Savitribai Phule Pune University

Faculty of Science and Technology

Syllabus for

B.E (Electronics & Telecommunication Engineering)

(Course 2019)

(w.e.f. June 2022)

Savitribai Phule Pune University, Pune
B.E. (Electronics & Telecommunication) 2019 Course
(With effect from Academic Year 2022-23)

Semester-VII

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit			
		Theory	Practical	Tutorial	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR	TUT	Total
404181	Radiation & Microwave Theory	03	-	-	30	70	-	-	-	100	03	-	-	03
404182	VLSI Design and Technology	03	-	-	30	70	-	-	-	100	03	-	-	03
404183	Cloud Computing	03	-	-	30	70	-	-	-	100	03	-	-	03
404184	Elective - 3	03	-	-	30	70	-	-	-	100	03	-	-	03
404185	Elective - 4	03	-	-	30	70	-	-	-	100	03	-	-	03
404186	Lab Practice - 1 (RMT & Cloud Computing)	-	04	-	-	-	25	-	50	75	-	02	-	02
404187	Lab Practice - 2 (VLSI Design & Elective -3)	-	04	-	-	-	25	50	-	75	-	02	-	02
404188	Project Stage - I	-	02	-	-	-	50	-	-	50	-	01	-	01
404189	Mandatory Audit Course 7	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	**15**	**10**	**-**	**150**	**350**	**100**	**50**	**50**	**700**	-	-	-	-
	Total Credits										**15**	**05**	**-**	**20**

Elective - 3	**Elective - 4**
1. Speech Processing	1. Data Mining
2. PLC SCADA & Automation	2. Electronic Product Development
3. JAVA Script	3. Deep Learning
4. Embedded & RTOS	4. Low Power CMOS
5. Modernized IoT	5. Smart Antennas

Mandatory Audit Course - 7
1. Management Information System
2. Patent Search & Analysis
3. Knowledge Management
4. Energy Economics & Policy
5. Educational Leadership
6. Human Resource Development

Savitribai Phule Pune University, Pune
B.E. (Electronics & Telecommunication) 2019 Course
(With effect from Academic Year 2022-23)

Semester-VIII

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit			
		Theory	Practical	Tutorial	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR	TUT	Total
404190	Fiber Optic Communication	03	-	-	30	70	-	-	-	100	03	-	-	03
404191	Elective - 5	03	-	-	30	70	-	-	-	100	03	-	-	03
404192	Elective - 6	03	-	-	30	70	-	-	-	100	03	-	-	03
404193	Innovation & Entrepreneurship	-	-	02	-	-	50	-	-	50	-	-	02	02
404194	Digital Business Management	-	-	02	-	-	50	-	-	50	-	-	02	02
404195	Fiber Optic Lab	-	02	-	-	-	25	-	50	75	-	01	-	01
404196	Lab Practice - 3 (Elective - 5)	-	02	-	-	-	25	50	-	75	-	01	-	01
404197	Project Stage - II	-	10	-	-	-	100	-	50	150	-	05	-	05
	Total	**09**	**14**	**04**	**90**	**210**	**250**	**50**	**100**	**700**	**-**	**-**	**-**	**-**
							Total Credits				**09**	**07**	**04**	**20**

Elective - 5	Elective - 6
1. Biomedical Signal Processing	1. System on Chip
2. Industrial Drives & Automation	2. Nano Electronics
3. Android Development	3. Remote Sensing
4. Embedded System Design	4. Digital Marketing
5. Mobile Computing	5. Open Elective

Program Outcomes (PO's)	
Engineering Graduates will be able to:	
1.	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2.	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3.	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4.	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of theinformation to provide valid conclusions.
5.	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6.	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant tothe professional engineering practice.
7.	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and needfor sustainable development.
8.	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9.	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10.	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11.	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12.	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

SEMESTER - VII

Savitribai Phule Pune University

Fourth Year of E & Tc Engineering (2019 Course)

404181: Radiation and Microwave Theory

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 Hrs. / Week	03	In-Sem (Theory): 30 Marks End Sem (Theory): 70 Marks

Prerequisite Courses, if any:

1. Electromagnetic Field Theory

Companion Course, if any:

1. Lab Practice – 1

Course Objectives:

1. To introduce fundamental theory of radiation and microwaves.
2. To understand theory of passive and active components of microwave systems.
3. To know the characteristics of various microwave solid state active devices.
4. To learn microwave measurement techniques.

Course Outcomes: On completion of the course, learner will be able to

CO1: Apply the fundamentals of electromagnetic to derive free space propagation equation and distinguish various performance parameters of antenna.

CO2: Identify various modes in the waveguide. Compare: coaxial line, rectangular waveguides & striplines and identify applications of the same.

CO3: Explore construction and working of principles passive microwave devices/components.

CO4: Explore construction and working of principles active microwave devices/components.

CO5: Analyze the structure, characteristics, operation, equivalent circuits and applications of various microwave solid state active devices.

CO6: Know the various microwave systems, device set ups of microwave measurement devices and Identify the effect of radiations on environmental sustainability.

Course Contents

Unit I	Fundamental Theory of Radiation and Radiating Elements	6 Hrs.

Fundamental equations for free space **(Friis transmission equation)**, Definition of antenna, radiation mechanism and types of antenna, performance parameters such as radiation pattern, directivity, gain, efficiency, half power beam width, bandwidth, polarization, input impedance, radiation efficiency, effective length, effective area, radiation sphere.

Mapping of Course Outcomes for Unit I	**CO1: Apply** the fundamentals of electromagnetic to derive free space propagation equation and distinguish various performance parameters of antenna.

Unit II	Transmission Lines and Waveguides	6 Hrs.
Introduction to microwaves, short history of microwave engineering, frequency band definitions, advantages and applications of microwaves (overall applications). Introduction to wave guides, advantages of waveguides, comparison of waveguides and co-axial cables, Rectangular waveguides, modes of propagation in waveguides, cut off frequency, dominant mode, waveguide characteristics and parameters, excitation in waveguides, coupling methods (probe, slot, loop), application of re-entrant cavities, coupling of cavities, Striplines: Structural details, types and applications.		
Mapping of Course Outcomes for Unit II	**CO2: Identify various modes in the waveguide. Compare: coaxial line, rectangular waveguides & striplines and identify applications of the same.**	
Unit III	**Passive Microwave Components**	**6 Hrs.**
Construction, working principle and scattering analysis of passive microwave components such as E-plane, H-plane and magic tee. Ferrite composition, characteristics and Faraday rotation principle. Construction, working principle and scattering analysis of Isolator, Circulator and Directional coupler. Construction and operation of Gyrator, Microwave Filters, Phase Shifter, Microwave Attenuator.		
Mapping of Course Outcomes for Unit III	**CO3: Explore construction and working of principles passive microwave devices / components.**	
Unit IV	**Active Microwave Components**	**6 Hrs.**
Limitations of conventional tubes, O and M type classification of microwave tubes, re-entrant cavity, velocity modulation. Construction, operation, performance analysis and applications of -Single cavity and two cavity klystron, Cylindrical wave Magnetron and Helix Traveling wave, Numericals.		
Mapping of Course Outcomes for Unit IV	**CO4: Explore construction and working of principles active microwave devices/components.**	
Unit V	**Solid State Microwave Devices**	**6 Hrs.**
Introduction, Principle of operation, construction, characteristics, parameters with analysis of Microwave transistors, MOSFET, Varactor diodes, Parametric amplifiers, PIN diodes, Tunnel diodes, application as amplifiers, oscillators, modulators, demodulators, Schottky Barrier diodes, Transferred Electron devices: Gunn diode, Avalanche diode, Transit Time devices like IMPATT, TRAPATT diodes.		
Mapping of Course Outcomes for Unit V	**CO5: Analyze the structure, characteristics, operation, equivalent circuits and applications of various microwave solid state active devices.**	

Unit VI	Microwave Systems and Microwave Measurement Techniques	6 Hrs.
Microwave terrestrial and satellite communication system, Fundamentals of RADAR and RADAR range equation. Industrial applications of microwaves such as microwave heating, medical application such as microwave diathermy. Microwave measurement devices such as slotted line, tunable detector, VSWR meter, power meter, and their working principles. Microwave measurement techniques to measure S-parameters, frequency, power, attenuation, VSWR, impedance. Radiation hazards and protection.		
Mapping of Course Outcomes for Unit VI	**CO6: Know the various microwave systems, device set ups of microwave measurement devices and Identify the effect of radiations on environmental sustainability.**	

Learning Resources

Text Books:

1. C.A. Balanis, "Antenna Theory - Analysis and Design", 4th Edition, John Wiley.
2. Samuel Y. Liao, "Microwave Devices and Circuits", 3rd Edition, Pearson.
3. Annapurna Das and Sisir K. Das, "Microwave Engineering", 2nd Edition, Tata McGraw Hill.

Reference Books:

1. K. D. Prasad, "Antenna & Wave Propagation", 3rd Edition, Satya Prakashan, New Delhi.
2. E.C. Jordon and E.G. Balman, "Electromagnetic Waves and Radiation Systems", 2nd Edition, Prentice Hall Inc.
3. David M. Pozar, "Microwave Engineering", 4th Edition, John Wiley.
4. Ahmad Shahid Khan, "Microwave Engineering: Concepts and Fundamentals", CRC Press
5. M. Kulkarni, "Microwave and Radar Engineering, 3rd Edition, Umesh Publication

MOOC / NPTEL Courses:

1. NPTEL Course on "**Microwave Theory and Techniques**", By Prof. Girish Kumar, IIT Mumbai
   Link: https://nptel.ac.in/courses/108101112

2. NPTEL Course on "**Antenna**", By Prof. Girish Kumar, IIT Mumbai
   Link: https://nptel.ac.in/courses/108101092

Savitribai Phule Pune University

Fourth Year of E & Tc Engineering (2019 Course)

404182: VLSI Design and Technology

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 Hrs. / Week	03	In-Sem (Theory): 30 Marks End Sem (Theory): 70 Marks

Prerequisite Courses, if any:

1. Digital Electronics

Companion Course, if any:

1. Lab Practice – 2

Course Objectives:

1. To explore Hardware Description Language (HDL) and respective digital design methodologies.
2. To train the students for Complementary Metal Oxide Semiconductor (CMOS) circuit designs.
3. To realize importance of testability in logic circuit design.
4. To overview an Application Specific Integrated Circuit (ASIC) issues and to understand Programmable Logic Devices (PLD) architectures with advanced features.

Course Outcomes: On completion of the course, learner will be able to

CO1: Develop effective HDL codes for digital design.
CO2: Apply knowledge of real time issues in digital design.
CO3: Model digital circuit with HDL, simulate, synthesis and prototype in PLDs.
CO4: Design CMOS circuits for specified applications.
CO5: Analyze various issues and constraints in design of an ASIC.
CO6: Apply knowledge of testability in design and Build In Self Test (BIST) circuit.

Course Contents

Unit I	Design with HDL	7 Hrs.
Design Flow, Language constructs, Data objects, Data types, Entity, Architecture & types of modeling, Sequential statements, Concurrent statements, Packages, Sub programs, Attributes, HDL modeling of Combinational, Sequential circuits and FSM. Simulations, Synthesis, Efficient coding styles, Hierarchical and flat designs, Partitioning for synthesis, Pipelining, Resource sharing.		
Mapping of Course Outcomes for Unit I	**CO1: Develop effective HDL codes for digital design.**	
Unit II	**Digital Design and Issues**	**6 Hrs.**
Sequential synchronous machine design, Moore and Mealy machines, HDL code for Machines, FIFO. Meta-stability and solutions. Noise margin, Fan-out, Skew, Timing considerations, Hazards, Clock distribution, Clock jitter, Supply and ground bounce, Power distribution techniques, Power optimization. Interconnect routing techniques, Wire parasitic, Signal integrity issues. I/O architecture.		
Mapping of Course Outcomes for Unit II	**CO2: Apply knowledge of real time issues in digital design.**	

Unit III	PLD Architectures and Applications	6 Hrs.
Design Flow. CPLD Architecture, Features, Specifications, Applications. FPGA Architecture, Features, Specifications, Applications. Clock management techniques. The Simulation and Synthesis Tools, FPGA synthesis and implementation. Comparison of CPLD & FPGA.		
Mapping of Course Outcomes for Unit III	**CO3: Model digital circuit with HDL, simulate, synthesis and prototype in PLDs.**	
Unit IV	**Digital CMOS Circuits**	**7 Hrs.**
N-MOS, P-MOS and CMOS. MOSFET parasitic, Technology scaling, Channel length modulation, Hot electron effect, Velocity saturation. CMOS Inverter, Device sizing, CMOS combinational logic design, Power dissipations, Power delay product, Body Effect, Rise and fall times, Latch Up effect, Transmission gates.		
Mapping of Course Outcomes for Unit IV	**CO4: Design CMOS circuits for specified applications.**	
Unit V	**Application Specific Integrated Circuits**	**7 Hrs.**
Design Flow, Cell design specifications, Spice simulation, AC and DC analysis, Transfer Characteristics, Transient responses, Noise analysis, Lambda rules, Design Rule Check, Fabrication methods of circuit elements, Layout of cell, Library cell designing for NAND & NOR, Circuit Extraction, Electrical Rule Check, Layout Vs. Schematic, Post-layout Simulation and Parasitic extraction, Design Issues like Antenna effect, Electro migration effect, Cross talk and Drain punch through, Timing analysis.		
Mapping of Course Outcomes for Unit V	**CO5: Analyze various issues and constraints in design of an ASIC.**	
Unit VI	**VLSI Testing and Analysis**	**6 Hrs.**
Types of fault, Need of Design for Testability (DFT), DFT Guideline, Testability, Fault models, Path sensitizing, Test pattern generation, Sequential circuit test, Built In Self Test, JTAG & Boundary scan, TAP Controller.		
Mapping of Course Outcomes for Unit VI	**Apply knowledge of testability in design and Build In Self Test (BIST) circuit.**	

Learning Resources

Text Books:

1. Charles H. Roth, "Digital Systems Design using VHDL", 2nd Edition, Thompson Learning
2. Wyane Wolf, "Modern VLSI Design (IP-Based Design)", 4th Edition, Prentice Hall.
3. Steve Kilts, "Advanced FPGA Design Architecture, Implementation and Optimization" Wiley Interscience.
4. E. Weste, David Money Harris, "CMOS VLSI Design: A Circuit & System Perspective", 4th Edition, Pearson Publication.

Reference Books:

1. R. Jacob Baker, “CMOS Circuit Design, Layout, and Simulation”, 3rd Edition, Wiley-IEEE Press.
2. John F. Wakerly, “Digital Design Principles and Practices”, 3rd Edition, Prentice Hall.
3. M. Morris Mano , “Digital Design”, 3rd Edition , Pearson.
4. Cem Unsalan, Bora Tar, “Digital System Design with FPGA: Implementation Using Verilog and VHDL”, McGraw-Hill.

MOOC / NPTEL Courses:

1. NPTEL Course on “**VLSI Technology**”, By Dr. Nandita Dasgupta, IIT Madras

   Link: https://nptel.ac.in/courses/117106093

2. NPTEL Course on “**VLSI Circuits**”, By Prof. S.Srinivasan, IIT Madras

   Link: https://nptel.ac.in/courses/117106092

Savitribai Phule Pune University Fourth Year of E & Tc Engineering (2019 Course) 404183: Cloud Computing		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Theory: 03 Hrs. / Week	**03**	**In-Sem (Theory): 30 Marks** **End Sem (Theory): 70 Marks**

Prerequisite Courses, if any:

1. Database Management

Companion Course, if any:

1. Lab Practice – 1

Course Objectives:

1. To introduce the fundamentals of Cloud computing, its technologies, Challenges and Applications
2. To give Insights into the virtualization technologies and Architecture.
3. To know the relationship between Cloud and SOA.
4. To classify and evaluate Cloud Security Issues.
5. To apply theory to practical knowledge through case Studies.

Course Outcomes: On completion of the course, learner will be able to

CO1: Understand the basic concepts of Cloud Computing.
CO2: Describe the underlying principles of different Cloud Service Models.
CO3: Classify the types of Virtualization.
CO4: Examine the Cloud Architecture and understand the importance of Cloud Security.
CO5: Develop applications on Cloud Platforms.
CO6: Evaluate distributed computing and the Internet of Things.

Course Contents

Unit I	Fundamentals of Cloud Computing	6 Hrs.

Introduction to Cloud Computing, History of Cloud Computing, Characteristics of Cloud Computing, Cloud Types: NIST, Cloud cube, Cloud service models, Cloud Computing deployment models, Exploring the Cloud Computing Stack, Advantages, Disadvantages and Applications of cloud computing.

Mapping of Course Outcomes for Unit I	CO1: Understand the basic concepts of Cloud Computing.

Unit II	Cloud Service Models	6 Hrs.

Introduction and benefits of Cloud services, Characteristics, benefits, applications of different cloud service models, Software as a service(SaaS), Platform as a service (PaaS), Infrastructure as a service (IaaS), Network as a service (NaaS), Identity as a service (IdaaS), Database as a service (DbaaS), Comparison of cloud services.

