert Systems	
		Total	**39**

Text 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.

Reference Books:

1. Ivan Bratko "PROLOG Programming for Artificial Intelligence", Pearson Education, Third Edition.
2. D. W. Patterson, Artificial Intelligence and Expert Systems, Prentice Hall.
3. Saroj Kaushik "Artificial Intelligence", Cengage Learning.
4. Davis E. Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
5. Patrick Henry Winston, "Artificial Intelligence", Addison-Wesley, Third Edition.
6. N. P. Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will consist of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on the entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 603	Computer Networks	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC 603	Computer Networks	20	20	20	80	03	--	--	--	100

Course Pre-requisite: Communication Engineering

Course Objectives:

1. To understand the fundamental concepts of computer networking, protocols, architectures, and applications.
2. To study the multiple layer design issues, services, and state-of-the-art protocols of TCP/IP and OSI based Architectures.
3. To help students to acquire knowledge of address in the configuration of various scales of networks
4. To be conversant with the principles of Network Application Programming

Course Outcomes:

After successful completion of the course students will be able to:

1. Enumerate the layers of OSI model and TCP/IP model and describe their functions.
2. Identify the characteristics of network devices and media used to design networks.
3. Demonstrate the knowledge of networking protocols at various layers of TCP/IP model.
4. Classify the routing protocols and analyse how to assign the IP addresses for a given network
5. Design and configure the networks using IP addressing and sub-netting / super-netting schemes.
6. Explain the functions of Application layer and Presentation layers, their paradigms and Protocols.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Data Communications and Networking**	05
	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	Reference models: Layer details of OSI, TCP/IP models. Communication between layers. Internet	

2		**Physical Layer**	06
	2.1	Guided Transmission Media: Twisted pair, Coaxial, Fiber optics.	
	2.2	Unguided media (Wireless Transmission): Radio Waves, Microwave, Bluetooth, Infrared, Circuit and Packet Switching	
	2.3	Network Devices: Repeaters, Hubs, Switches, Routers and Gateways	
3		**Data Link Layer**	08
	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.	
	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	
4		**Network layer**	08
	4.1	Network Layer design issues, Communication Primitives: Unicast, Multicast, Broadcast. Network Layer Protocols: IPv4 Datagram Format, IPv4 Addresses, IPv4 Addressing (classfull and classless), Sub-netting and Super-netting design problems, IPv4 Protocol, IPv6 Packet Format, IPv6 Addressing, Transition from IPv4 to IPv6	
	4.2	Routing algorithms: Intra-domain Routing -Shortest Path, Distance Vector Algorithms, Link State Routing, Inter-domain Routing Protocols.	
	4.3	Congestion control algorithms: Open loop congestion control, Closed loop congestion control, QoS parameters.	
5		**Transport Layer**	07
	5.1	The Transport Service: Transport service primitives, Berkeley Sockets, Connection management (Handshake), UDP, TCP, TCP state transition, TCP timers	
	5.2	TCP Flow control (sliding Window), TCP Congestion Control: Slow Start	
6		**Application layer**	05
	6.1	Application layer Paradigms, Client-Server Paradigm: Application Programming Interface	
	6.2	Standard Client Server applications: World Wide Web and HTTP, FTP, Electronic Mail, TELNET, Secure Shell (SSH), Domain Name System (DNS)	
		Total	**39**

Text 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.

Reference Books:

1. James F. Kurose, K. W. Ross, Computer Networking: A Top-Down Approach Featuring the Internet, 3rd Edition, Pearson Education.

2. S. Keshav, An Engineering Approach to Computer Networks, 2nd Edition, Pearson Education.
3. W. A. Shay, Understanding communications and Networks, 3rd Edition, W. A. Shay, Cengage Learning.
4. L. L. Peterson and B. S. Davie, Computer Networks: A Systems Approach, 4th Ed, Elsevier India

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC604	Data Warehousing and Mining	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC604	Data Warehousing and Mining	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

Database Concepts, Algorithm Design and Analysis Concepts, Data Structures

Course Objectives:

1. To identify the scope and understand the fundamentals of Data Warehousing and Mining.
2. To understand the importance of data warehouse that would assist in providing business insights for data mining applications.
3. To instigate research interest towards advances in Data Mining.