Mapping of Course Outcomes for Unit II	**CO2: Describe the underlying principles of different Cloud Service Models.**	
Unit III	**Virtualization**	**6 Hrs.**
Introduction to Virtualization, Difference between Cloud Computing and Virtualization **Types of Virtualization:** Hardware, Software, Operating system, Server, Storage, Methods of implementing storage Virtualization, Network Virtualization Types, Advantages, Disadvantages, Virtualization Architecture and Software, Virtual Clustering, Applications of Virtualization.		
Mapping of Course Outcomes for Unit III	**CO3: Classify the types of Virtualization.**	
Unit IV	**Service Oriented Architecture and Cloud Security**	**7 Hrs.**
Cloud Computing Architecture (COA): Design principles, Cloud computing life cycle (CCLC), Cloud computing reference architecture, Service Oriented Architecture (SOA) characteristics and fundamental components. **Cloud Security:** Cloud CIA security model (Confidentiality, Integrity and Availability), Cloud computing security architecture, Service provider security issues, Cloud Security Issues and challenges, Security issues in virtualization, Host Security, Data Security, Firewalls.		
Mapping of Course Outcomes for Unit IV	**CO4: Examine the Cloud Architecture and understand the importance of Cloud Security.**	
Unit V	**Cloud Environment and Application Development**	**7 Hrs.**
Cloud Platforms: Google App Engine, Compute Services, Storage Services, Communication Services, Amazon Web Services Architecture and core concepts, Application Lifecycle, Cost Model, Microsoft Azure Cloud services Azure core concepts, Windows Azure Platform Appliance.		
Mapping of Course Outcomes for Unit V	**CO5: Develop applications on Cloud Platforms.**	
Unit VI	**Distributed Computing and Internet of Things**	**6 Hrs.**
Distributed Computing: Need, Distributed computing vs. Cloud computing, Enabling Technologies for the Internet of Things, Innovative Applications of the Internet of Things, Online Social and Professional Networking.		
Mapping of Course Outcomes for Unit VI	**CO6: Evaluate Distributed Computing and the Internet of Things.**	

Learning Resources

Text Books:

1. Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, Dr. Deven Shah, "Cloud Computing: Black Book", Dreamtech Press.
2. Surbhi Rastogi, "Cloud Computing Simplified", 2021 Edition, BPB Publications.
3. Kai Hwang, Geoffrey.C.Fox., Jack J. Dongarra, "Distributed and Cloud Computing: From Parallel Processing to Internet of Things", MK Publications, Elsevier

Reference Books:

1. Kamal Kant Hiran, et al. "Cloud Computing: Master the concepts, Architecture and Applications with Real-world examples and Case Studies", 1st Edition, BPB Publication.
2. Judith Hurwitz, "Cloud Computing for dummies", 2nd Edition, Wiley India.
3. A. Srinavasan, J. Suresh, "Cloud Computing: A Practical Approach for Learning and Implementation", Pearson.
4. Anthony T. Velte Toby J. Velte, Robert Elsenpeter, "Cloud Computing: A Practical Approach", McGraw-Hill.
5. Barrie Sosinsky, "Cloud Computing Bible", Wiley Publishing Inc.
6. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, "Mastering Cloud Computing", McGraw Hill Education

MOOC / NPTEL Courses:

1. NPTEL Course on "**Cloud Computing**", By Prof. Soumya Kanti Ghosh, IIT Kharagpur.

   Link: https://nptel.ac.in/courses/106105093

2. NPTEL Course on "**Google Cloud Computing Foundation Course**", By Prof. Soumya Kanti Ghosh, IIT Kharagpur.

   Link: https://nptel.ac.in/courses/106105223

Recommended Websites:

1. www.whatiscloud.com
2. www.cloudcomputingpatterns.org
3. www.w3schools.com

Savitribai Phule Pune University

Fourth Year of E & Tc Engineering (2019 Course)

404184 (A): Speech Processing (Elective - III)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 Hrs. / Week	03	In-Sem (Theory): 30 Marks End Sem (Theory): 70 Marks

Prerequisite Courses, if any:

1. Signals & Systems
2. Digital Signal Processing

Companion Course, if any:

1. Lab Practice – 2

Course Objectives:

1. To understand basics of Human speech production mechanism and classification of speech sounds.
2. To understand the short-term analysis of speech signal in time and frequency domain.
3. To extract the information of the speech signal in terms of cepstral features.
4. To understand various audio and speech coding techniques using speech Modelling algorithms.
5. To provide a platform for developing applications in the field of speech and audio processing.

Course Outcomes: On completion of the course, learner will be able to

CO1: Understand basics of Human speech production mechanism.

CO2: Classify speech sounds based on acoustic and articulatory phonetics.

CO3: Analyse speech signal to extract the characteristic of vocal tract (formants) and vocal cords (pitch).

CO4: Evaluate speech signal for extracting LPC and MFCC Parameters of speech signal.

CO5: Implement algorithms for processing of speech and audio signals considering the properties of acoustic signals.

CO6: Design speech recognition application for speech signal analysis.

Course Contents

Unit I	Fundamentals of Speech Processing	6 Hrs.

Human speech production mechanism, LTI model for speech production, Nature of speech signal, phonetics, articulators, manner of articulation, place of articulation, linear time varying model.

Classification of speech sounds: vowels, semivowels, nasal diphthongs, stops, affricates, fricative, vowel triangle.

Parameters of speech: Fundamental frequency or pitch frequency-Autocorrelation method for finding pitch period, AMDF method for finding pitch period. Formants.

Mapping of Course Outcomes for Unit I	**CO1: Understand basics of Human speech production mechanism.**

Unit II	Time and Frequency domain methods for Speech and Audio signal analysis.	7 Hrs.
Time dependent speech processing. Short-time energy, short time average magnitude, Short time average zero crossing rate. Speech Vs. silence discrimination using energy and zero crossing rate. Short-time autocorrelation function, short-time average magnitude difference function. Audio feature extraction, Spectral centroid, spectral spread, spectral entropy, spectral flux, spectral roll-off. Spectrogram: narrow band and wide band spectrogram.		
Mapping of Course Outcomes for Unit II	**CO2: Classify speech sounds based on acoustic and articulatory phonetics.**	
Unit III	**Linear prediction and cepstral analysis**	**6 Hrs.**
Basic principles of linear predictive analysis, Linear prediction of speech, auto correlation, formulation of LPC equation, solution of LPC equations, Cepstral analysis of speech, cepstral coefficients, Computation of Mel Frequency Cepstral Coefficients (MFCC).		
Mapping of Course Outcomes for Unit III	**CO3: Analyse speech signal to extract the characteristic of vocal tract (formants) and vocal cords (pitch).**	
Unit IV	**Speech and Audio Coding**	**6 Hrs.**
Time domain waveform coding: Linear PCM, Companded PCM, DPCM. **Spectral coders:** Filter bank analysis, sub-band coders, Adaptive transform coders (ATC), Harmonic coding. Linear predictive coders (LPC), Non-LP source voice coders: phase vocoders, Homomorphic (Cepstral) vocoders.		
Mapping of Course Outcomes for Unit IV	**CO4: Evaluate speech signal for extracting LPC and MFCC Parameters of speech signal.**	
Unit V	**Applications of Speech Processing**	**6 Hrs.**
Automatic Speech Recognition, Feature Extraction for ASR, Deterministic sequence recognition, Statistical Sequence recognition, ASR systems, Speaker identification and verification. **Speech Synthesis:** Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, intelligibility and naturalness in speech synthesis, role of prosody.		
Mapping of Course Outcomes for Unit V	**CO5: Implement algorithms for processing of speech and audio signals considering the properties of acoustic signals.**	
Unit VI	**Speech Processing using Machine Learning techniques**	**6 Hrs.**
Comparison of speech processing applications **Automatic Speech Recognition** and **Speech Synthesis- Text-to-Speech Synthesis** using Support Vector Machine (SVM), Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN). Performance parameters for comparison - Accuracy, True Positives, True Negatives, False Positives, False Negatives, Sensitivity, Specificity, Area Under Curve (AUC), Receiver Operating Characteristic (ROC).		

Mapping of Course Outcomes for Unit VI	CO6: Design speech recognition application for speech signal analysis.

Learning Resources

Text Books:

1. L.R.Rabiner and S.W.Schafer, "Digital Processing of Speech Signals" 1st Edition Pearson Education.
2. Daniel Jurafsky and James H Martin, "Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", 2nd Edition, Pearson Education.

Reference Books:

1. Thomas F. Quateri, "Discrete-Time Speech Signal Processing: Principles and Practice", Prentice Hall- Signal Processing Series.
2. Shaila Apte, "Speech and Audio Processing", 1st Edition, Wiley India Publication.
3. Ben Gold and Nelson Morgan, "Speech and Audio Signal Processing: Processing and Perception of Speech and Music", 2nd Edition, Wiley India Publication.
4. Uday Kamath, John Liu, James Whitaker, "Deep Learning for NLP and Speech Recognition", 1st Edition , Springer Publication

MOOC / NPTEL Courses:

1. NPTEL Course on "**Digital Speech Processing**", By Prof. Shyamal Kumar Das Mandal, IIT Kharagpur.

   Link: https://nptel.ac.in/courses/117105145

Savitribai Phule Pune University

Fourth Year of E & Tc Engineering (2019 Course)

404184 (B): PLC SCADA and Automation (Elective - III)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 Hrs. / Week	03	In-Sem (Theory): 30Marks End Sem (Theory): 70 Marks

Prerequisite Courses, if any:

1. Control Systems
2. Sensor's in Automation
3. Power Devices and Circuits

Companion Course, if any:

1. Lab Practice – 2

Course Objectives:

1. Understanding and Recognize Industrial control problems.
2. Concept of PLC's and Its Importance in Industrial Automation.
3. Development of Ladder Programming in PLC and PLC Interface in real time applications.
4. Overview of technology of advanced automation Systems such as SCADA, DCS Systems.
5. Learning of CNC fundamentals and Important Protocols in Industrial Automation

Course Outcomes: On completion of the course, learner will be able to

CO1: Understand and Recognize Industrial Control Problems.
CO2: **Analyze** & explain different hardware functions of PLC.
CO3: Develop Ladder Programming in PLC and PLC Interface in real time applications.
CO4: Explore and interpret functionality of SCADA.
CO5: Identify and interpret the functionality of DCS.
CO6: Define and explain CNC machines and Applications of Industrial Protocols.

Course Contents

Unit I	Elements of Process Control Automation	7 Hrs.

Process control principles, Control System Evaluation, Analog control, Digital control, Architecture of Industrial Automation Systems (Automation Pyramid), Advantages and limitations of Automation, Concept and Need of transmitters, Standardization of signals, Current, Voltage and Pneumatic signal standards, 2-Wire & 3-Wire transmitters, Concept of VFD, Energy conservation schemes through VFD.

Mapping of Course Outcomes for Unit I	CO1: Understand and Recognize Industrial Control Problems

Unit II	Fundamentals of PLC	7 Hrs.

Architecture of PLC- Types of PLC's, Applications of PLC's, PC v/s PLC, Different Modules, Power Supply Unit etc. Need of PLC, Different Types of Sensors- Sinking, Sourcing. Operation and function. Monitoring of Process through Sensors- Connection Details. Analog Addressing, continuous Process Monitoring and Control.

Mapping of Course Outcomes for Unit II	CO2: Analyze & explain different hardware functions of PLC.

Unit III	Programming of Programmable Logic Controllers	7 Hrs.
PLC programming, NO/ NC Concept, Ladder diagram: of logic gates, arithmetic instructions, multiplexer, Ladder diagram for different logical conditions or logical equations or truth table. Timers: types of timer, Characteristics, Function of timer in PLC, Classification of a PLC timer, Ladder diagram using timer, PLC counter, Ladder diagram using counter. PLC Programming of Branded PLCs. Concept of P,PI,PD,PID w.r.t. PLC, Data File Handling- Forcing I/O.		
Mapping of Course Outcomes for Unit III	**CO3: Develop Ladder Programming in PLC and PLC Interface in real time applications.**	
Unit IV	**Supervisory Control and Data Acquisition Systems (SCADA)**	**6 Hrs.**
Concept of SCADA, Architecture of SCADA, Components of SCADA Systems, MTU- functions of MTU, RTU- Functions of RTU, Directly interact with devices such as sensors, valves, pumps, motors, and more through human-machine interface (HMI) software. Working of SCADA, Applications of SCADA in Industrial Automation like Oil and gas, Power etc.		
Mapping of Course Outcomes for Unit IV	**CO4: Explore and interpret functionality of SCADA.**	
Unit V	**Distributed Control Systems (DCS)**	**6 Hrs.**
Basic Concept of DCS, History and Hierarchy of DCS, Basic Componenents of DCS as Operator Station, Control Module, and I/O module , Types of DCS, Need of DCS, Functions of each level, Advantages and Disadvantages, Applications of DCS such as Water Treatment Plant, Comparison of PLC, DCS and SCADA		
Mapping of Course Outcomes for Unit V	**CO5: Identify and interpret the functionality of DCS.**	
Unit VI	**CNC Machines and Industrial Protocols**	**7 Hrs.**
Introduction of CNC Machines, Basics and need of CNC machines, NC, CNC and DNC (Direct NC) systems, Structure of NC systems, Applications of CNC machines in manufacturing, Advantages of CNC machines. Industrial Communication: Devicenet, Foundation Fieldbus, PROFIBUS, MODBUS, Ethernet, TCP/IP, Concept of Industry 4.0.		
Mapping of Course Outcomes for Unit VI	**CO6: Define and explain CNC machines and Applications of Industrial Protocols.**	

Learning Resources

Text Books:

1. Curtis Johnson, "Process Control Instrumentation Technology", 8th Edition, Pearson Education.
2. Madhuchhanda Mitra, Samarjit Sen Gupta, "Programmable Logic controllers and Industrial Automation", 2nd Edition, Penram International Publishing India Pvt. Ltd.

Reference Books:

1. Stuart A. Boyer, "SCADA Supervisory Control and Data Acquisition", 4th Edition, ISA Publication.
2. John W. Webb, Ronold A Reis," Programmable Logic Controllers, Principles and Applications", 5th Edition, Prentice Hall of India Pvt. Ltd.
3. Kilian, "Modern control technology: components & systems", 2nd Edition, Delmar.
4. Bela G Liptak "Process Software and Digital Networks", 4th Edition, CRC Press
5. Pollack. Herman, W & Robinson., T. "Computer Numerical Control", Prentice Hall.
6. Pabla, B.S. &Adithan, M. "CNC Machines", New Age Publishers.
7. R.G. Jamkar, "Industrial Automation Using PLC SCADA & DCS" Global Education Limited

MOOC / NPTEL Courses:

1. NPTEL Course on "**Industrial Automation and Control**", by Prof. S. Mukhopadhyay, IIT Kharagpur.

Link: https://nptel.ac.in/courses/108105088

Savitribai Phule Pune University

Fourth Year of E & TC Engineering (2019 Course)

404184 (C): Java Script (Elective - III)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 Hrs. / Week	03	In-Sem (Theory): 30 Marks End Sem (Theory): 70 Marks

Prerequisite Courses, if any:

1. Fundamentals of Java Programming
2. Advanced Java Programming

Companion Course, if any:

1. Lab Practice – 2

Course Objectives:

1. To learn the syntax and semantics of Java script.
2. To understand the data types and variables in Java script.
3. To learn how functions and objects are used in Java script.
4. To learn how to use regular expressions in java script for handling various string operations.
5. To understand the concept of object models and event handling in java script programs.
6. To learn the use of java script for controlling Windows and form handling

Course Outcomes: On completion of the course, learner will be able to -

CO1: Use basic features of java script.

CO2: Use relevant data types for developing application in java script.

CO3: Use the function and objects as self-contained, with data passing in and out through well-defined interfaces in development of small systems.

CO4: Apply the regular expression for Text matching and manipulation.

CO5: Explore use of the various aspects of JavaScript object models that are fundamental to the proper use of the language.

CO6: Develop the application using windows controlling and form handling.

Course Contents

Unit I	Introduction to Java Scripts	6 Hrs.

Introduction – First Look at JavaScript, Adding JavaScript to XHTML Documents- The <script> Element, Using the <script> Element, Event Handlers, Linked Scripts, History and Use of JavaScript, JavaScript Core Features- Overview-Basic Definitions, Language Characteristics, Variables, Basic Data Types, Composite Types, Flow Control Statements, Loops, Functions, Input and Output in JavaScript, Regular Expressions.

Mapping of Course Outcomes for Unit I	CO1: Use basic features of java script.

Unit II	Data Types and Variables	8 Hrs.
JavaScript's Primitive Types- Numbers, Hexadecimal Literals, Octal Literals, Special Values, Data Representation Issues, Data Representation Issues, Strings, Undefined and Null; Composite Types- Objects, The typeof Operator, Type Conversion, Variables. Operators, Expressions, and Statements- Statement Basics, Whitespace, Termination: Semicolons and Returns, Blocks. **Operators**- Assignment Operator, Arithmetic Operators, Bitwise Operators, Bitwise Shift Operators, Increment/Decrement, Logical Operators, void Operator, Object Operators **Core JavaScript Statements**- if Statements, switch, while Loops, do-while Loops, for Loops, for Loops, Object-Related Statements, Object Loops Using for in		
Mapping of Course Outcomes for Unit II	**CO2: Use relevant data types for developing application in java script.**	
Unit III	**Functions and Objects**	**6 Hrs.**
Function Basics- Parameter-Passing Basics, return Statements, Parameter Passing: In and Out. Global and Local Variables- Mask Out, Local functions **Functions as Objects**- Function Literals and Anonymous Functions, Static Variables, Advanced Parameter Passing, Recursive Functions, Using Functions **Objects**- Objects in JavaScript, Object Fundamentals Enumerating Properties, Objects Are Reference Types, Passing Objects to Functions, Common Properties and Methods, Array, Date, Math, Number, String, Object Types and Primitive Types		
Mapping of Course Outcomes for Unit III	**CO3: Use the function and objects as self-contained, with data passing in and out through well-defined interfaces in development of small systems.**	
Unit IV	**Regular Expressions**	**6 Hrs.**
The Need for Regular Expressions, Introduction to JavaScript Regular Expressions, Creating Patterns, Repetition Quantifiers, Grouping, Common Character Classes, RegExp Object, exec(). **String Methods for Regular Expressions:** search(), split(),replace(),replace() with Sub expressions **Advanced Regular Expressions:** Multiline Matching, Non-capturing Parentheses, Lookahead, Greedy Matching, Limitations of Regular Expressions.		
Mapping of Course Outcomes for Unit IV	**CO4: Apply the regular expression for Text matching and manipulation.**	
Unit V	**Fundamental Client-Side JavaScript and Event Handling**	**6 Hrs**
JavaScript Object Models: Object Model Overview, The Initial JavaScript Object Model, The Object Models **The Standard Document Object Model**: DOM Flavors, Document Trees, Accessing Elements, Creating Nodes, Inserting and Appending Nodes, Deleting and Replacing Nodes, The DOM and HTML Elements, The DOM and CSS, The DOM Versus DHTML Object Models. Overview of Events and Event Handling, The Basic Event Model, Netscape 4 Event Model, Internet Explorer 4+ Event Model, DOM2 Event Model, Event Model Issues.		
Mapping of Course Outcomes for Unit V	**CO5: Explore use of the various aspects of JavaScript object models that are fundamental to the proper use of the language.**	

Unit VI	Using Java scripts	8 Hrs.
Controlling Windows and Frames: Introduction to Window, Dialogs, Opening and Closing Generic Windows, Window Features, Writing to Windows, Controlling Windows, Window Events, Frames: A Special Case of Windows, Frames: A Special Case of Windows. **Form Handling:** Form Basics, Form Fields, Select Menus Option Groups, Other Form Elements: Label, Fieldset, and Legend, Form Validation, Form Usability and JavaScript, Dynamic Forms.		
Mapping of Course Outcomes for Unit VI	**CO6: Develop the application using windows controlling and for handling.**	

Learning Resources

Text Books:

1. Thomas Powell and Fritz Schneider, "JavaScript 2.0: The Complete Reference", 2nd Edition, McGraw Hill
2. Kogent Learning Solutions, "HTML, JavaScript, PHP, Java, JSP, XML and AJAX" Black Book, Dreamtech Press.