Course Outcomes:

After successful completion of the course students will be able to:

1. Understand Data Warehousing fundamentals and Dimensionality modelling principles
2. Understand the use of ETL techniques and apply OLAP operations.
3. Perceive the importance of data pre-processing and basics of data mining techniques.
4. Relate to the concepts of market basket analysis in real world applications.
5. Apply classification algorithms in real world dataset for classification and prediction.
6. Visualize the concept of clustering and its applications.

	Unit No.	Contents	Hrs.
1		**Data Warehousing and Dimension Modelling**	8
	1.1	Introduction to Data Warehouse, Characteristics of Data Warehouse	
	1.2	Components of Data warehouse Architecture, Data warehouse architecture	
	1.3	Data warehouses versus Data Marts,	
	1.4	E-R Modelling versus Dimensional Modelling,	
	1.5	Data Warehouse Schemas; Star Schema, Snowflake Schema, Fact Less Fact Table, Fact Constellation Schema.	
	1.6	Inside Dimensional Table, Inside Fact Table,	
	1.7	Update to the dimension tables. OLTP Systems versus OLAP	

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

Text 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.

Reference Books:

1. Ian H. Witten, Eibe Frank and Mark A. Hall, "Data Mining ", 3rd Edition Morgan Kaufmann publisher.
2. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, Introduction to Data Mining", Person Publisher.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

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1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDO601	Machine Learning	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECCDO 601	Machine Learning	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

Data Structures, Basic Probability and Statistics, Algorithms

Course Objectives:

1. To introduce Machine learning concepts
2. To develop mathematical concepts required for Machine learning algorithms
3. To understand various Regression techniques
4. To understand Clustering techniques
5. To develop Neural Network based learning models

Course Outcomes:

After successful completion of the course students will be able to:

1. Comprehend basics of Machine Learning
2. Build Mathematical foundation for machine learning
3. Understand various Machine learning models
4. Select suitable Machine learning models for a given problem
5. Build Neural Network based models
6. Apply Dimensionality Reduction techniques

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Machine Learning**	6
	1.1	Introduction to Machine Learning, Issues in Machine Learning, Application of Machine Learning, Steps of developing a Machine Learning Application.	
	1.2	Supervised and Unsupervised Learning: Concepts of Classification, Clustering and prediction, Training, Testing and validation dataset, cross validation, overfitting and under fitting of model	
	1.3	Performance Measures: Measuring Quality of model- Confusion Matrix, Accuracy, Recall, Precision, Specificity, F1 Score, RMSE	

2		**Mathematical Foundation for ML**	5
	2.1	System of Linear equations, Norms, Inner products, Length of Vector, Distance between vectors, Orthogonal vectors	
	2.2	Symmetric Positive Definite Matrices, Determinant, Trace, Eigenvalues and vectors, Orthogonal Projections, Diagonalization, SVD and its applications.	
3		**Liner models**	7
	3.1	The least-squares method, Multivariate Linear Regression, Regularised Regression, Using Least-Squares Regression for classification	
	3.2	Support Vector Machines	
4		**Clustering**	4
	4.1	Hebbian Learning rule	
	4.2	Expectation -Maximization algorithm for clustering	
5		**Classification models**	12
	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.	
	5.2	Perceptron Learning Rule. Delta Learning Rule (LMS-Widrow Hoff), Multi-layer perceptron network. Adjusting weights of hidden layers. Error back propagation algorithm.	
	5.3	Logistic regression	
6		**Dimensionality Reduction**	5
	6.1	Curse of Dimensionality.	
	6.2	Feature Selection and Feature Extraction	
	6.3	Dimensionality Reduction Techniques, Principal Component Analysis.	
		Total	**39**

Text 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

Reference Books:

1. Tom M. Mitchell, “Machine Learning”, McGraw Hill
2. Kevin P. Murphy, “Machine Learning — A Probabilistic Perspective”, MIT Press
3. Stephen Marsland, “Machine Learning an Algorithmic Perspective”, CRC Press
4. Shai Shalev-Shwartz, Shai Ben-David, “Understanding Machine Learning”, Cambridge University Press
5. Peter Harrington, “Machine Learning in Action”, DreamTech Press

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
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3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC DO601	Industrial Automation	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC DO601	Industrial Automation	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

Knowledge of Basic Electrical Engineering,
Basic Electronics,
Digital Electronics,
Electronics Measurement and Instruments

Course Objectives:

1. To measure industrial parameters like temperature, pressure, force, displacement, speed, flow, level, humidity and pH.
2. To explain fundamentals of process control
3. To list basic devices used in automated systems
4. To use programmable logic controllers for industrial automation
5. To draw block diagram of supervisory control and data acquisition (SCADA) and integrate it with PLC systems
6. To use Internet of Things for Industrial Automation
7. To make use of robots for industrial applications

Course Outcomes:

After successful completion of the course students will be able to:

1. Understand and draw block diagram of industrial automation and control system
2. Understand various automation components and systems
3. Explain architecture of industrial automation system
4. Demonstrate working of PLC and SCADA and interface the same.
5. Demonstrate the use of IOT and robotics in Automation
6. Distinguish between the usage of custom embedded systems, FPGAs and PLCs

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

Text Books:

1. S. K. Singh, “Industrial Instrumentation and Control”, The McGraw Hill Companies
2. C.D. Johnson, “Process Control Instrumentation Technology”, PHI
3. E. Andrew Parr, “Industrial control handbook”, Newnem publication

Reference Books:

1. Garry Dunning, Introduction to Programmable logic controller, Delmar Thomson Learning,
2. Norman A. Anderson, Instrumentation and Process measurements and Control 2nd Edition. CRC Press

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC DO601	Digital Signal Processing	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC DO601	Digital Signal Processing	20	20	20	80	03	--	--	--	100

Prerequisite Courses:

Engineering Mathematics - III

Course Objectives:

1. To make conversant with the fundamentals of digital signal processing
2. To familiarise with the transforms used in Digital Signal Processing
3. To familiarise with the design techniques and performance analysis of digital filters
4. To introduce digital signal processors and applications

Course Outcomes:

After successful completion of this course students will be able to

1. Apply the concept of DT Signal and DT Systems.
2. Classify and analyse discrete time signals and systems
3. Implement Digital Signal Transform techniques DTFT, DFT and FFT.
4. Design FIR and IIR digital filters to meet arbitrary specifications and Develop algorithms for implementation
5. Use signal processing techniques and digital signal processors in various applications

Module No.	Unit No.	Contents	Hrs.
1		**Discrete-Time Signal and Discrete-Time Systems**	08
	1.1	Introduction to Digital Signal Processing, Sampling and Reconstruction, Standard DT Signals, Concept of Digital Frequency, Representation of DT signal using Standard DT Signals, Signal Manipulations-shifting, reversal, scaling, addition, multiplication.	
	1.2	Classification of Discrete-Time Signals, Classification of Discrete-Systems, LTI system, Impulse Response.	

	1.3	Linear Convolution, Circular Convolution- Emphasis on graphical method, linear convolution using Circular Convolution. Software simulation - Impulse Response, Step Response, convolution, Correlation.	
2		**Frequency Domain Analysis using DTFT and Z Transform**	07
	2.1	Introduction to DTFT. Properties of DTFT.	
	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	
	2.3	Analysis and characterization of LTI system using Z transform, impulse and step response, causality, stability, stability of causal system	
3		**Discrete Fourier Transform and Fast Fourier Transform**	06
	3.1	DFT, Relation between DFT and DTFT, IDFT	
	3.2	Properties of DFT, circular convolution of sequences using DFT	
	3.3	Fast Fourier transforms (FFT), Radix-2 decimation in time and decimation in frequency FFT algorithms, inverse FFT	
4		**IIR Digital Filters**	09
	4.1	Comparison of IIR and FIR filters, Types of IIR Filters, Analog filter approximations: Butterworth, Chebyshev I and II	
	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	
	4.3	Analog and digital frequency transformations	
5		**FIR Digital Filters**	05
	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	
	5.2	Design of FIR filters using window techniques -Rectangular, Hamming, Hanning, Blackman, Bartlett, Software simulation – Design of FIR Filters.	
6		**DSP Processors and Applications**	04
	6.1	General purpose digital signal processors, DSP processor architecture, Selecting digital signal processors, Special purpose DSP hardware	
	6.2	Applications of DSP: Radar Signal Processing and Speech Processing	
		Total	**39**

Text 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

Reference Books:

1. ProakisJ., Manolakis D., "*Digital Signal Processing*", 4th Edition, Pearson Education
2. Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach", edition 4e McGraw Hill Education (India) Private Limited
3. Oppenheim A, Schafer R, Buck J., "*Discrete Time Signal Processing*", 3rd Edition, Pearson Education.