Reference Books:

1. Jon Duckett, "JavaScript & J Query: Interactive Front-End Web Development", John Wiley & Sons.
2. David Flanagan, "JavaScript: The Definitive Guide", 7th Edition, O'Reilly Media.
3. Mike Mackgrath, "Javascripts in Easy Steps" Dreamtech Press

MOOC / NPTEL Courses:

1. NPTEL Course on "**Internet Technology**", by Prof. Indranil Sengupta, IIT Kharagpur
   Link: https://nptel.ac.in/courses/106105084

2. Udemy course on **"JavaScript: Understanding the Weird Parts**"
   Link: **https://www.udemy.com/course/understand-javascript/**

Savitribai Phule Pune University

Fourth Year of E & Tc Engineering (2019 Course)

404184 (D): Embedded System & RTOS (Elective - III)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 Hrs. / Week	03	In-Sem (Theory): 30 Marks End Sem (Theory): 70 Marks

Prerequisite Courses, if any:

1. ARM7 / ARM9 / ARM Cortex- M

Companion Course, if any:

1. Lab Practice - 2

Course Objectives:

1. To understand the Embedded system design issues.
2. To understand real time operating system concepts.
3. To understand the Embedded Linux environment
4. To understand embedded software development and testing tools.

Course Outcomes: On completion of the course, learner will be able to-

CO1: Apply design metrics of Embedded systems to design real time applications to match recent trends in technology.
CO2: Apply Real time systems concepts.
CO3: Evaluate µCOS operating system and its services.
CO4: Apply Embedded Linux Development Environment and testing tools.
CO5: Analyze Linux operating system and device drivers.
CO6: Analyze the hardware – software co design issues for testing of real time Embedded system.

Course Contents

Unit I	Introduction to Embedded Systems	8 Hrs.

Introduction to Embedded Systems, Architecture, Classification and Characteristics of Embedded System, Design Process, Design Metrics and optimization of various parameters of embedded system. Embedded processor technology, IC technology, Design technology. Software development life cycle. Various models like waterfall, spiral,V, Rapid Prototyping models and Comparison

Mapping of Course Outcomes for Unit I	CO1: Apply design metrics of Embedded systems to design real time applications to match recent trends in technology.

Unit II	Concepts of Real Time Operating System	6 Hrs.

Foreground/ Background systems, Critical section of code, Resource, Shared resource, multitasking, Task, Context switch, Kernel, Scheduler, Non-Preemptive Kernel , Preemptive Kernel, Reentrancy, Round robin scheduling, Task Priorities, Static & Dynamic Priority, Priority Inversion, Assigning task priorities, Mutual Exclusion, Deadlock, Clock Tick, Memory requirements, Semaphore as signaling & Synchronizing, External Interrupt, Advantages & disadvantages of real time kernels.

Mapping of Course Outcomes for Unit II	CO2: Apply Real time systems concepts.

Unit III	µCOS II	6 Hrs.
Features of µCOS II Kernel structure. µCOS II RTOS services: Task management, Time management, Intertask Communication and Synchronization.		
Mapping of Course Outcomes for Unit III	**CO3: Evaluate µCOS operating system and its services.**	
Unit IV	**Embedded Linux Development Environment**	**6 Hrs.**
Need of Linux, Embedded Linux Today, Open Source and the GPL, BIOS Versus Boot loader, Storage Considerations, Embedded Linux Distributions. Embedded Development Environment, Cross-Development Environment, Host System Requirements, Hosting Target Boards. Development Tools, GNU Debugger, Tracing and Profiling Tools, Binary Utilities.		
Mapping of Course Outcomes for Unit IV	**CO4: Apply Embedded Linux Development Environment and testing tools.**	
Unit V	**Linux Kernel Structure**	**6 Hrs.**
Linux Kernel Background, Linux Kernel Construction, Kernel Build System, Kernel Configuration. Role of a Bootloader, Bootloader Challenges. A Universal Bootloader: Das UBoot. Porting U-Boot. Device Driver Concepts, Module Utilities, Driver Methods. Linux File System & Concepts		
Mapping of Course Outcomes for Unit V	**CO5: Analyze Linux operating system and device drivers.**	
Unit VI	**Embedded Software Development and Testing**	**8 Hrs.**
Embedded Software development process and tool chain, Host and Target Machines, Porting Embedded Software into the Target System, Testing on Host Machine, Simulators. Introduction to Development Platform Trends (only introduce IDE, board Details and Application) Arduino, Beaglebone, Rasberry PI, Intel Galileo Gen 2 (Simple Programs to discussed)		
Mapping of Course Outcomes for Unit VI	**CO6: Analyze the hardware – software co design issues for testing of real time Embedded system.**	

Learning Resources

Text Books:

1. Jean J. Labrosse, "MicroC OS II, The Real-Time Kernel", 2nd Edition, CMP Books.
2. Christopher Hallinan, "Embedded Linux Primer -A Practical, Real-World Approach "2nd Edition, Prentice Hall.

Reference Books:

1. Raj Kamal, "Embedded Systems – Architecture, Programming and Design" 2nd Edition, McGraw Hill.
2. Frank Vahid and Tony Givargis, "Embedded System Design – A Unified Hardware/Software Introduction " 3rd Edition, Wiley.
3. David E. Simon, "An Embedded Software Prime", Pearson Education.

MOOC / NPTEL Courses:

1. NPTEL Course on "**Embedded System Design with ARM**", by Prof. Indranil Sengupta, and Prof. Kamalika Datta, IIT Kharagpur
   Link of the Course: https://nptel.ac.in/courses/106105193

2. NPTEL Course on "**Real-Time Systems**", by Prof. Rajib Mall, Prof. Durga Prasad Mohapatra, IIT Kharagpur
   Link of the Course: https://nptel.ac.in/courses/106105229

Savitribai Phule Pune University

Fourth Year of E & TC Engineering (2019 Course)

404184 (E): Modernized IoT (Elective - III)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 Hrs. / Week	03	In-Sem (Theory): 30 Marks End-Sem (Theory): 70 Marks

Prerequisite Courses, if any:

1. Basics of sensors and hardware components
2. Basic networking concepts
3. Knowledge of Microcontroller and Embedded systems

Companion Course, if any:

1. Lab Practice- 2

Course Objectives:

1. To introduce the fundamentals of sensors and actuators along with the basic concepts of an IoT & IoE.
2. To give insights into the Architecture and M2M technology for an IoT.
3. To Exposing students to the usage of Protocol Standardization for IoT with IoT Edge and Gateway Network with Communication protocols.
4. To develop design skills in industrial IoT.
5. To provide IoT Solutions with sensor-based application through embedded system platform.

Course Outcomes: On completion of the course, learner will be able to

CO1: Comprehend and analyze concepts of sensors, actuators, IoT and IoE.
CO2: Interpret IoT Architecture Design Aspects.
CO3: Comprehend the operation of IoT protocols.
CO4: Describe various IoT boards, interfacing, and programming for IoT.
CO5: Illustrate the technologies, Catalysts, and precursors of IIoT using suitable use cases.
CO6: **Provide** suitable solution for domain specific applications of IoT.

Course Contents

Unit I	Sensors, Actuators, IoT & IoE	6 Hrs.

Definitions, Types of sensors, Types of Actuators, Example and Working, Networking Basics, RFID Principles and components, Wireless Sensor Networks, Definition, and characteristics of an IoT, Physical Design of an IoT, Logical design of IoT, Communication Models, Communication API's, What is the IoE? Difference between IoT and IoE, Pillars of the IoE, Connecting the Unconnected, Transitioning to the IoE, Bringing it all together.

Mapping of Course Outcomes for Unit I	CO1: Comprehend and analyze concepts of sensors, actuators, IoT and IoE.

Unit II	IoT Architecture Design Aspects	6 Hrs.

IoT-An Architectural Overview, building architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management

Mapping of Course Outcomes for Unit II	CO2: Interpret IoT Architecture Design Aspects.

Unit III	IoT Protocols	6 Hrs.
PHY/MAC Layer (3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART, Z Wave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH, ND, DHCP, ICMP, RPL, CORPL, CARP, Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session Layer HTTP, CoAP, XMPP, AMQP, MQTT		
Mapping of Course Outcomes for Unit III	**CO3: Comprehend the operation of IoT protocols.**	
Unit IV	**Interfacing Boards and Programming**	**6 Hrs.**
Introduction to IoT Boards, Interfacing with IoT Boards, IoT deployment for Raspberry Pi /Arduino/Equivalent platform – Reading from Sensors, Communication: Connecting microcontroller with mobile devices – communication through Bluetooth, WiFi and USB - Contiki OS- Cooja Simulator.		
Mapping of Course Outcomes for Unit IV	**CO4: Describe various IoT boards, interfacing, and programming for IoT.**	
Unit V	**Industrial IoT**	**6 Hrs.**
Introduction, Key IIOT technologies, Catalysts, and precursors of IIoT, Innovation and the IIoT, Applications of IIoT Examples: Healthcare, Oil and Gas Industry, Logistics and the Industrial Internet, Retail applications, IoT innovations and design methodologies, Industrial Internet Architecture Framework (IIAF): Control domain, operational domain and application domain, Three tier topology, Design of low power device network, legacy industrial protocols, Bluetooth, Zigbee IP, Z-wave, Wi-Fi backscatter in IIoT design.		
Mapping of Course Outcomes for Unit V	**CO5: Illustrate the technologies, Catalysts, and precursors of IIoT using suitable use cases.**	
Unit VI	**Applications of IoT**	**6 Hrs.**
Smart Environment: Forest Fire Detection, Air Pollution. **Smart Cities:** Parking, Structural Health, Noise Urban maps. **Smart Metering:** Smart Grid, Tank level, Photovoltaic Installations, Silos Stock Calculation, Health: Fall Detection, Medical Fridges, Sportsmen Care, Patients Surveillance, Ultraviolet Radiation		
Mapping of Course Outcomes for Unit VI	**CO6**: **Provide** suitable solution for domain specific applications of IoT.	

Learning Resources

Text Books:

1. Ovidiu Vermesan, Peter Fresiss, “Internet of Things” From research and innovation to market Deployment”, River Publishers series in Communication, USA.
2. Olivier Hersent, David Boswarthick, and Omar Elloumi, “The Internet of Things: Key Applications and Protocols”, 2nd Edition, Wiley Publications.

Reference Books:

1. Dr. Ovidiu Vermesan, Dr. Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers Series in Communication
2. "Internet of Things: Case Studies", Libelium Inc, White papers, Spain
   http://www.libelium.com/resources/case-studies

3. Useful Links for IoT Applications and Use Cases:
   http://52.16.186.190/resources/case-studies/
   https://pressbooks.bccampus.ca/iotbook/chapter/iot-use-cases/
   https://research.aimultiple.com/iot-applications/
   https://www.jigsawacademy.com/101-applications-of-iot/
   https://www.youtube.com/watch?v=xmt6OCBeS94

MOOC / NPTEL Courses:

1. NPTEL Course on "**Introduction to IoT**", by Prof. Sudip Misra, IIT Kharagpur
   Link of the Course: https://nptel.ac.in/courses/106105166

2. NPTEL Course on "**Introduction to Industry 4.0 and Industrial Internet of Things**", by Prof. Sudip Misra, IIT Kharagpur
   Link of the Course: https://nptel.ac.in/courses/106105195

Savitribai Phule Pune University

Fourth Year of E & Tc Engineering (2019 Course)

404185 (A): Data Mining (Elective - IV)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 Hrs. / Week	03	In-Sem (Theory): 30 Marks End Sem (Theory): 70 Marks

Prerequisite Courses, if any:

1. Database Management Systems
2. Signals and Systems

Companion Course, if any:

Course Objectives:

1. To understand the basic concepts of Data mining and major issues in Data Mining.
2. To be familiar with the Data warehouse architecture and its Implementation.
3. To characterize the kinds of patterns that can be discovered by classification, clustering, and association rule mining.
4. To describe and demonstrate basic data mining algorithms, methods, tools.
5. To understand and apply various classification and clustering techniques using tools.
6. To understand latest trends in Data Mining.

Course Outcomes: On completion of the course, learner will be able to -

CO1: Understand the process of data mining and performance issues in data mining.

CO2: Apply data preprocessing techniques to the historical data collected in data warehouse.

CO3: Analyze various types of Frequent pattern analysis methods and advanced Pattern mining Techniques.

CO4: Evaluate various data mining algorithms for developing effective data mining models.

CO5: Analyze different clustering and outlier detection methods.

CO6: Design data mining models in different mining application areas.

Course Contents

Unit I	Introduction to Data Mining	7 Hrs.

Introduction: Definition, Mining Functionalities, Kinds of Patterns, Technologies used for data mining- Machine Learning, Database Systems and Data Warehouses, Major Issues in Data Mining - Mining Methodology, User Interaction, Efficiency and Scalability, Diversity of Database Types, Data Mining and Society

Mapping of Course Outcomes for Unit I	CO1: Understand types of data to be mined, choose and major issues in Data Mining.

Unit II	Data Preprocessing and Data Ware housing	6 Hrs.

Data Objects and Attribute, Data Cleaning: Missing Values, Noisy Data- Binning, Clustering, Regression, Computer and Human inspection, Inconsistent Data, Data Integration and Transformation. Data Reduction.

Data Warehouse: Basic Concepts, Data Warehouse Modeling, Data Warehouse Design and Usage

Mapping of Course Outcomes for Unit II	CO2: Perform different data processing, Model and design the Data Warehouse

Unit III	Frequent Pattern Analysis and Advanced Pattern Mining	7 Hrs
Frequent Pattern Analysis: Basic Concepts, Frequent Itemset Mining Methods Pattern Evaluation Method. **Advanced Pattern Mining:** Basic Concepts, Pattern Mining in multi-level multidimensional space, Constraint-Based Frequent Pattern Mining, Mining High-Dimensional Data and Colossal Patterns, Mining Compressed or Approximate Patterns.		
Mapping of Course Outcomes for Unit III	**CO3: Understand the Frequent pattern analysis and advanced Pattern mining.**	
Unit IV	**Data mining algorithms**	**7 Hrs.**
Classification - Basic issues regarding classification and predication - General Approach to solving a classification problem- Decision Tree Classification, Attribute Selection Measures, Tree Pruning-Bayesian Classification – Rule Based Classification – Support Vector Machines, Techniques to Improve Classification Accuracy.		
Mapping of Course Outcomes for Unit IV	**CO4: Choose and employ suitable data mining algorithms to build analytical applications**	
Unit V	**Cluster Analysis and Outlier Detection**	**7 Hrs.**
Basics and Importance of Cluster Analysis- Different Types of Clusters Partitioning Methods, Clustering high dimensional data- Clustering with constraints, Outlier analysis-outlier detection methods. **Outlier Detection:** Need, Detection Methods, Approaches – Statistical, Proximity-Based, Clustering-Based, Classification-Based, Outlier Detection in High-Dimensional Data		
Mapping of Course Outcomes for Unit V	**CO5: Implement clustering and outlier detection methods.**	
Unit VI	**Advanced Concepts**	**6 Hrs.**
Basic concepts in Mining data streams: Mining Time series Data Mining sequence patterns in Transactional database Mining Object, Spatial Multimedia, Text - extracting attributes (keywords), structural approaches (parsing, soft parsing). **Web Mining:** Introduction to Web Mining, Web content mining, Web usage mining, Web Structure mining, Web log structure and issues regarding web logs, Spatial Data Mining.		
Mapping of Course Outcomes for Unit VI	**CO6: Orient towards the advanced approaches of Data mining.**	

Learning Resources

Text Books:

1. Jiawei Han & Micheline Kamber, "Data Mining: Concepts and Techniques", 3rd Edition Elsevier.
2. Margaret H Dunham, "Data Mining Introductory and Advanced topics", 1st Edition Pearson

Reference Books:

1. Ian H. Witten and Eibe Frank, "Data Mining: Practical Machine Learning Tools and Techniques" 2nd Edition, Morgan Kaufmann.

MOOC / NPTEL Courses:

1. NPTEL Course "**Data Mining**" by Prof. Pabitra Mitra IIT Kharagpur

   Link of the Course: https://nptel.ac.in/courses/106105174

2. NPTEL Course "**Business analytics and data mining Modeling using R**" by Dr. Gaurav Dixit IIT Roorkee

   Link of the Course: https://nptel.ac.in/courses/110107092

Savitribai Phule Pune University

Fourth Year of E & Tc Engineering (2019 Course)

404185 (B): Electronics Product Design (Elective - IV)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 Hrs. / Week	03	In-Sem (Theory): 30 Marks End Sem (Theory): 70 Marks

Prerequisite Courses, if any:

1. Electronic Circuits
2. Digital Circuits
3. Data structures
4. Microcontrollers
5. Project Management
6. Power Devices & Circuits

Companion Course, if any:

Course Objectives:

1. To understand the stages of product (hardware/ software) design and development.
2. To learn the different considerations of analog, digital and mixed circuit design.
3. To be acquainted with methods of PCB design and different tools used for PCB Design.
4. To understand the importance of testing in product design cycle.
5. To understand the processes and importance of documentation.

Course Outcomes: On completion of the course, learner will be able to

CO1: Understand and explain design flow of design of electronics product.

CO2: Associate with various circuit design issues and testing.

CO3: Inferring different software designing aspects and the Importance of product test & test specifications.

CO4: Summarizing printed circuit boards and different parameters.

CO5: Estimating assorted product design aspects.

CO6: Exemplifying special design considerations and importance of documentation.

Course Contents

Unit I	Introduction to Electronic Product Design	6 Hrs.

Overview Of System Engineering, System Perspectives, Documentation, Concept Development, Requirements, Design Development, Rapid Prototyping And Field Testing, Validation, Verification And Integration, Maintenance And Life Cycle Costs, Failure, Iteration And Judgment, Good Engineering, Architecturing, Design Concerns And Heuristics, Teamwork And Trust.

Mapping of Course Outcomes for Unit I	**CO1: Understand and explain design flow of design of electronics product.**

Unit II	Circuit Design and Testing Methods	6 Hrs.
From Symbols to Substance, Convert Requirements into Design, Reliability, Fault Tolerance, High Speed Design, Low Power Design, Noise and Error Budget, Standard Data Buses And Networks, Reset And Power Failure Detection, Interface: Inputs, Outputs, Breadboards, Evaluation Boards And Prototypes.		
Mapping of Course Outcomes for Unit II	**CO2: Associate with various circuit design issues and testing.**	
Unit III	**Software Design and Testing Methods**	**6 Hrs.**
Types Of Software, Traditional Software Life Cycle, Models, Metrics and Software Limitations, Risk Abatement and Failure Preventions, Software Bugs and Testing, Good Programming Practice, User Interface, Embedded, Real Time Software, Case Studies and Design Examples.		
Mapping of Course Outcomes for Unit III	**CO3: Inferring different software designing aspects and the Importance of product test & test specifications.**	
Unit IV	**PCB Design**	**6 Hrs.**
Circuit Boards, Component Placement, Routing Signal Traces, Grounds, Returns and Shields, Connectors and Cables, Design for Manufacture, Testing and Maintenance, Power Conversion Choices, Power Distribution, Line Conditioning, Electromagnetic Interference, Heat Transfer, Mechanisms for Cooling, Heat Sink Selection, Heat Pipes and Thermal Pillows, Fans and Forced Cooling, Liquid Cooling, Evaporation and Refrigeration, Trade-Offs in Design.		
Mapping of Course Outcomes for Unit IV	**CO4: Summarizing printed circuit boards and different parameters.**	
Unit V	**Product Debugging and Testing**	**6 Hrs.**
Steps Of Debugging, Techniques for Troubleshooting, Characterization, Electromechanical Components, Passive Components, Active Components, Active Devices, Operational Amplifier, Analog-Digital Conversion, Digital Components, Inspection and Test of Components, Simulation, Prototyping and Testing, Integration, Validation and Verification. Procurement, Manufacturing, Maintenance and Repair.		
Mapping of Course Outcomes for Unit V	**CO5: Estimating assorted product design aspects.**	
Unit VI	**Documentation**	**6 Hrs.**
Definition, Need, Types of Documentation, Records, Accountability and Liability. Audience. Preparation, Presentation, Preservation of Documents. Methods of Documentation, Visual Techniques, Layout of Documentation, Bill of Material.		
Mapping of Course Outcomes for Unit VI	**CO6: Exemplifying special design considerations and importance of documentation.**	

Learning Resources

Text Books:

1. Kim Fowler, “Electronic Instrument Design”, Oxford University Press.
2. Robert J. Herrick, “Printed Circuit board design Techniques for EMC Compliance”, 2nd Edition, IEEE press.

Reference Books:

1. James K. Peckol, “Embedded Systems – A Contemporary Design Tool”, Wiley Publication
2. J.C. Whitakar, “The Electronics Handbook”, CRC press.

Udemy Courses :

1. Introduction to Product Management

   Link: **https://www.udemy.com/product-management/**

2. Fundamental Steps of Product Management

   Link: **https://www.udemy.com/productmgt/**

3. Digital Product Manufacturing: The Roadmap to Success

   Link: **https://www.udemy.com/digital-product-manufacturing/**

4. Agile Product Owner Career Guide

   Link: **https://www.udemy.com/product-owner-career-guide/**

Savitribai Phule Pune University Fourth Year of E & Tc Engineering (2019 Course) 404185 (B): Deep Learning (Elective - IV)		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Theory: 03 Hrs. / Week	**03**	**In-Sem (Theory): 30 Marks** **End Sem (Theory): 70 Marks**

Prerequisite Courses, if any:

Companion Course, if any:

Course Objectives:

1. To comprehend the theoretical foundations, algorithms and methodologies of Neural Network.
2. To design and develop an application using specific deep learning models and know complexity of Deep Learning algorithms and their limitations
3. To examine the case studies of deep learning techniques

Course Outcomes: On completion of the course, learner will be able to:

CO1: Classify machine learning algorithms and its types.
CO2: Discuss the concepts of deep learning and its Frameworks.
CO3: Identify the deep learning architectures with respect to the applications.
CO4: Demonstrate different architectures of Convolutional neural networks.
CO5: Discuss natural language processing architectures.
CO6: Make use of various case studies and deep learning applications.

Course Contents

Unit I	Machine Learning	6 Hrs.
Introduction to Machine Learning, Types of Machines Learning, Linear Regression, Classification and Logistic Regression, Decision Tree and Random Forest, Naïve Bayes and Support Vector Machine. Applications of machine learning		
Mapping of Course Outcomes for Unit I	**CO1: Classify machine learning algorithms and its types.**	
Unit II	**Introduction to Deep Learning and Frameworks**	**6 Hrs.**
Deep Learning Basics: Intro, History, capabilities, the perceptron, Multi Layer Perceptron, ANN architecture. Tensor Flow, Creating and Manipulating Tensor Flow Variables, Tensor Flow Operations, Placeholder Tensors, Managing Models over the CPU and GPU, Specifying the Logistic Regression Model in Tensor Flow, Logging and Training the Logistic Regression, Introduction to Keras, PyTorch.		
Mapping of Course Outcomes for Unit II	**CO2: Discuss the concepts of deep learning and its Frameworks.**	

Unit III	Deep Learning Architecture	6 Hrs.
Width and Depth of Neural Networks, Different Activation Functions, Batch-normalization, Overfitting and generalization., Dropout, regularization Unsupervised Training of Neural Networks, Restricted Boltzmann Machines, Auto Encoders, Deep Learning Applications		
Mapping of Course Outcomes for Unit III	**CO3: Identify the deep learning architectures with respect to the applications.**	
Unit IV	**Computer Vision**	**6 Hrs.**
Architectural Overview, Motivation, Layers, Filters, Parameter sharing, Regularization, Convolution neural networks (CNNs), convolution, pooling and its variations, different deep CNN architectures - LeNet, AlexNet, VGG, PlacesNet, DenseNet, Training a CNNs: weights initialization, batch normalization, hyperparameter tuning. **Popular CNN Architectures:** ResNet, AlexNet – Applications.		
Mapping of Course Outcomes for Unit IV	**CO4: Demonstrate different architectures of Convolutional neural networks.**	
Unit V	**Natural Language Processing**	**6 Hrs.**
Recurrent Neural Networks, Bidirectional RNNs, Encoder-decoder sequence to sequence architectures - BPTT for training RNN, Long Short Term Memory Networks. Advanced RNN: LSTM, GRU, introduction to Generative Adversarial Networks (GANs).		
Mapping of Course Outcomes for Unit V	**CO5: Discuss natural language processing architectures.**	
Unit VI	**Case Study and Applictions**	**6 Hrs.**
Computer Vision: Image Classification, Image net- Detection-Audio Wave Net. **Natural Language Processing:** Sentimental Analysis, Text preprocessing and chatBot		
Mapping of Course Outcomes for Unit VI	**CO6: Make use of various case studies and deep learning applications.**	

Learning Resources

Text Books:

1. Nikhil Buduma, “Fundamentals of Deep Learning Designing Next-Generation Machine Intelligence Algorithms”, 1st Edition, O’REILLY.
2. Michael Nielsen, “Neural Networks and Deep Learning”, Determination Press.
3. Ian Goodfellow, YoshuaBengio and Aaron Courville, “Deep Learning”, MIT Press.
4. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media.
5. Kevin P. Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press.
6. Ethem Alpaydin,"Introduction to Machine Learning”, 3rd Edition, Prentice Hall of India.
7. Umberto Michelucci “Applied Deep Learning. A Case-based Approach to Understanding”, Deep Neural Networks” Apress, 2018.

Reference Books:

1. Goodfellow. I., Bengio.Y., and Courville, A.,"Deep Learning", MIT Press.
2. Bishop, C.M., "Pattern Recognition and Machine Learning", Springer.
3. Satish Kumar, "Neural Networks: A Classroom Approach", Tata McGraw-Hill Education.

MOOC / NPTEL Courses:

1. NPTEL Course on "**Deep Learning**", by Prof. Prabir Kumar Bhiswas, IIT Kharagpur.

   Link of the Course: https://nptel.ac.in/courses/106105215

2. NPTEL Course on "**Deep Learning - Part I**", by Prof. Sudarshan Iyengar, Prof Sanatan Sukhija IIT Ropar

   Link of the Course: https://nptel.ac.in/courses/106106184

Savitribai Phule Pune University

Fourth Year of E & Tc Engineering (2019 Course)

404185 (D): Low Power CMOS (Elective - IV)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 Hrs. / Week	03	In-Sem (Theory): 30 Marks End Sem (Theory): 70 Marks

Prerequisite Courses, if any:

1. Electronic Circuits
2. Digital Circuits

Companion Course, if any:

1. VLSI Design and Technology

Course Objectives: is to make the student

1. Identify sources of power in an IC.
2. To relate the power reduction techniques based on technology independent and technology. dependent power dissipation mechanism in various MOS logic style.
3. To describe suitable techniques to reduce the power dissipation.
4. To design memory circuits with low power dissipation.
5. To learn to use CAD tools for low power synthesis .

Course Outcomes: On completion of the course, learner will be able to

CO1: Explain the sources of power dissipation in CMOS.
CO2: Classify the special techniques to mitigate the power consumption in CMOS circuits.
CO3: Summarize the power optimization and trade off techniques in digital circuits.
CO4: Illustrate the power estimation at logic and circuit level.
CO5: Explain the software design for low power in various level.
CO6: Use the CAD tools for low power synthesis.

Course Contents

Unit I	Fundamentals of Power Dissipation in CMOS	07 Hrs.

Sources of power dissipation, Physics of power dissipation in MOSFET devices: The MIS structure, long channel MOSFET, Submicron MOSFET, gate induced drain leakage, Power dissipation in CMOS: short circuit dissipation, dynamic dissipation, load capacitance, Low power VLSI design: Limits, principles of low power design, hierarchy of limits, fundamental limit, material limit, device limit, system limit.

Mapping of Course Outcomes for Unit I	CO1: Explain the sources of power dissipation in CMOS.

Unit II	Power Optimization Techniques	08 Hrs.
Power Reduction in Clock Networks: Clock Gating, Reduced Swing Clock, Oscillator Circuit for Clock Generation, Frequency Division and Multiplication, Other Clock Power Reduction Techniques, CMOS Floating Node: Tristate Keeper Circuit, Blocking Gate, Low Power Bus: Low Swing Bus, Charge Recycling Bus, Delay Balancing, Low Power Techniques for SRAM: SRAM Cell, Memory Bank Partitioning, Pulsed Word line and Reduced bit line Swing. Introduction to Low-Power Design through Voltage Scaling: VTCMOS circuits, MTCMOS circuits, Architectural Level Approach –Pipelining and Parallel Processing Approaches. Switched Capacitance Minimization Approaches: System Level Measures, Circuit Level Measures, Mask level Measures.		
Mapping of Course Outcomes for Unit II	**CO2: Classify the special techniques to mitigate the power consumption in CMOS circuits.**	
Unit III	**Design of Low Power Circuits**	**07 Hrs.**
Transistor and Gate Sizing : Sizing an Inverter Chain, Transistor and Gate Sizing for Dynamic Power Reduction, Transistor Sizing for Leakage Power Reduction, Network Restructuring and Reorganization : Transistor Network Restructuring, Transistor Network Partitioning and Reorganization, Special Latches and Flip-flops : Self-gating Flip-flop, Combinational Flip-flop, Double Edge Triggered Flip-flop, Low Power Digital Cell Library : Cell Sizes and Spacing, Varieties of Boolean Functions, Adjustable Device Threshold Voltage.		
Mapping of Course Outcomes for Unit III	**CO3: Summarize the power optimization and trade off techniques in digital circuits.**	
Unit IV	**Power Estimation**	**07 Hrs.**
Modelling of signals, signal probability calculation, Statistical techniques, estimation of glitching power, Sensitivity analysis, Power estimation using input vector compaction, power dissipation in Domino logic, circuit reliability, power estimation at the circuit level, Estimation of maximum power: test generation based approach, steepest descent, generic based algorithm based approach.		
Mapping of Course Outcomes for Unit IV	**CO4: Illustrate the power estimation at logic and circuit level.**	
Unit V	**Software Design for Low Power**	**07 Hrs.**
Sources of software power dissipation, software power estimation: Gate level, architecture level, bus switching activity, instruction level power analysis, software power optimization: minimizing memory access costs, instruction selection and ordering, power management, Automated low power code generation, Co-design for low power.		
Mapping of Course Outcomes for Unit V	**CO5: Explain the software design for low power in various level**	
Unit VI	**Hardware Design for Low Power**	**06 Hrs.**
Adiabatic Switching Circuits, Battery-aware Synthesis, Variation tolerant design, CAD tools for low power synthesis.		
Mapping of Course Outcomes for Unit VI	**CO6: Able to use the CAD tools for low power synthesis**	

Learning Resources

Text Books:

1. Kaushik Roy and S. C. Prasad, “Low power CMOS VLSI Circuit Design”, Wiley Publication
2. Gary Yeap, “Practical Low Power Digital VLSI Design”, Springer
3. A. P. Chandrasekaran and R. W. Broadersen, “Low Power Digital CMOS Design”, Kluwer,1995

Reference Books:

1. J. B. Kulo and J.H Lou, “Low voltage CMOS VLSI Circuits”, Wiley Publication
2. Dimitrios Soudris, Christians Pignet, Costas Goutis, “Designing CMOS Circuits for Low Power”, Kluwer.
3. James B. Kulo, Shih-Chia Lin, “Low voltage SOI CMOS VLSI devices and Circuits”, John Wiley and sons.
4. Steven M. Rubin, “Computer Aids for VLSI Design”, Addison Wesley Publishing
5. Abdelatif Belaouar, Mohamed. I. Elmasry, “Low power digital VLSI design”, Kluwer.

Online Resources:

1. https://www.youtube.com/watch?v=w0cSahiDvFQ
2. https://www.youtube.com/watch?v=LjDb6VQlOeQ
3. http://freevideolectures.com/Course/3059/Low-Power-VLSI-Circuits-and-Systems
4. http://www.springer.com/us/book/9788132219361

Savitribai Phule Pune University

Fourth Year of E & Tc Engineering (2019 Course)

404185 (E): Smart Antennas (Elective - IV)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 Hrs. / Week	03	In-Sem (Theory): 30 Marks End Sem (Theory):70 Marks

Prerequisite Courses, if any:

1. Electromagnetic Field Theory
2. Cellular Networks

Companion Course, if any:

Course Objectives:

1. To understand design principles of various radiating elements.
2. To understand theory reconfiguration antenna and smart antenna.
3. To learn DOA estimation techniques for smart antenna.
4. To understand beam forming and MIMO technology.
5. The main focus will be on the 4G, 5G and beyond needs of antenna to improve the signal quality, power management and BW for higher data rate.

Course Outcomes: On completion of the course, learner will be able to

CO1: Compare various linear wire antenna and uniform array in terms of antenna parameters and analyze them based on the current distribution and identify an appropriate wire antenna for given application.

CO2: Classify Microstrip & re-configurable antenna and techniques.

CO3: Describe smart antenna systems and discuss the beam steering and mutual coupling effects.

CO4: Explain DOA estimation methods and classify.

CO5: Classify the beam forming methods.

CO6: Describe and Compare MIMO systems.

Course Contents

Unit I	Radiating Elements and Array	8 Hrs.

Comparison of various radiating elements- Infinitesimal dipole, small dipole, finite length dipole, half wave length dipole, and analytical treatment of these elements. Types of Array antenna, two element array, N-element array, Uniform amplitude-uniformed spaced linear broadside and end fire array.

Mapping of Course Outcomes for Unit I	CO1: Compare various linear wire antenna and uniform array in terms of antenna parameters and analyze them based on the current distribution and identify an appropriate wire antenna for given application.

Unit II	Microstrip and Reconfigurable Antenna	6 Hrs.

Microstrip antenna: Introduction, feeding techniques, Fractal antenna and array.

Re-configurable Antenna: Classification of re-configurable antenna, Re-configurable techniques, Multiple Re-configurable features in antenna.

Mapping of Course Outcomes for Unit II	CO2: Classify Microstrip & re-configurable antenna and techniques.