4. B. Venkata Ramani and, M. Bhaskar, "Digital Signal Processors, Architecture, Programming and Applications", Tata McGraw Hill, 2nd edition 2017.
5. L. R. Rabiner and B. Gold, "Theory and Applications of Digital Signal Processing", Prentice-Hall of India, 2015.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the module

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC DO601	Electronic Product Design	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC DO601	Electronic Product Design	20	20	20	80	03	--	--	--	100

Course Pre-requisite: Electronic Circuits, Controls and Instrumentation

Course Objectives:

1. To understand the customer need-based product development process
2. To understand the Lab to market challenges in the product design and development
3. To understand the electronic product development stages
4. To understand the development consideration of hardware and software design and various testing method
5. To gain knowledge about various processes, safety & qualification certifications & the importance of documentation

Course Outcomes:

After successful completion of the course students will be able to:

1.Importance of customer-centric approach in the electronic product development process
2. Electronic product development stages and challenges
3. Implement learning for meeting a prototype as per industry standard/specification
4. Demonstrate problem-solving & troubleshooting skills in electronic product design
5. Prepare the relevant set of design documentation & present it as a case study

Module No.	Unit No.	Contents	Hrs.
1		**CUSTOMER CENTRIC APPROACH FOR PRODUCT DEVELOPMENT**	08
	1.1	Prototype, MVP, commercial product and related terminologies	
	1.2	Basics of customer discovery process, customer and value proposition	
	1.3	Understand product market fit, product failure, internal challenges for product development.	
	1.4	Identify the available market place for the product.	
2		**PRODUCT DEVELOPMENT CHALLENGES**	06
	2.1	Idea segmentation, product features, lab to market journey, Product development	

		stages, product development challenges.	
	2.2	Electronic product classification and certifications requirement. Indian and international standard for product compliance.	
3		**HARDWARE DESIGN & TESTING METHODS**	07
	3.1	Design process, identifying the requirements, formulating specifications, design specifications, system partitioning, functional design, architectural design,	
	3.2	Component selection criteria	
	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	
4		**SOFTWARE DESIGN & TESTING METHODS**	06
	4.1	Types of software, the waterfall model of software development, models, metrics & software limitations, risk abatement & failure prevention	
	4.2	Software bugs & testing	
	4.3	Good programming practice, user interface, embedded & real-time software	
5		**PRODUCT DEBUGGING & TESTING**	06
	5.1	Steps of debugging, the techniques for troubleshooting	
	5.2	Characterization, electromechanical components, passive components, active components, active devices, operational amplifier, analog-to-digital conversion, digital components,	
	5.3	Inspection & testing of components, process of simulation, prototyping & testing, integration, validation & verification, EMI & EMC issues	
6		**THE DOCUMENTATION PROCESS**	06
		Definition, needs & types of documentation, records, accountability & liability, audience, steps in preparation, presentation & preservation of documents	
		Methods of documentation, visual techniques, layout of documentation, bills of materials, manuals – instructional or operating manual, service and maintenance manual,	
		Fault finding tree, software documentation practices	
		Total	**39**

Text 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

Reference Books:

1. GIFF CONSTABLE, Talking to humans
2. R. G. Kaduskar & V. B. Baru, Electronic Product Design, 3rd edition, Wiley India
3. Kim Fowler, Electronic Instrument Design, 2nd edition, Oxford University Press
4. Robert J. Herrick, PCB Design Techniques for EMC Compliance, 2nd edition, IEEE Press

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the module

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 601	Embedded Systems Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical /Oral	Oral	Total
		Internal assessment			End Sem Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL 601	Embedded Systems Lab	--	--	--	--	--	25	25	--	50

Prerequisite:

1. Basics of Microcontroller programming
2. C programming

Laboratory Outcomes:

After successful completion of the course students will be able to:

1. Interface various sensors and actuators to embedded cores.
2. Write code using RTOS for multi-tasking Embedded systems
3. Design applications using different embedded cores

Term Work:

At least 10 experiments covering entire syllabus of **Embedded Systems and RTOS (ECC 601)** should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Name
1	Interfacing of LEDs /switches with any embedded core. (8051/ARM/STM32, etc)
2	Interfacing of Temperature sensor with any embedded core. (8051/ARM/STM32, etc)