Unit III	Smart Antennas	8 Hrs.
Introduction, Need for Smart Antennas, Overview: Smart Antenna Configurations, Switched-Beam Antennas, Adaptive Antenna Approach, beam steering, degree of freedom. **Architecture of a Smart Antenna System:** Transmitter and Receiver, Types of Smart Antennas, Benefits and Drawbacks of Smart Antennas, Mutual Coupling Effects, Applications of Smart Antennas.		
Mapping of Course Outcomes for Unit III	**CO3: Describe smart antenna systems and discuss the beam steering and mutual coupling effects.**	
Unit IV	**Direction of Arrival Estimation (DOA) Methods**	**6 Hrs.**
Spectral estimation methods, linear prediction method, Maximum entropy method, Maximum likelihood method, Eigen structure methods, MUSIC algorithm – root music and cyclic music algorithm, the ESPRIT algorithm.		
Mapping of Course Outcomes for Unit IV	**CO4: Explain DOA estimation methods and classify.**	
Unit V	**Beam Forming Methods**	**6 Hrs.**
Classical Beam former, Statistically Optimum Beam-forming Weight Vectors, Maximum SNR Beam former, Multiple Sidelobe Canceler and Maximum, SINR Beam former, Minimum Mean Square Error (MMSE), Direct Matrix Inversion (DMI), Linearly Constrained Minimum Variance (LCMV), Adaptive Algorithms for Beam forming.		
Mapping of Course Outcomes for Unit V	**CO5: Classify the beam forming methods.**	
Unit VI	**MIMO Antennas**	**6 Hrs.**
Introduction, Principles of MIMO systems: SISO, SIMO, MISO MIMO, Hybrid antenna array for mm Wave, massive MIMO: concept and applications.		
Mapping of Course Outcomes for Unit VI	**CO6: Describe and Compare MIMO systems.**	

Learning Resources

Text Books:

1. C.A. Balanis “Antenna Theory: Analysis and Design”, 4th Edition, John Wiley & Sons.
2. Lal Chand Godara, “Smart Antennas”, CRC Press, LLC-20.
3. Ahmed El Zooghby, “Smart Antenna Engineering**”,** ARTECH HOUSE, INC, 2005**.**

Reference Books:

1. C.A.Balanis,“Introduction to Smart Antennas”, John Wiley & Sons
2. Mohammod Ali, “Reconfigurable antenna Design and Analysis”, Publisher: Artech House
3. George Tsoulos,“ MIMO system technology for wireless communications”, CRC- Taylor & Francis.
4. Long Zhao, Hui Zhao , Kan Zheng, Wei Xiang,“Massive MIMO in 5G Networks: Selected Applications”, Springer.
5. Jian Li and Petre Stoica,“ Robust adaptive Beamforming”, John Wiley.

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Fourth Year of E & Tc Engineering (2019 Course)

404186: Lab Practice - 1

Teaching Scheme:	Credit	Examination Scheme:
Practical: 04 Hrs. / Week	02	Term Work: 25 Marks Oral: 50 Marks

Companion Course, if any:

1. Radiation and Microwave Theory
2. Cloud Computing

Guidelines for Student's Lab Journal

The student's Lab Journal can be experimental write-ups. It should include following as applicable: Assignment No, Title of Assignment, Date of Performance, Date of Submission, Aims & Objectives, Theory, Description of data used, Results, Conclusion.

Guidelines for Lab /TW Assessment

The oral examination will be based on the work carried out by the student in the Lab course. Suitable rubrics can be used by the internal & external examiner for assessment.

Subject: Radiation and Microwave Theory

List of Experiments

1.	To study of different types of Microwave Components
2.	To measure radiation pattern and gain of horn or parabolic antenna at microwave frequency
3.	To measure and plot Mode characteristics of Reflex klystron.
4.	To measure V-I characteristics of Gunn Diode and study of PIN modulator.
5.	To measure and verify port characteristics of microwave tees (E, H, E-H or magic planes).
6.	To measure and verify port characteristics of directional coupler and calculate coupling factor, insertion loss and directivity.
7.	To measure and verify port characteristics of isolator and circulator and calculate insertion loss and isolation in dB.
8.	To measure wavelength of the microwave using microwave test bench and verify with its theoretical calculations.
9.	To plot standing wave pattern and measure SWR for open, short and matched termination at microwave frequency using slotted section with probe carriage.
10.	Study the network analyzer and carry out the measurements of s-parameters.
11.	To design and simulate any type of microwave antenna using EM simulation software.

Virtual Lab:

1. **https://www.ee.iitb.ac.in/course/~vel/ (Virtual Electromagnetics Lab.)**
2. **http://www.iitk.ac.in/mimt_lab/vlab/index.php (RF and Microwave Characterization Lab.)**

Subject: Cloud Computing	
List of Experiments (Any 6 to be performed)	
1.	Install Google App Engine. Create hello world app and other simple web applications using python / java.
2.	Use GAE launcher to launch the web applications.
3.	Simulate a cloud scenario using CloudSim and run a scheduling algorithm that is not present in CloudSim.
4.	Find a procedure to transfer the files from one virtual machine to another virtual machine.
5.	Find a procedure to launch virtual machine using try stack (Online Openstack Demo Version)
6.	Design and deploy a PaaS environment.
7.	Design and develop custom Application (Mini Project) using Cloud (like Salesforce/GCP/AWS.)
8.	Design an Assignment to retrieve, verify, and store user credentials using Firebase Authentication, the Google App Engine standard environment, and Google Cloud Data store.
Case Studies (Any 2 to be performed)	
1.	Data storage security in private cloud.
2.	Application of IoT / Ubiquitous based on cloud.
3.	Tools for building private cloud.
4.	Instance creation in cloud environment.

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Fourth Year of E & Tc Engineering (2019 Course)

404187: Lab Practice – 2

Teaching Scheme:	Credit	Examination Scheme:
Practical: 04 Hrs. / Week	02	Term Work: 25 Marks Practical: 50 Marks

Companion Course, if any:

1. VLSI Design and Technology
2. Speech Processing (Elective - III)
3. PLC SCADA and Automation (Elective - III)
4. JAVA Script (Elective - III)
5. Embedded System and RTOS (Elective - III)
6. Modernized IoT (Elective - III)

Guidelines for Student's Lab Journal

The student's Lab Journal can be experimental write-ups. It should include following as applicable: Assignment No, Title of Assignment, Date of Performance, Date of Submission, Aims & Objectives, Theory, Description of data used, Results, Conclusion.

Guidelines for Lab /TW Assessment

The oral examination will be based on the work carried out by the student in the Lab course. Suitable rubrics can be used by the internal & external examiner for assessment.

Subject: VLSI Design and Technology

Part A: To write VHDL code, simulate with test bench, synthesis, implement on PLD **(Any 5 to be performed)**

1.	4 bit ALU for Add, Subtract, AND, NAND, OR, XOR & XNOR.
2.	Universal shift register with mode selection input for SISO, SIPO, PISO, & PIPO.
3.	Mod - N Counter
4.	FIFO memory
5.	LCD Interface
6.	Keypad interface

Part B: To prepare CMOS layout in selected technology, simulate with & without capacitive load, comment on rise & fall times. **(Any 3 to be performed)**

1.	Inverter, NAND, NOR gates
2.	Half Adder & Full Adder
3.	2:1 Mux using logic gates & transmission gates
4.	One bit SRAM Cell

Virtual Lab:

1. **https://vlsi-iitg.vlabs.ac.in (Digital VLSI Design Lab.)**
2. **https://cse14-iiith.vlabs.ac.in/ (VLSI Lab.)**

Subject: Speech Processing (Elective - III)

NOTE:

1. To perform the experiments software like Python, SCILAB, OCTAVE or **any appropriate open source software can be used.**
2. For analysis of speech signals tools like PRAAT, Audacity, WAVESURFER, WEKA can be used.

Part A (Any 7 to be performed)

1.	Record speech signals (isolated words, continuous speech) and analyse the speech signal using speech analysis tool (e.g. PRAAT). Observe spectrogram, pitch, formants, intensity etc.
2.	Write a program for extracting pitch period for a voiced part of the speech signal using autocorrelation method and average magnitude difference function (AMDF).
3.	Write a program to compute short time Energy and ZCR for different frame rates and comment on the result.
4.	Write a program to classify voiced, unvoiced and silence frames using frame level energy and zero crossing rate.
5.	Write a program to compute narrow band and wide band spectrogram. Comment on the time and frequency resolution of wide band and narrow band spectrogram.
6.	Write a program to design a Mel filter bank and using this filter bank write a program to extract MFCC features.
7.	Write a program to perform the cepstral analysis of speech signal and detect the pitch from the voiced part using cepstrum analysis.
8.	Write a program to enhance the noisy speech signal using spectral subtraction method.
9.	Write a program to extract frequency domain audio features like SC, SF and Spectral roll off.

Part B (Any 1 to be performed)

1.	Write a program for Automatic Speech Recognition using Convolutional Neural Networks (CNN) or Recurrent Neural Networks (RNN).
2.	Write a program for Text to Speech synthesis using Convolutional Neural Networks (CNN) or Recurrent Neural Networks (RNN).

Virtual Lab:

1. **https://ssp-iiith.vlabs.ac.in/Introduction.html**
2. **https://vlab.amrita.edu/index.php?sub=59&brch=164**

Speech database:

http://festvox.org/databases/iiit_voices/

Subject: PLC SCADA and Automation (Elective - III)	
Part A (Any 5 to be performed)	
1.	Implementation of Logic Gates Using PLC(Software/Hardware Implementation).
2.	Development of a ladder program for DOL Starter.
3.	Implementation of Boolean Expression using PLC(Software/Hardware Implementation).
4.	Traffic Light Control using PLC (Any Application of Timer using PLC will be accepted) (Software/Hardware Implementation).
5.	Counting Objects (Any Application of Counter using PLC will be accepted) (Software/Hardware Implementation).
6.	Interfacing of Encoder with PLC to control a particular application.
7.	Interfacing of Limit Switch/ Proximity Switch/or any sensor/sensors with PLC to control a particular application.
Part B (Any 2 to be performed)	
1.	Interfacing of RTD with PLC for Temperature control application.
2.	Motor speed control using PLC and VFD.
3.	Pneumatic Trainer Kit/Hydraulic Trainer Kit control using PLC.
4.	Close Loop control using PID Controller (Any One Parameter Like Temperature, Flow, Pressure, Level)
Part C (Any 1 to be performed)	
1.	Any Example Using SCADA.
2.	Study of Hardware and Software Platform for DCS **https://ial-coep.vlabs.ac.in/exp/software-platforms-dcs/procedure.html**
3.	PLC controlled Case study- 1: **[Faculty will give (or students will choose) one problem statement to a group of 2/3 students. Students will develop a program and simulate it on their own]** **Suggested case studies (Not Limited to)** **a. Bottle Filling Plant using PLC** **b. Operation of Lift (Elevator) using PLC** **c. PLC based Gas Detection System using Ladder Logic Project** **d. Alarm Management Systems using PLC** **e. Water Distribution System using PLC**
Virtual Lab: 1. **http://plc-coep.vlabs.ac.in/ (Programmable Logic Controller Lab.)** 2. **http://ial-coep.vlabs.ac.in/List%20of%20experiments.html (Industrial Automation Lab.)**	

Subject: JAVA Script (Elective - III)

Part A (Compulsory)

1.	Write a JavaScript program to calculate area of triangle, area of rectangle and area of circle
2.	Write a JavaScript program to generate the multiplication table of a given number.
3.	Write a JavaScript program to following operations on a given string, • Reverse string • Replace characters of a string. • String is Palindrome.
4.	Write a JavaScript program to compare two strings using various methods.
5.	Write a JavaScript program that will create a countdown timer.

Part B (Any 2 to be performed)

1.	Write a JavaScript program that will create an array and perform following operations • To remove specific element from the array. • Check if an array contains a specified value. • To empty an array
2.	Write a JavaScript program that will append an object to an array and will check if an object is an array.
3.	Write a JavaScript program to illustrate different Set operations like- • Union • Intersection • Difference • Set Difference

Part C (Any 2 to be performed)

1.	Write a JavaScript program to create a Home page of any website and change background color using • On mouse over event • On focus event
2.	Create a student information Form to accept information like Name, Address, City, State Gender, Mobile Number, and email id. Perform validations for: • Correct Names • Mobile Names • Email I.D.'s • If no entered value • Re-display for wrongly entered values with message • Congratulation and Welcome page upon successful entries
3.	Design and implement a simple calculator using Java script for operations like addition multiplication, subtraction, division, square of a number etc: • Design a calculator like text field for input and output, buttons for numbers and operations etc. • Validate input values • Prompt / Alerts for invalid values etc.

Virtual Lab:

1. **https://cse02-iiith.vlabs.ac.in/List%20of%20experiments.html (Computer Programming Lab.)**

Subject: Embedded System and RTOS (Elective - III)	
Part A (Any 4 to be performed)	
NOTE: Practicals from 1 to 5 in Group A can be performed using µCOS -II / Free RTOS on ARM 7 / ARM Cotex – M / Arduino	
1.	Multitasking in µCOS II RTOS using minimum 3 tasks on ARM7/ ARM Cortex- M.
2.	Semaphore as signaling & Synchronizing on ARM7/ ARM Cortex- M.
3.	Mailbox implementation for message passing on ARM7/ ARM Cortex- M.
4.	Queue implementation for message passing on ARM7/ ARM Cortex- M.
5.	Implementation of MUTEX using minimum 3 tasks on ARM7/ ARM Cortex- M.
6.	Porting of linux operating system on ARM9/ARM Cortex-M.
Part B (Any 4 to be performed)	
1.	Interfacing sensors and actuators with Arduino Uno- Door opener using Ultrasonic sensor and servo motor.
2.	Weather Station- Build a cloud-ready temperature and Humidity sensor (DHT-11/22) with the Node MCU and the any IoT Platform.
3.	IoT based Wireless Controlled Home Automation using ESP8266.
4.	Interfacing of 4 LED bank with Raspberry Pi to blink.
5.	Interfacing Sensors and actuators with Raspberry Pi- Hand gesture robot.

Virtual Lab:

1. **https://docs.simuli.co/getting-started/arduino/arduino-ide-and-vlab**

2. **https://docs.simuli.co/getting-started/raspberry-pi/setting-up-iotify-virtual-lab**

Subject: Modernized IoT (Elective – III)	
List of Experiments	
1.	Study of Raspberry-Pi, Beagle board, Arduino, and different operating systems for Raspberry-Pi/Beagle board/Arduino. Understanding the process of OS installation on Raspberry-Pi/Beagle board/Arduino
2.	Open-source prototype platform- Raspberry-Pi/Beagle board/Arduino -Simple program digital read/write using LED and Switch -Analog read/write using sensor and actuators.
3.	Interfacing sensors and actuators with Arduino/Raspberry-pi.
4.	IoT based Stepper Motor/DC Motor Control with Arduino/Raspberry Pi.
5.	Introduction to MQTT/ CoAP and sending sensor data to cloud using Raspberry-Pi/Beagle board/Arduino.
6.	Get the status of a bulb at a remote place (on the LAN) through web.
7.	Interfacing Arduino to Bluetooth Module.
8.	Communicate between Arduino and Raspberry PI using any wireless medium like ZigBee.
9.	IoT based small project implementation on the topics based on small problem statements of the fields like chat bot, smart home (Home Automation), social issues and environmental issues etc. This project can be built on any IoT simulation platform like Tinkercad, Cooja etc.

Savitribai Phule Pune University

Fourth Year of E & Tc Engineering (2019 Course)

404188: Project Phase – I

Teaching Scheme:	Credit	Examination Scheme:
Practical: 02 Hrs. / Week	01	Term Work: 50 Marks

Course Objectives:

- To understand the basic concepts & broad principles of projects.
- To understand the value of achieving perfection in project implementation & completion.
- To apply the theoretical concepts to solve real life problems with teamwork and Multidisciplinary approach.
- To demonstrate professionalism with ethics; present effective communication skills and relate engineering issues to broader societal context.

Course Outcomes:

CO1: Demonstrate a sound technical knowledge in field of E&TC in the form of project.
CO2: Undertake real life problem identification, formulation and solution.
CO3: Design engineering solutions to complex problems utilizing a systematic approach.
CO4: Demonstrate the knowledge, effective communication skills and attitudes as professional engineer.

Project phase 1 is an integral part of the project work. The project work shall be based on the knowledge acquired by the student during the graduation and preferably it should meet and contribute towards the needs of the society. The project aims to provide an opportunity of designing and building complete system or subsystems in the field of Electronics and communication where the student likes to acquire specialized skills. The student shall prepare the duly certified Fourth report of project work in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

Guidelines:

1. Group Size: The student shall carry the project work individually or by a group of students. Optimum group size shall be 3 students. However, if project complexity demands a maximum group size of 4 students, the project committee should be convinced about such complexity and scope of the work. Projects selected should meet and contribute towards the needs of the society.
2. Selection and approval of topic: Topic should be related to real life application in the field of Electronics and Telecommunication engineering.
3. The topic may be based on : Investigation of the latest development in a specific field of Electronics or Communication / The investigation of practical problem in manufacture and / or testing of electronics or communication equipment/ Software based projects related to VHDL, Communication, Instrumentation, Signal Processing agriculture Engineering etc. with the justification for techniques used / any topic in the field of E&TC may be allowed.
4. Interdisciplinary projects should be encouraged. The examination of Interdisciplinary projects shall be conducted independently in respective departments.
5. The term work assessment of project phase 1 shall be based on Innovative Idea of selected project, literature survey, Depth of understanding, Applications, Individual contributions, presentation, project report, timely completion of work.
6. The department should prepare project planner and should follow accordingly
7. A log book of work carried out during the semester should be maintained with weekly review remarks by the guide and committee.
8. A certified copy of report preferably using LATEX is required to be presented to external examiner at the time of Fourth examination.
9. The project report must undergo by plagiarism check and the similarity index must be less than 15%. The plagiarism report should be included in the project report.

Savitribai Phule Pune University Fourth Year of E & Tc Engineering (2019 Course) 404189: Mandatory Audit Course - 7		
Teaching Scheme:	**Credit**	**Examination Scheme:**
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GUIDELINES FOR CONDUCTION OF AUDIT COURSE

In addition to credits courses, it is mandatory that there should be audit course (non-credit course) from second year of Engineering. The student will be awarded grade as AP on successful completion of audit course. The student may opt for two of the audit courses (One in each semester). Such audit courses can help the student to get awareness of different issues which make impact on human lives and enhance their skill sets to improve their employability. List of audit courses offered in the semester is provided in the curriculum. Student can choose one of the audit course from list of courses mentioned. Evaluation of audit course will be done at institute level.

The student registered for audit course shall be awarded the grade AP and shall be included such grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory in-semester performance and secured a passing grade in that audit course. No grade points are associated with this 'AP' grade and performance in these courses is not accounted in the calculation of the performance indices SGPA and CGPA. Evaluation of audit course will be done at institute level itself.

Selecting an Audit Course:

Using NPTEL Platform:

NPTEL is an initiative by MHRD to enhance learning effectiveness in the field of technical education by developing curriculum based video courses and web based e-courses. The details of NPTEL courses are available on its official website www.nptel.ac.in

- Student can select any one of the courses mentioned above and has to register for the corresponding online course available on the NPTEL platform as an Audit course.
- Once the course is completed the student can appear for the examination as per the guidelines on the NPTEL portal.

- After clearing the examination successfully; student will be awarded with certificate.

Assessment of an Audit Course:

- The assessment of the course will be done at the institute level. The institute has to maintain the record of the various audit courses opted by the students. The audit course opted by the students could be interdisciplinary.
- During the course students will be submitting the online assignments. A copy of same students can submit as a part of term work for the corresponding Audit course.
- On the satisfactory submission of assignments, the institute can mark as “Present” and the student will be awarded the grade AP on the marksheet.

SEMESTER - VIII

Savitribai Phule Pune University

Fourth Year of E & Tc Engineering (2019 Course)

404190: Fiber Optic Communication

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 Hrs. / Week	03	In-Sem (Theory): 30 Marks End Sem (Theory): 70 Marks

Prerequisite Courses, if any:

1. Digital Communication
2. Electromagnetics Field Theory

Companion Course, if any:

1. Fiber Optic Lab

Course Objectives:

1. To familiarize learners with various components & equipments used in fiber optic communication systems.
2. To study the impact of choice of components on system design.
3. To introduce students to the WDM components and their role in capacity upgrade.
4. To extend the fundamentals to design and analysis of fiber optic communication links.
5. Expose students to the measurement standards, specifications and state of art developments in optical networks.

Course Outcomes: On completion of the course, the learner will be able to

CO1: Explain the working of components and measurement equipments in optical fiber networks.

CO2: Calculate the important parameters associated with optical components used in fiber optic telecommunication systems.

CO3: Compare and contrast the performance of major components in optical links.

CO4: Evaluate the performance viability of optical links using the power and rise time budget analysis.

CO5: Design digital optical link by proper selection of components and check its viability using simulation tools.

CO6: Compile technical information related to state of art components, standards, simulation tools and current technological trends by accessing the online resources to update their domain knowledge.

Course Contents

Unit I	Optical Fibers for Telecommunication	8 Hrs.

Fundamentals of Optical Communication: EM spectrum - Optical Spectral bands, Shannon channel capacity, power units (watts, dB & dBm), Block diagram of optical fiber communications link, advantages of optical fibers.

Optical Fiber Waveguides: Introduction, Total internal reflection, acceptance angle, numerical aperture, fiber types, mode theory for circular waveguides: overview of modes & key modal concepts (V number, number of modes, power in clad), single mode fibers, cutoff wavelength

Transmission characteristics of optical fibers: attenuation - material absorption, scattering losses, fiber bend loss, loss due to fiber misalignment, splices and connectors; **signal distortion** - intermodal delay, intramodal dispersion or chromatic dispersion, modal delay, bit rate-distance product, plot of material & waveguide dispersions for standard single mode, dispersion shifted and dispersion flattened fibers; optical fibers for 5G networks, comparison.

Mapping of Course Outcomes for Unit I	**CO1: Explain the working of components and measurement equipments in optical fiber networks.** **CO2: Calculate the important parameters associated with optical components used in fiber optic telecommunication systems.** **CO3: Compare and contrast the performance of major components in optical links.**

Unit II	**Optical Sources**	**7 Hrs.**

Optical Sources: Introduction, wavelength and material consideration (direct & indirect bandgap semiconductors); requirements from optical sources for telecommunication.

LED: principle of working, quantum efficiency, optical output power characteristics, spectral width, effect of temperature on characteristics, modulation bandwidth, analog modulation, digital modulation, LED analog transmitter;

Semiconductor Laser Diodes: absorption, spontaneous emission, stimulated emission, concept of population inversion and optical feedback, output power characteristics of LASER; Bias point and amplitude modulation range for analog applications of LEDs & laser diodes, comparison of LEDs & Lasers.

Mapping of Course Outcomes for Unit II:	**CO1: Explain the working of components and measurement equipments in optical fiber networks.** **CO2: Calculate the important parameters associated with optical components used in fiber optic telecommunication systems.** **CO3: Compare and contrast the performance of major components in optical links.**

Unit III	**Photodetectors**	**6 Hrs.**

Introduction, requirements from optical detectors, material considerations, types: p-n, pin, Avalanche photodiode, photo transistor, principle of working, quantum efficiency, responsivity, long cutoff wavelength, detector response time, comparison of photodetectors, thermal noise, dark current noise, quantum noise and receiver sensitivity, bit error rate

Mapping of Course Outcomes for Unit III	**CO1: Explain the working of components and measurement equipments in optical fiber networks.** **CO2: Calculate the important parameters associated with optical components used in fiber optic telecommunication systems.** **CO3: Compare and contrast the performance of major components in optical links.**

Unit IV	**Fiber Optic Link Design & WDM Systems**	**8 Hrs.**

Point to point optical link: Choice of components, system design considerations, optical power budget, rise time budget, bit rate for RZ and NRZ pulse format. Optical system design and performance analysis using software tools.

WDM Concepts & Components: Overview of WDM, WDM components: 2 x 2 fiber coupler, isolator, circulator, basics of fiber grating filters, optical add/drop multiplexer, architecture of optical amplifiers (SOA, EDFA & FRA), Noise figure, OSNR & system impact of ASE.

Mapping of Course Outcomes for Unit IV	**CO1: Explain the working of components and measurement equipments in optical fiber networks.** **CO4: Evaluate the performance viability of optical links using the power and rise time budget analysis.** **CO5: Design digital optical link by proper selection of components and check its viability using simulation tools.**

Unit V	**Optical Networks**	**7 Hrs.**

Optical Network concepts: fundamentals, network terminology, desirable properties, elements of an optical network, optical network topology types, advantages of optical network.
Overview of Optical Networks: FDDI, SONET/SDH, FTTX, FTTP, FTTH, PON, **GPON,** Long haul, Metro, Access, Submarine optical networks, role of fiber optic network in the 5G networks. Current technology trends, standards and challenges.

Mapping of Course Outcomes for Unit V	**CO6: Compile technical information related to the state of art components, standards, simulation tools and current technological trends by accessing the online resources to update their domain knowledge.**

Unit VI	**Optical Fiber Measurements**	**6 Hrs.**

Overview of Measurement Standards for fiber optics:
Test Equipments for field work: Test support lasers, visual fault indicator, optical power meter, Optical Time Domain Reflectometry (OTDR), optical spectrum analyzer (OSA), BER test equipment
Measurements: measurement of: optical power, numerical aperture of fiber, fiber attenuation (cutback method, insertion loss method, OTDR), macrobending loss, fiber dispersion
System performance evaluation: Eye Diagram Test, study of OTDR.

Mapping of Course Outcomes for Unit VI	**CO1: Explain the working of components and measurement equipments in optical fiber networks.** **CO6: Compile technical information related to state of art components, standards, simulation tools and current technological trends by accessing the online resources to update their domain knowledge.**

Learning Resources

Text Books:

1. Gerd Keiser, "Optical Fiber Communications" 4th Edition, Tata McGraw Hill.
2. John M Senior, "Optical Fiber Communications" 2nd Edition, PHI.

Reference Books:

1. Djafar K Mynbaev and Lowell L Scheiner, "Fiber Optic Communications Technology", 1st Edition, Pearson Education.
2. Uyless Black, "Optical Networks- Third Generation Transport Systems", Pearson Education.
3. Govind P Agrawal, "Fiber Optic Communication Systems", 3rd Edition, Wiley India.
4. Fredrick C Allard, "Fiber Optics Handbook for Engineers & Scientists", MH International

MOOC / NPTEL Courses:

1. NPTEL Course on "**Advanced Optical Communication***",* by Prof R K Shevgaonkar, IIT Madras

   Link of the Course: https://nptel.ac.in/courses/117101002

2. NPTEL Course on "Fiber Communication Technology", by Prof Deepa Venkitesh, IIT Madras

   Link of the Course: https://nptel.ac.in/courses/108106167

3. NPTEL Course on "Fiber- Optic Communication Systems & Techniques", by Dr Pradeep Kumar K, IIT Kanpur

   Link of the Course: https://nptel.ac.in/courses/108104113

Savitribai Phule Pune University

Fourth Year of E & Tc Engineering (2019 Course)

404191 (A): Biomedical Signal Processing (Elective - V)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 Hrs. / Week	03	In-Sem (Theory): 30 Marks End-Sem (Theory): 70 Marks

Prerequisite Courses, if any:

1. Digital Signal Processing

Companion Course, if any:

1. Lab Practice -3

Course Objectives:

1. To understand the basic biomedical signals .
2. To study origins and characteristics of most commonly used biomedical signals, including ECG, EEG, Evoked potentials, and EMG.
3. To Study the signal acquisition and preprocessing of physiological signals.
4. To study the extraction of meaningful information to identify patterns and trends within the signals.
5. To understand the Sources and characteristics of noise and artifacts in bio signals

Course Outcomes: On completion of the course, learner will be able to -

CO1: Describe the origin of various biomedical signals and Interpret the meaning of various parameters associated with biomedical signals

CO2: Analyze ECG Signals with extraction of meaningful information

CO3: Explain Processing of EEG signals for Diseases of Central Nervous System

CO4: Analyze EMG signals for understanding Neuromuscular Diseases

CO5: Analyze various Biomedical Signals

CO6: Process the biomedical signals to remove adaptive interference and noise

Course Contents

Unit I	Introduction to Biomedical Signals	7 Hrs.

Introduction and Overview, Ion Transport in Biological Cells, Trans membrane Potential, Electric Characteristics of Cell Membrane, Membrane Resistance, Membrane Capacitance , Cell Membrane's Equivalent Electric Circuit, Action Potential, Electric Data Acquisition, Propagation of Electric Potential as a Wave , Some Practical Considerations on Biomedical Electrode Summary

Mapping of Course Outcomes for Unit I	CO1: Describe the origin of various biomedical signals and Interpret the meaning of various parameters associated with biomedical signals

Unit II	Cardiological Signal Processing	7 Hrs.

Function and Structure of the Heart- Cardiac Muscle, Cardiac Excitation Process

Electrocardiogram: Signal of Cardiovascular System - Origin of ECG, ECG Electrode Placement, Modeling and Representation of ECG, Periodicity of ECG Heart Rate, Cardiovascular Diseases and ECG- Atrial Fibrillation, Ventricular Arrhythmias, Ventricular Tachycardia, Ventricular Fibrillation, Myocardial Infarction, Atrial Flutter, Cardiac Reentry, Atrioventricular Block, Wolf–Parkinson–White Syndrome, Extrasystole Processing and Feature Extraction of ECG- Time-Domain Analysis, Frequency-Domain Analysis, Wavelet-Domain Analysis

Mapping of Course Outcomes for Unit II	**CO 2: Analyze ECG Signals for extraction of meaningful information**	
Unit III	**Neurological Signal Processing**	**7 Hrs.**
Brain and Its Functions **Electroencephalogram:** Signal of the Brain- EEG Frequency Spectrum, Significance of EEG, Evoked Potentials- Auditory-Evoked Potentials, Somatosensory-Evoked Potentials, Visual-Evoked Potentials, Event-Related Potentials, Diseases of Central Nervous System and EEG- Epilepsy, Sleep Disorders, Brain Tumor Processing and Feature Extraction of EEG- Sources of Noise on EEG, Frequency-Domain Analysis, Time-Domain Analysis, Wavelet-Domain Analysis		
Mapping of Course Outcomes for Unit III	**CO 3: Explain use of EEG signals for Diseases of Central Nervous System.**	
Unit IV	**Electromyogram (EMG)**	**7 Hrs.**
Muscle- Motor Unit, Muscle Contraction, Muscle EMG: Signal of Muscles- Significance of EMG Neuromuscular Diseases and EMG- Abnormal Enervation, Pathological Motor Units, Neuromuscular Transmission in Motor Units, Defects in Muscle Cell Membrane Processing and Feature Extraction of EMG- Sources of Noise on EMG, Time-Domain Analysis, Frequency- and Wavelet-Domain Analysis		
Mapping of Course Outcomes for Unit IV	**CO 4: Analyze EMG signals for understanding Neuromuscular Diseases.**	
Unit V	**Other Biomedical Signals**	**6 Hrs.**
Introduction and Overview, Blood Pressure and Blood Flow, Electrooculogram, Respiratory Signals Magneto encephalogram,		
Mapping of Course Outcomes for Unit V	CO5: Analyze the various Biomedical Signals.	
Unit VI	**Adaptive interference / Noise Cancellation**	**6 Hrs.**
Types of noise in bio signals: **Digital filters:** IIR and FIR, Notch filters , Optimal and adaptive filters, Weiner filters. LMS adaptive algorithm, Steepest descent algorithm **Adaptive noise canceller:** Cancellation of 50 Hz signal in ECG		
Mapping of Course Outcomes for Unit VI	**CO6: Process the biomedical signals to remove adaptive interference and noise.**	
Learning Resources		
Text Books: 1. Kayvan Najarian, Robert Splinter, "Biomedical Signal and Image Processing", 2nd Edition, CRC Press 2. R. Rangayan, "Biomedical Signal Analysis", Wiley		

Reference Books:

1. R.S.Khandpur, "Handbook of Biomedical Instrumentation", 2nd Edition,Tata McGraw Hill,
2. C.Reddy "Biomedical Signal Processing: Principles and techniques", Tata McGraw Hill.
3. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", 4th Edition, Prentice Hall.

MOOC / NPTEL Courses:

1. NPTEL Course on "**Biomedical Signal Processing***",* by Prof Sudipta Mukhopadhyay, IIT Kharagpur

   Link of the Course: https://nptel.ac.in/courses/108105101

Savitribai Phule Pune University

Fourth Year of E & Tc Engineering (2019 Course)

404191 (B): Industrial Drives & Control (Elective - V)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 hrs. / week	03	In-Sem (Theory): 30 Marks End-Sem (Theory): 70 Marks

Prerequisite Courses, if any:

1. Basic Electrical Engineering
2. Electronic Circuits
3. Electrical Circuits
4. Power Devices and Converters

Companion Course, if any:

1. Lab Practice -3

Course Objectives:

1. To introduce components of electrical drives and its parameters .
2. To understand working, design and performance analysis of DC motor drives, Induction motor and stepper motor drives.
3. To know various protections circuit required for motor drives.

Course Outcomes: On completion of the course, learner will be able to -

CO1: Understand significance and design of various components of electrical drives.

CO2: **Develop**, evaluate and analyze the performance of DC motor drives.

CO3: Design, estimate and examine the performance of chopper controlled DC drives.

CO4: Adapt, choose and categorize performance of PWM inverter drives for Induction motors.

CO5: **Elaborate**, interpret and analyze the performance of Synchronous motor drive.

CO6: **Develop**, explain and examine performance of stepper motor control.

Course Contents

Unit I	Components of Electrical Drives	6 Hrs.

Electric machines, Power converter, Controllers, Dynamics of electric drive - torque equation - equivalent values of drive parameters- components of load torques types of load – four-quadrant operation of a motor – steady state stability – load equalization – classes of motor duty determination of motor rating.

Mapping of Course Outcomes for Unit I	CO1: Understand significance and design of various components of electrical drives.

Unit II	DC Motor Drives	6 Hrs.

DC motors & their performance (shunt, series, compound, permanent magnet motor, universal motor, dc servomotor) – braking – regenerative, dynamic braking, plugging –Transient analysis of separately excited motor – converter control of dc motors – analysis of separately excited & series with 1-phase and 3-phase converters ,soft start and field failure protection in DC drives, BLDC motor drive

Mapping of Course Outcomes for Unit II	CO2: Develop, evaluate and analyze the performance of DC motor drives.