3	Interfacing of LCD/ Seven segment display with any embedded core. (8051/ARM/STM32,etc)
4	Interfacing of Ultrasonic/Humidity sensor with any embedded core. (8051/ARM/STM32,etc)
5	Interfacing of a relay with any embedded core. (8051/ARM/STM32,etc)
6	Interfacing of a DC motor (speed and Direction control) with any embedded core.(8051/ARM/STM32,etc)
7	Interfacing of a stepper motor (to move by a particular angle) with any embedded core. (8051/ARM/STM32, etc)
8	Implement power management in any embedded core of your choice
9	Implement the I2C communication to connect to DS1307 RTC
10	Porting of FreeRTOS to Arduino/STM32.
11	Write a Program to Create Multiple Tasks and understand the Multitasking capabilities of RTOS(FreeRTOS).
12	Write a Program to illustrate the Queue Management Features of FreeRTOS.
13	Write a Program to illustrate the Event Management Features of FreeRTOS.
14	Write a Program to illustrate the use of Binary and Counting Semaphore for Task Synchronisation using FreeRTOS.
15	Build a Multitasking Real-Time Applications using the above IPC Mechanisms (Message Queue, EventGroup, Semaphores) with FreeRTOS on Arduino/STM32.
• *Students must perform the experiments using Simulation as well as in Hardware.* • *Experiments must include a minimum of 3 experiments using FreeRTOS*	

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 602	Artificial Intelligence and Computer Networks Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical/ Oral	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL 602	Artificial Intelligence and Computer Networks Lab	--	--	--	--	--	25	25	--	50

Laboratory Outcomes (LO)

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

1. Identify suitable Agent Architecture for a given real world AI problem
2. Implement simple programs using Prolog.
3. Implement various search techniques for a Problem-Solving Agent.
4. Represent natural language description as statements in Logic and apply inference rules to it.
5. Construct a Bayesian Belief Network for a given problem and draw probabilistic inferences from it.
6. Design and implement various network applications such as data transmission between client and server, file transfer etc. using Socket Programming
7. Determine how to assign the IP addresses and configure a network on different operating environments.
8. Configure the networks using IP addressing and subnetting / supernetting schemes using various OS commands

Term Work:

At least 10 experiments covering entire syllabus of **Artificial Intelligence and Computer Networks (50 % Artificial intelligence and the remaining 50% Computer Networks experiments)** should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Name
	Artificial Intelligence
1	Provide the PEAS description and TASK Environment for a given AI problem. Identify suitable Agent Architecture for the problem
2	Write simple programs using PROLOG as an AI programming Language
3	Implement any one of the Uninformed search techniques
4	Implement any one of the Informed search techniques E.g. A-Star algorithm for 8 puzzle problem
5	Implement adversarial search using min-max algorithm.
6	Write a program to implement genetic algorithm.
7	Prove the goal sentence from the following set of statements in FOPL by applying forward, backward and resolution inference algorithms.
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)
	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
2	Socket programming using TCP and/or UDP
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
4	Working with routing in Linux/windows: • View the current routing table • Add and delete routes • Change default gateway Perform IP Tables for IP forwarding
5	Set up and configuration of firewalls in Linux/windows (Use IPTables)
6	Packet Sniffing using Wireshark

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL603	Data Warehousing and Mining Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical/ Oral	Oral	Total
		Internal assessment			End Sem Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL603	Data Warehousing and Mining Lab	--	--	--	--	--	25	25	--	50

Laboratory Outcomes (LOs):

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

1. Design data warehouse using dimensional modelling
2. Perform different OLAP operations
3. Differentiate among different data mining techniques and decide the applicability for each.
4. Demonstrate classifications, prediction, etc. on datasets using open source tools
5. Perform Market basket analysis in real world data using data mining tools
6. Appreciate and visualize clustering techniques

Term Work:

At least 10 experiments covering entire syllabus of **Data Warehousing and Mining** should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Name
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

2	Implementation of OLAP operations: Slice, Dice, Rollup, Drilldown and Pivot for the above problem statement (experiment 1)
3	Implementation of Classification algorithm(Decision Tree/Naive Bayes)
4	Implementation of Clustering algorithm(K-means/Agglomerative)
5	Implementation of Association Rule Mining algorithm (Apriori)
6	Implementation of prediction algorithm (Linear regression)
7	Perform data Pre-processing task and Demonstrate Classification algorithm on data sets using data mining tool (WEKA, R tool, XL Miner, Orange etc.)
8	Perform data Pre-processing task and Demonstrate Clustering algorithm on data sets using data mining tool (WEKA, R tool, XL Miner, Orange etc.).
9	Perform data Pre-processing task and Demonstrate Association algorithm on data sets using data mining tool (WEKA, R tool, XL Miner, Orange etc.).
10	Demo on any cloud-based data warehousing process (an end to end process) which gives a holistic view of Data Warehouse