Unit III	Chopper Controlled DC Drives	6 Hrs.
Closed loop control – transfer function of self, separately excited DC motors – linear transfer function model of power converters – sensing and feeds back elements – current and speed loops, P, PI and PID controllers – response comparison – simulation of converter and chopper fed DC drive		
Mapping of Course Outcomes for Unit III	**CO3: Design, estimate and examine the performance of chopper Controlled DC drives.**	
Unit IV	**PWM Drives for Induction Motors**	**6 Hrs.**
Multi quadrant drives – rotor resistance control – slip torque characteristic – torque equations, constant torque operation – slip power recovery scheme – torque equation – torque slip characteristics – power factor – methods of improving power factor – limited sub synchronous speed operation – super synchronous speed operation		
Mapping of Course Outcomes for Unit IV	**CO4: Adapt, choose and categorize performance of PWM inverter drives for Induction motors.**	
Unit V	**Synchronous Motor Drives**	**6 Hrs.**
Synchronous motor drives – speed control of synchronous motors – adjustable frequency operation of synchronous motors – principles of synchronous motor control – voltage source inverter drive with open loop control		
Mapping of Course Outcomes for Unit V	**CO5: Elaborate, interpret and analyze the performance of Synchronous motor drive.**	
Unit VI	**Stepper Motors**	**6 Hrs.**
Constructional features, principle of operation, modes of excitation, single phase stepping motors, torque production in variable Reluctance (VR) stepping motor, Dynamic characteristics, Drive systems and circuit for open loop control, Closed loop control of stepping motor, microprocessor based controller.		
Mapping of Course Outcomes for Unit VI	**CO6: Develop, explain and examine performance of stepper motor control.**	

Learning Resources

Text Books:

1. R. Krishnan, “Electrical Motor Drives: Modeling, Analysis, and Control”, PHI
2. G. K.Dubey, “Fundamentals of Electrical Drives”, Narosa Publishers

Reference Books:

1. K.Dubey, “Power Semiconductor Controlled Drives”, Prentice Hall.
2. S.A. Nasar, Boldea, “Electrical Drives”, 2nd Edition, CRC Press.
3. M. A. ElSharkawi , “Fundamentals of Electrical Drives” , Thomson Learning.
4. W. Leohnard, “Control of Electric Drives”, Springer.
5. Murphy and Turnbull, “Power Electronic Control of AC motors”, Pergamon Press.
6. Vedam Subrahmaniam, “Electric Drives: Concepts and Applications”, McGraw Hill

MOOC / NPTEL Courses:

1. NPTEL Course on "**Power Electronics***",* Prof. D.Prasad, Prof. N.K. De, Dr. D.Kastha, Prof. Sabyasachi Sengupta, IIT Kharagpur
   Link of the Course: https://nptel.ac.in/courses/108105066

2. NPTEL Course on "**Power Electronics***",* Prof. G.Bhuvanseshwari, IIT Delhi
   Link of the Course: https://nptel.ac.in/courses/108102145

3. NPTEL Course on "**Advanced Power Electronics and Control***",* Prof. Avik Bhattacharya, IIT Roorkee
   Link of the Course: https://nptel.ac.in/courses/108107128

4. NPTEL Course on "**Industrial Drives: Power Electronics***",* Prof. K.Gopakumar, IISc Bangalore
   Link of the Course: https://nptel.ac.in/courses/108108077

Savitribai Phule Pune University Fourth Year of E & Tc Engineering (2019 Course) 404191 (C): Android Development (Elective - V)		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Theory: 03 hrs. / week	**03**	**In-Sem (Theory): 30 Marks** **End-Sem (Theory): 70 Marks**

Prerequisite Courses, if any:

1. Object Oriented Programming

Companion Course, if any:

Course Objectives:

1. To understand the Android Operating System.
2. To study Android Apps Development Cycle.
3. To learn to create Android Applications.

Course Outcomes: On completion of the course, learner will be able to -

CO1: Describe the process of developing mobile applications.

CO2: Create mobile applications on the different android platform.

CO3: Design and implement mobile applications involving data storage in databases.

Course Contents

Unit I	Introduction to JAVA and Android	5 Hrs.
Overview of Java, XML and SQL, History of Android, Android Stack, Android Project Structure, Android OS, Features of Android, Android Architecture and building blocks, Android App build process, Android UI– resources, themes, threads etc,		
Mapping of Course Outcomes for Unit I	**CO1: Describe the process of developing mobile applications.**	
Unit II	**Introducing Android**	**5 Hrs.**
SDK Overview, Android Emulator, Android Installation, setting up development environment using Eclipse/ Android Studio, DDMS, Activity Lifecycle, Manifest File, Locales, Drawable, Listeners, Supporting Multiple Screens.		
Mapping of Course Outcomes for Unit II	**CO1: Describe the process of developing mobile applications.**	
Unit III	**Android Application Structure**	**8 Hrs.**
Android basic building blocks: Activities, Services, Broadcast Receivers & Content providers, UI Components - Views & notifications, Components for communication -Intents & Intent Filters, Android API levels (versions & version names) AndroidManifest.xml, Uses-permission & uses-sdk, Dalvik Virtual Machine & .apk file extension, Resources & R.java, Assets, Layouts & Drawable Resources, Activities and Activity lifecycle, First sample Application.		
Mapping of Course Outcomes for Unit III	**CO2: Create mobile applications on the different android platform.**	

Unit IV	Activities, Fragments, Intents and Android User Interface	8 Hrs.
Introduction to Activities, Activity Lifecycle, Introduction to Intents, Linking Activities using Intents, calling built-in applications using Intents, Introduction to Fragments, Adding Fragments Dynamically, Lifecycle of Fragment, Toast, Understanding the components of a screen, Adapting to Display Orientation, Split Screen / Multi-Screen Activities.		
Mapping of Course Outcomes for Unit IV	**CO2: Create mobile applications on the different android platform.**	
Unit V	**Designing User Interface with Widgets**	**8 Hrs.**
Using Basic Views: Text View, Button, ImageButton, EditText, CheckBox, Switch, ToggleButton, Radio Button, and Radio Group Views, ProgressBar View, AutoCompleteTextView View, Using Picker Views, Using RecyclerView to Display Long Lists, Understanding Specialized Fragments, Displaying Pictures and Menus, VideoView. **Multimedia, Animation and Graphics:** Playing Audio, Playing Video, Rotate Animation, Fade In / Fade Out Animation, Zoom Animation, Scale Animation, 2D and 3D Graphics.		
Mapping of Course Outcomes for Unit V	**CO3: Design and implement mobile applications involving data storage in databases.**	
Unit VI	**Databases, Location-Based Services and Google Map**	**8 Hrs.**
Data Storage: Shared Preferences, Internal Storage, External Storage, SQLite Databases, Content provider. and Remote Databases. Introduction to SQLite and Room library, SQLite Open Helper and SQLite Database, Creating, opening and closing database, Creating, opening and closing database, Building and executing queries, SMS Messaging, Sending E-mail, Web App**,** JSON Parsing, JSON Web Service, Display Google Maps, Getting Location Data, Monitoring a Location. Accessing Phone services (Call, SMS, MMS), Network connectivity services, Sensors, Bluetooth/Wi-Fi Connectivity.		
Mapping of Course Outcomes for Unit VI	**CO3: Design and implement mobile applications involving data storage in databases.**	

Learning Resources

Text Books:

1. David Griffiths and Dawn Griffiths, “Head First Android Development: A Brain-Friendly Guide”, 2nd Edition, Shroff / O’Reily Publication
2. Barry Burd, “Java Programming for Android Developers for Dummies”, 2nd Edition, Dummies.
3. Wei-Meng Lee, “Beginning Android 4 Application Development”, WROX Publication

Reference Books:

1. Herbert Schildt, “Java: The Complete Reference”, 9th Edition, Tata McGraw Hill
2. Reto Meier, “Professional Android 4 Application Development”, John Wiley and sons
3. John Horton, “Android Programming for Beginners”, 3rd Edition, Packt Publication

MOOC / NPTEL Courses:

1. NPTEL Course on "**Introduction to Mobile Application Development***",* by Prof. G.Raina, T.Gopal , IIT Madras
   Link of the Course: https://nptel.ac.in/courses/106106156

2. Swayam Course on "**Android Mobile Application Development**", by Dr. Himanshu.N.Patel, Dr. Babasaheb Ambedkar Open University Ahmedabad.
   Link of the Course: https://onlinecourses.swayam2.ac.in/nou21_ge41/preview

Ebooks:

1. https://enos.itcollege.ee/~jpoial/allalaadimised/reading/Android-Programming- Cookbook.pdf.
2. https://www.programming-book.com/download/?file=10988
3. https://www.programmer-books.com/professional-android-4th-edition-pdf/

Websites:

1. https://developer.android.com
2. https://www.javatpoint.com/android-tutorial

Savitribai Phule Pune University

Fourth Year of E & Tc Engineering (2019 Course)

404191 (D): Embedded System Design (Elective - V)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 hrs. / week	03	In-Sem (Theory): 30 Marks End-Sem (Theory): 70 Marks

Prerequisite Courses, if any:

Companion Course, if any:

1. Lab Practice -3

Course Objectives:

1. To define design considerations of the embedded system.
2. To utilize specific resources of embedded processor.
3. To integrate embedded hardware and software.
4. To design embedded system as per the application

Course Outcomes: On completion of the course, learner will be able to -

CO1: Apply the design aspects of Embedded system.
CO2: Create and debug a firmware for the Embedded System using ARM Cortex M4.
CO3: Develop a specific software code for the functionality of the Embedded System.
CO4: Utilize an open source RTOS for embedded system design.
CO5: Design an advanced embedded system.
CO6: Explore Embedded Android system.

Course Contents

Unit I	Introduction to Embedded System Design	6 Hrs.

Embedded System fundamental, Design Technology, Design challenges, Design productivity gap. Classification and Characteristics of Embedded System, Design Process and Skills required. Designer. Processor to be embedded into a system**:** Microprocessors and Microcontrollers, Embedded system hardware components and software architecture**:** Round Robin, FQS, RTOS, and selection of architecture. Integration of embedded hardware and software. Embedded software development tools and debugging techniques. Embedded system design cycle.

Mapping of Course Outcomes for Unit I	CO1: Apply the design aspects of Embedded system.

Unit II	Embedded Processor ARM Cortex M4	8Hrs.

Comparison of STM32F family and MCU selection criteria for specific application, Architectural review of STM32F4XX MCU**:** Pin diagram, CPU, Memory, GPIO, Clock and Timer module, ADC-DAC module, Study of STM32F4 Development board, Software development tool SM32CubeIDE IDEs for STM32; Interfacing requirements issues, GPIO configuration of STM32F4, interfacing of input switch, heavy loads (sample program mapping with any application), Concept of Watchdog timer and RTC, Configure an UART Setup with the STM32F4 Microcontroller. Debugging with SM32CubeIDE.

Mapping of Course Outcomes for Unit II	CO2: Create and debug a firmware for the Embedded System using ARM Cortex M4.

Unit III	GPIO and HAL	6 Hrs.
Overview of Hardware Abstraction Layer (HAL) drivers; HAL data structure, API classification, naming rules, Configuration, GPIO HAL API, Driving a GPIO.GPIO ports function and their relationship to HAL, , Use of HAL library for SPI, I2C and CAN module, USB Modules in the STM32F4Microcontroller.		
Mapping of Course Outcomes for Unit III	**CO3: Develop a specific software code for the functionality of the Embedded System.**	
Unit IV	**RTOS for STM32F4**	**8 Hrs.**
Reviewing the concepts underlying an RTOS, Introduction to FreeRTOS. Configure FreeRTOS Using STM32CubeMX, Thread Management, FreeRTOS and the C stdlib, Synchronization Primitives, Debugging features of FreeRTOS, debugging with STM32CubeIDE. Alternatives open source RTOS to FreeRTOS: ChibiOS and Contiki OS. Create a FreeRTOS project in STM32CubeIDE. Write C code for any task/event/thread with FreeRTOS		
Mapping of Course Outcomes for Unit IV	**CO4: Utilize an open source RTOS for embedded system design.**	
Unit V	**Embedded System Design with STM32**	**6 Hrs.**
Interfacing with SPI based graphical LCD with STM32F4, interfacing the Touch Screen with STM32F4, Installing TouchGFX for Graphical User Interface (GUI), GUI Formation with TouchGFX for any two applications. Design an embedded system for any two applications like Image transfer between PC and STM32F4, PID speed control of DC motor, Transferring the Digital Signal Between the PC and STM32F4 Microcontroller.		
Mapping of Course Outcomes for Unit V	**CO5: Design an advanced embedded system.**	
Unit VI	**Embedded Android**	**6 Hrs.**
Features and characteristics of Android, different android platforms, requirements of android, App development tools, Overall architecture of Android, Linux Kernel, Hardware Abstraction Layer, Loading and interfacing methods. Device hardware methods and interfaces, File system layout, Libraries: within AOSP and imported into the AOSP(Android Open Source Project)		
Mapping of Course Outcomes for Unit VI	**CO6: Explore Embedded Android system.**	

Learning Resources

Text Books:

1. Frank Vahid, Tony-Givargis, “Embedded System Design”, 3rd Edition Wiley India Publications.
2. David Simon, “An Embedded Software Primer”, 2nd Edition, Pearson Publication.
3. Cem Unsalan, Huseyin Deniz Gurhan, Mehmet Erkin Yucel, “Embedded System Design with Arm Cortex-M”, Spinger.

Reference Books:

1. Carmine Noviello, “Mastering STM32”, 2nd Edition, Lean Publisher.
2. Muhamad Ali Mazidi, Shujen Chen, Eshragh, “STM32 ARM Programming for Embedded Systems”.
3. Donald Norris, “Programming with STM32”, Mc Graw Hill Publication,
4. KarimYagbmour, “Embedded Android”, 1st Edition, O’Reilly publishers.
5. RM0390 Reference manual, STM32F446xx advanced Arm®-based 32-bit MCUs

MOOC/NPTEL Courses:

1. NPTEL Course on, **“Introduction to Embedded System Design”**, by Prof. D.V.Gadre, Prof.B.N. Subudhi IIT Jammu

Link of the course: https://nptel.ac.in/courses/108102169

Savitribai Phule Pune University Fourth Year of E & Tc Engineering (2019 Course) 404191 (E): Mobile Computing (Elective - V)		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Theory: 03 Hrs. / Week	**03**	**In-Sem (Theory): 30 Marks** **End Sem (Theory): 70 Marks**

Prerequisite Courses, if any:

1. Basics of Communication Technologies.
2. Fundamental of Networking

Companion Course, if any:

Course Objectives:

1. To learn Wireless technologies and planning Ad-hoc Network.
2. To study the basics of wireless, cellular technology and the working of Mobile IP, ad hoc network, features of mobile operating systems.
3. To understand the use of M-Commerce application.

Course Outcomes: On completion of the course, learner will be able to -

CO1: Understand concepts of Mobile Communication.
CO2: Analyse next generation Mobile Communication System.
CO3: Understand network layers of Mobile Communication.
CO4: Understand IP and Transport layers of Mobile Communication.
CO5: Study of different mathematical models.
CO6: Understand different mobile applications.

Course Contents

Unit I	Introduction to Mobile Computing	6 Hrs.
Introduction to Mobile Computing: Applications of Mobile Computing- Generations of Mobile Communication Technologies, Multiplexing: Spread spectrum, MAC Protocols: SDMA, TDMA, FDMA, and CDMA.		
Mapping of Course Outcomes for Unit I	**CO1: Understand concepts of Mobile Communication.**	
Unit II	**Mobile Telecommunication System**	**7 Hrs.**
Introduction to Cellular Systems, GSM architecture, Protocols, Connection Establishment, Frequency Allocation, Routing, Mobility Management, Security, GPRS and UMTS: Architecture, Handover, Security. **Introduction to 5G:** Introduction, 5G network architecture, Applications, 5G enable technologies, Recent trends in Telecommunication Industries.		
Mapping of Course Outcomes for Unit II	**CO2: Analyse next generation Mobile Communication System.**	

Unit III	Network Layer	6 Hrs.
Mobile IP, DHCP, AdHoc, Proactive protocol-DSDV, Reactive Routing Protocols: DSR, AODV, Hybrid routing: ZRP, Multicast Routing: ODMRP, Vehicular Ad Hoc networks (VANET), MANET Vs VANET: Security.		
Mapping of Course Outcomes for Unit III	**CO3: Understand network layers of Mobile Communication.**	
Unit IV	**Mobile IP and Transport Layer**	**8 Hrs.**
Mobile IP: Need of mobile IP, IP packet delivery, Agent Discovery, Registration, Tunnelling and encapsulation, Route optimization, IP Handoff. **Transport Layer:** Overview of Traditional TCP and implications of mobility control. Improvement of TCP: Indirect TCP, Snoop TCP, Mobile TCP, Fast Retransmit/fast recovery, Time-out freezing, Selective retransmission, Transaction-oriented TCP.		
Mapping of Course Outcomes for Unit IV	**CO4: Understand IP and TCP layers of Mobile Communication.**	
Unit V	**Fading Channels**	**7 Hrs.**
Rayleigh Fading and Statistical Characterization, Properties of Rayleigh Distribution, BER in Fading, Narrowband vs Wideband Channels, Characterization of Multipath Fading Channels, Choice of Modulation, Coherent versus Differential Detection, BER in Fading , Ricean Fading.		
Mapping of Course Outcomes for Unit V	**CO5: Study of different mathematical models.**	
Unit VI	**Operating System & Applications of Mobile Computing**	**8 Hrs.**
Operating System: A Few Basic Concepts, Special Constraints and Requirements of Mobile OS, A Survey of Commercial Mobile Operating Systems, Windows Mobile, Palm OS, Symbian OS, iOS, Android, Blackberry OS, A Comparative study of Mobile OS, OS for sensor Network. **Applications:** M-Commerce, Business to Consumer (B2C) Applications, Business to Business (B2B) Applications. Structure of M-Commerce, Pros and Cons of M-Commerce, Mobile Payment System, Mobile Payment Schemes, Desirable properties of a Mobile Payment system, Mobile Payment solutions, Process of Mobile Payment, Security Issues.		
Mapping of Course Outcomes for Unit VI	**CO6:** Understand different mobile applications.	

Learning Resources

Text Books:

1. Clint Smith, Daniel Collins, “Wireless Networks”, 3rd Edition, McGraw Hill Publications,
2. Share Conder, Lauren Darcey, “Android Wireless Application Development”, Volume I, 3rd Edition, Pearson.

Reference Books:

1. Jochen Schiller, "Mobile Communications", 2nd Edition, Pearson.
2. Paul Bedell, "Cellular networks: Design and Operation – A real world Perspective", Outskirts Press.
3. Zigurd Mednieks, Laird Dornin, G, Blake Meike and Masumi Nakamura, "Programming Android", O"Reilly.
4. Alasdair Allan, "iPhone Programming", O"Reilly.
5. Donny Wals, "Mastering iOS 12 Programming".
6. Reza B"Far, "Mobile Computing principles", Cambridge University Press.