Text Books:

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/"

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

Web References

1. https://www.coursera.org/specializations/data-mining
2. https://www.udemy.com/course/data-mining-python/
3. https://onlinecourses.nptel.ac.in/noc21_cs06/preview

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL604	Skill base Lab: Linux Server Administration Lab	--	2*+ 2 Hours (Batch-wise)	--	--	02	--	02
*Theory class to be conducted for full class								

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical/ Oral	Oral	Total
		Internal assessment			End Sem Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL604	Skill base Lab: Linux Server Administration Lab	--	--	--	--	--	50	--	--	50

Course Pre-requisites: Familiarity to computer systems, Computer Networks

Course Objectives:

1. To introduce the concept of Open-Source Software.
2. To impart knowledge and skills on various practical and theoretical aspects of Linux operating system (OS) basics and Linux OS based server configuration, management and administration.
3. To provide a comprehensive introduction to SHELL programming, services and utilities.
4. To Introduce the Linux system Security and Virtualization technologies concepts like Hypervisor, emulation, and application

Course Outcomes:

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

1. Understand the concept of Open-source technology and basics of Linux operating system
2. Learn various Linux Command Line administration tasks and perform file, user, group and process management tasks
3. Learn various Linux Command Line utilities to perform storage and network management tasks
4. Learn Linux Server administration tasks and configure servers for front and backend services.
5. Analyse a given problem and apply requisite facets of SHELL programming in order to devise a SHELL script to solve the problem
6. Apply security measures to protect the operating environment and explain virtualization and their role in elastic computing.

Module No		Topics	Hours
1		**Introduction to Open-Source Software**	**06**
	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**
	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**
	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**	**08**
	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	

	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**
	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**
	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 XE	

Text 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

Reference Books:

1. Linux Administration: A Beginner's Guide by Wale Soyinka, McGraw-Hill Education; 8th edition (28 April 2020)
2. Red Hat Enterprise Linux 6 Administration, Real World Skills for Red Hat Administrators by Sander van Vugt, John Wiley and Sons 2013
3. 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

Sr. 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

Subject Code	Subject Name	Credits Assigned
ECM601	Mini project – 2B	02

Subject Code	Subject Name	Examination Scheme							
		Theory Marks					Term Work	Practical/ Oral	Total
		Internal Assessment			End Sem Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECM601	Mini project – 2B	--	--	--	--	--	25	25	50

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcomes:

Learner will be able to;

1. Identify problems based on societal /research needs.
2. Apply knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/experimental/simulations.
5. Analyze the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices.
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life-long learning.
9. 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.
- Major focus of Mini-project 2 shall be towards exploration and applicability of knowledge acquired in the domain areas of DLOs available for the year.
- Student shall give special consideration to identify and provide solutions to the burning societal and/or environmental issues which may affect the mankind to larger extend.

- 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 shall 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-to-case basis.

Guidelines for Assessment of Mini Project:

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 logbook:		***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 on identification and finalization of problem
- Second on proposed solution for the 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 shall base on readiness of building working prototype.
- 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 students' group shall complete project in all aspects, in a semester, including;

- Identification of need/problem
- Proposed acceptable solution for the identified problem
- Procurement of components/systems, if any,
- Building a working prototype and testing

The group shall be evaluated twice during the semester by review committee, mainly look for the progress as;

- First review focus shall be towards identification & selection of problem and probable solution proposal.
- Second review shall be for implementation and testing of solution. (Innovative/out of box 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. Innovativeness and out of box thinking
6. Cost effectiveness and Societal impact
7. Functional working model as per stated requirements
8. Effective use of skillsets acquired through curriculum including DLOs
9. Effective use of standard engineering practices & norms
10. Contribution of an individual as team member/Leader
11. Feasibility to deploy the solution on large scale
12. 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 performance evaluation 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 the Institute.

Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed by team of external & internal examiner at the end of semester/year. Performance shall be evaluated based on;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Implementation of working model
5. Effective use of diversified skill-set
6. Effective use of standard engineering practices & norms
7. Contribution of an individuals as a member/Leader
8. Clarity in written and oral communication