MOOC / NPTEL Courses:

1. NPTEL Course **"**Mobile Computing**"b**y Prof. Sridhar Iyer and Prof. Pushpendra Singh IIT Madras

   Link of the Course: https://nptel.ac.in/courses/106106147

2. NPTEL Course **"Funadamentals of MIMO Wireless Communication"** by Prof. Suvra Sekhar Das IIT Kharagpur
   Link of the Course: https://nptel.ac.in/courses/117105132

3. NPTEL Course **"Principles of Modern CDMA/MIMO//OFDM Wireless Communications"** by Prof. Aditya. K. Jagannatham IIT Kanpur
   Link of the Course: https:// nptel.ac.in/courses/117104115

Savitribai Phule Pune University Fourth Year of E & Tc Engineering (2019 Course) 404192 (A): System on Chip (Elective - VI)		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Theory: 03 hrs. / week	**03**	**In-Sem (Theory): 30 Marks** **End-Sem (Theory): 70 Marks**
Prerequisite Courses, if any:		
Companion Course, if any:		

Course Objectives:

1. To understand the basic concepts and architecture of SOC.
2. To understand the basic terminology of Verilog HDL programming.
3. To apply the various Verilog modeling styles in writing the design and testbench codes.
4. To understand the basic steps used in the VLSI Physical Design.
5. To understand the basic architecture of various processors used in SOC.
6. To understand the working principle of various Buses and memory used in SOC.

Course Outcomes: On completion of the course, learner will be able to -

CO1: Understand the basic concepts and architecture of SOC.
CO2: Understand the basic terminology of Verilog HDL programming.
CO3: Apply the various Verilog modeling styles in writing the design and testbench codes.
CO4: Understand the basic steps used in the VLSI Physical Design.
CO5: Understand the basic architecture of various processors used in SOC.
CO6: Understand the working principle of various Buses and memory used in SOC.

Course Contents

Unit I	Introduction to SOC	6 Hrs.
System Architecture; System Complexity; Components of the system; Hardware & Software; An approach for SOC Design; SOC definition, benefits, and challenges; Application of SOC; SOC components: Processor, Accelerators, Memory and Peripherals, On-chip interconnects, and various signal processing units.		
Mapping of Course Outcomes for Unit I	**CO1: Understand the basic concepts and architecture of SOC.**	
Unit II	**Verilog HDL - I**	**8 Hrs.**
Evolution and need of CAD tools; HDL tools; Why Verilog; Verilog: datatypes, system tasks, compiler directives; Hierarchical Modeling Concepts: Top-down and bottom-up design methodology; modules and module instances; Modules and Ports: Module definition, port declaration, connecting ports, hierarchical name referencing, and timescale.		
Mapping of Course Outcomes for Unit II	**CO2: Understand the basic terminology of Verilog HDL programming.**	

Unit III	Verilog HDL-II	8 Hrs.
Gate-level modeling: Modeling using basic Verilog gate primitives, description of AND/OR and BUF/NOT type gates; Dataflow Modeling: Continuous assignments, delay specification, expressions, operators; Behavioral Modeling: Structured procedures, initial and always blocks, blocking and non-blocking statements, delay control, conditional statements, multiway branching, loops, sequential and parallel blocks; Tasks and Functions: tasks vs functions, declaration, invocation, automatic tasks and functions; testbench		
Mapping of Course Outcomes for Unit III	**CO3: Apply the various Verilog modeling styles in writing the design and testbench codes.**	
Unit IV	**Physical Design**	**8 Hrs.**
Floor planning: Abutted and Non-abutted floorplan techniques, floorplan control parameters, input and outputs of the floorplan; Partitioning; need of partitioning, rules of partitioning, methods of partitioning; Placement: goal of placement, coarse placement, legalization, placement blockage, keep-out margin; Routing: netlist, congestion, fixed-die routing, variable-die routing.		
Mapping of Course Outcomes for Unit IV	**CO4: Understand the basic steps used in the VLSI Physical Design.**	
Unit V	**SOC Processors**	**6 Hrs.**
Introduction to SOC processors; Processor selection for SOC; Basic concepts in processor architecture and processor micro architecture; Basic elements in Instruction handling; Buffers: minimizing pipeline delays, Branches; More Robust Processors: Vector processors and vector instructions extensions, VLIW Processors, Superscalar Processors.		
Mapping of Course Outcomes for Unit V	**CO5: Understand the basic architecture of various processors used in SOC.**	
Unit VI	**SOC Buses and Memory**	**6 Hrs.**
AMBA: Generation of AMBA (ASB, AHB, APB), Architecture of AMBA, Specification; Core Connect bus: PLB, OPB, DCR; ST bus protocols: Type I, II, III; SOC memory; Cache memory: performance, partitioning, multi-level cache; Memory chip technology: On die or Off die.		
Mapping of Course Outcomes for Unit VI	**CO6: Understand the working principle of various Buses and memory used in SOC.**	

Learning Resources

Text Books:

1. Michael J. Flynn, Wayne Luk, “Computer System Design: System on Chip”, John Wiley and sons.
2. Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis”,2nd Edition, Prentice Hall.

Reference Books:

1. M.Wolf, "Principles of Embedded Computing System Design",4th Edition, Morgan Kaufmann Publications.
2. Michael .D. Ciletti, "Advanced Digital Design with the Verilog(TM) HDL",2nd Edition, Pearson.
3. J.Bhasker, " A Verilog HDL Primer",3rd Edition, Star Galaxy Press.

MOOC / NPTEL Courses:

1. NPTEL Course on "**Hardware modeling using Verilog**", by Prof. Indranil Sengupta IIT Kharagpur

   Link of the course: https://nptel.ac.in/courses/106105165

2. NPTEL Course on "**VLSI Physical Design**", by Prof. Indranil Sengupta IIT Kharagpur

   Link of the course: https://nptel.ac.in/courses/106105161

3. NPTEL Course on "**Embedded Systems**", by Prof. Santanu Choudhary IIT Delhi

   Link of the course: https://nptel.ac.in/courses/106105161

Savitribai Phule Pune University

Fourth Year of E & Tc Engineering (2019 Course)

404192 (B): Nanoelectronics (Elective - VI)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 hrs. / week	03	In-Sem (Theory): 30 Marks End-Sem (Theory): 70 Marks

Prerequisite Courses, if any:

Companion Course, if any:

Course Objectives:

1. To understand the processes in Nanoelectronic devices manufacturing.
2. To understand the construction, characteristics, and operation of Nanoelectronic devices.
3. To get acquainted with Nano-CMOS technology.
4. To gain the concepts of Nanomaterial and Nanodevice fabrication.
5. To understand the Nanomachines and nanodevice fabrication.
6. To get acquainted with applications of Nanoelectronics in the electronics industry.

Course Outcomes: On completion of the course, learner will be able to -

CO1: Understand the fundamental knowledge behind nanotechnology.
CO2: Understand to Nano-CMOS technology.
CO3: Explore various Nanoelectronics material.
CO4: Understand the importance of carbon nanotubes.
CO5: Understand Nanomaterial and Nanodevice fabrication.
CO6: Understand various applications of Nanotechnology in Electronics.

Course Contents

Unit I	Introduction to Nanotechnology	6 Hrs.

Introduction to Nanotechnology: Fundamental science behind Nanotechnology, Tools for measuring Nanostructures, Tools to make nanostructures and imagine nano behaviors, Limitations of Silicon Material

Mapping of Course Outcomes for Unit I	CO1: Understand the fundamental knowledge behind nanotechnology.

Unit II	Nano CMOS Devices	6 Hrs.

Silicon Nanocrystal non-volatile memories, Novel dielectric materials for future transistors, Nano-CMOS devices, andapplications, AFM, scanning probe instrument,nanoscale lithography.

Mapping of Course Outcomes for Unit II	CO2: Understand to Nano-CMOS technology

Unit III	Nanoparticles and Nanotubes	6 Hrs.

Properties of Nanoparticles: Metal nanostructures and semiconducting nanoparticles.

Carbon nanostructures: Carbon molecules, Clusters, Nanotubes.

Properties of Nanotubes: Strength and Elasticity, Applications of Nanotubes.

Mapping of Course Outcomes for Unit III	CO3: Explore various Nanoelectronics material. CO4: Understand the importance of carbon nanotubes.

Unit IV	Nanoelectronics	6 Hrs.
Introduction, the tools of manufacturing of micro and nano fabrication optical lithography, electron beam lithography, atomic lithography. Nano-Electronics for advanced computation and communication.		
Mapping of Course Outcomes for Unit IV	**CO3: Explore various Nanoelectronics material.** **CO4: Understand the importance of carbon nanotubes.**	
Unit V	**Nanomachine and Nanodevice Fabrications**	**6 Hrs.**
Nanomachines and Nanodevices, NEMS and MEMS and their fabrication, molecular and supermolecular switches, Lithography.		
Mapping of Course Outcomes for Unit V	**CO5: Understand Nanomaterial and Nanodevice fabrication.**	
Unit VI	**Applications of Nanotechnology**	**6 Hrs.**
Use of Nanotechnology in Electronics: Application of nanostructures in electronics, sensors, optics, energy capture, transformation, and storage. Application of nanotechnology in biomedical electronics.		
Mapping of Course Outcomes for Unit VI	**CO6: Understand various applications of Nanotechnology in Electronics.**	

Learning Resources

Text Books:

1. Anatoli Korkin, Jan Labanowski, Evgeni Gusev, Serge Luryi, "Nanotechnology for Electronic Materials and Devices", Springer.
2. Mark Ratner, Daniel Ratner, "Nanotechnology: A Gentle introduction to a next big Idea", 1st Edition, Pearson Education.
3. Gregory Timp, "Nanotechnology", Springer.
4. Charles P. Poole Jr., Frank J. Owens, "Introduction to Nanotechnology" John Wiley and sons

Reference Books:

1. K. Goser P. Glosekotter, J. Dienstuhl, "Nanoelectronics & Nanosystems"; Springer

MOOC / NPTEL Courses:

1. NPTEL Course on "**Nanostructured materials-synthesis,properties,self assembly and applications**", by Prof. A.K.Ganguli IIT Delhi

   Link of the course: https://nptel.ac.in/courses/118102003

2. NPTEL Course on "**Nanoelectronics: Devices and Materials**", by Dr. Navkanta Bhat, Dr. S.N.Shivashankar, Prof. K.N.Bhat IISc Bangalore

   Link of the course: https://nptel.ac.in/courses/117108047

Savitribai Phule Pune University

Fourth Year of E & Tc Engineering (2019 Course)

404192 (C): Remote Sensing (Elective - VI)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 Hrs. / Week	03	In-Sem (Theory): 30 Marks End-Sem (Theory): 70 Marks

Prerequisite Courses, if any:

Companion Course, if any:

Course Objectives:

1. To introduce the basic principles of remote sensing.
2. To be familiar with Indian space missions and satellite sensors characteristics.
3. To know the different types of satellite data products, visual interpretation and basics of digital processing of satellite images.
4. To provide exposure of the global navigation satellite system and its application.
5. To understand underlying concepts of microwave and lidar remote sensing

Course Outcomes: On completion of the course, learner will be able to

CO1: Describe the concepts of remote sensing and electromagnetic radiation interaction.

CO2: Explain the sensors characteristics and analyze its resolution.

CO3: Classify different types of satellite data products and design various color composites.

CO4: Describe the fundamentals of microwave remote sensing.

CO5: Analyze GNSS signal structure and augmentation systems.

CO6: **Demonstrate** and describe real life applications of remote sensing.

Course Contents

Unit I	Principles of Remote Sensing	7 Hrs.

Basic principles of Remote Sensing, Data and Information, Remote Sensing Data Collection, Types of Remote Sensing- Active and Passive remote sensing; Advantages and Limitations of Remote Sensing, Electromagnetic Energy- Electromagnetic Spectrum, Interaction of EMR: Interaction with Earth's Atmosphere and Atmospheric window, Spectral Signature:Interaction with Soil, Water and Vegetation

Mapping of Course Outcomes for Unit I	CO1: Describe the concepts of remote sensing and electromagnetic radiation interaction.

Unit II	Satellite Sensors and Resolution	7 Hrs.

Types of Remote Sensing Platforms, Types of Satellite Orbits - Geosynchronous and Geostationary, Polar and sun synchronous orbit, low earth, medium earth, highly elliptical orbits, Recent Trends in Remote sensing Earth Observation data, Indian & Global Space Missions : Indian & Global Satellites and Sensors Characteristics, Satellite Resolution : Spatial, Temporal, Spectral, Radiometric; Differences between Multispectral and Hyperspectral remote sensing

Mapping of Course Outcomes for Unit II	CO2: Explain the sensors characteristics and analyze its resolution.

Unit III	Satellite Data Products & Processing	7 Hrs.
Satellite Data Analysis: Data Products and Their Characteristics, Data Pre-processing – Atmospheric, Radiometric, Geometric Corrections - Basic Principles of Visual Interpretation, Equipment for Visual Interpretation, Ground Truth; Color Composite : False and True Color Composite;Image enhancements; Classifications - Supervised and Unsupervised, Normalized satellite Indices - NDVI, NDWI, GDVI, NDSI etc; Remote Sensing Data Sources : USGS, Bhuvan, ESA, Sentinel etc		
Mapping of Course Outcomes for Unit III	**CO3: Classify different types of satellite data products and design various color composites.**	
Unit IV	**Active Remote Sensing**	**6 Hrs.**
Microwave Remote Sensing: Active and Passive Systems, Advantages, Platforms and Sensors, Microwave Radiation and Simulation, Principles of Radar – Resolution, Range, Angular Measurements, Microwave Scattering, Imagery – characteristics and Interpretation; Definitions of LiDAR - Concepts and its applications.		
Mapping of Course Outcomes for Unit IV	**CO4: Describe the fundamentals of microwave remote sensing.**	
Unit V	**GNSS Technology**	**7 Hrs.**
Introduction of GNSS Technology : GNSS Signal Structures, GNSS Vulnerabilities, GNSS Applications, GNSS Market and Business, Indian Regional Navigation Satellite System (IRNSS), Ground Based Augmentation Systems,Space Based Augmentation Systems - GAGAN; Principles of satellite positioning - Principle of Satellite Positioning, GNSS Orbits, Navigation Message Details; Positioning Errors, Data Formats, Location-Based Services (LBS), Tools for GNSS data processing.		
Mapping of Course Outcomes for Unit V	**CO5: Analyze GNSS signal structure and augmentation systems.**	
Unit VI	**Applications of Remote Sensing**	**6 Hrs.**
Applications of Remote Sensing: Environmental and Disaster, Coastal and Near Shore, Forest and Agriculture, Water Resource, Urban Planning and Management, Land Use and Land Cover Analysis.		
Mapping of Course Outcomes for Unit VI	**CO6: Demonstrate and describe real life applications of remote sensing.**	

Learning Resources

Text Books:

1. John A. Richards, “Remote Sensing Digital Image Analysis - An Introduction” 5th Edition, Springer-Verlag Berlin Heidelberg.
2. Joseph, G., “Fundamentals of Remote Sensing”, Universities Press,
3. Roy. P.S., Dwivedi. R. S., “Remote Sensing Application”, Published by NRSC ISRO Hyderabad.

Reference Books:

1. Liu, J.-G., & Mason, P.J. "Image Processing and GIS for Remote Sensing: Techniques and Applications", 2nd Edition, Wiley-Blackwell.
2. Sabins, F. F.,"Remote Sensing: Principles and Interpretation", 4th Edition, Waveland Pr. Inc.
3. Navalgund, R. R. Ray, S. S., "Hyperspectral Data, Analysis Techniques Application", Indian Society of Remote Sensing.
4. Lillesand, T. M., Kiefer, R. W.,Chipman, J. W., "Remote Sensing and Image Interpretation", 7th Edition, John Wiley & Sons.
5. Bernhard Hofmann-Wellenhof, Herbert Lichtenegger, Elmar Wasle, "GNSS - Global Navigation Satellite Systems: GPS, GLONASS, Galileo, and more", Springer.
6. Pinliang Dong, Qi Chen, "LiDAR Remote Sensing and Applications", 1st Edition CRC Press.

MOOC / NPTEL Courses:

1. NPTEL Course "**Remote Sensing: Principal and Application**", by Prof. Eswar Rajasekaran, IIT Bombay
   Link of the Course: https://nptel.ac.in/courses/105101206

2. NPTEL Course "**Remote Sensing Essentials**", by Dr. Arun.K.Saraf, IIT Roorkee
   Link of the Course: https://nptel.ac.in/courses/105107201

3. NPTEL Course "**Global Navigation Satellite Systems and Applications**", by Dr. Arun.K.Saraf, IIT Roorkee
   Link of the Course: https://nptel.ac.in/courses/105107194

Savitribai Phule Pune University Fourth Year of E & Tc Engineering (2019 Course) 404192 (D): Digital Marketing (Elective - VI)		
Examination Scheme:	**Credit**	**Examination Scheme:**
Theory: 03 Hrs. / Week	**03**	**In-Sem: 30 Marks** **End Sem: 70 Marks**

Prerequisite Courses, if any:

Companion Course, if any:

1. Digital Business Management

Course Objectives:

1. To understand digital marketing & process of website design.
2. To identify the keywords for a website & understand the SEO.
3. To study the various Digital Marketing Tools.
4. To learn the use of social media websites for Digital Marketing.
5. To be conversant with Linked In platform.
6. To know the recent trends in Digital Marketing.

Course Outcomes: On completion of the course, learner will be able to
CO1: Design websites using free tools like Wordpress and explore it for digital marketing.
CO2: Apply various keywords for a website & to perform SEO.
CO3: Understand the various SEM Tools and implement the Digital Marketing Tools.
CO4: Illustrate the use of Facebook, Instagram and Youtube for Digital Marketing in real life.
CO5: Use Linked in platform for various campaigning.
CO6: Understand the importance of recent trends in digital marketing.

Course Contents

Unit I	Digital Marketing Planning and Structure	7 Hrs.

Importance of Digital Marketing, Digital Marketing Vs. Traditional Marketing, Inbound vs Outbound Marketing, Understanding Demographics. WWW, Buying a Domain, Core Objective of Website and Flow, One Page Website, Strategic Design of Products & Services Page, Strategic Design of Landing Page, Segmentation & Targeting and Positioning to Digital Marketing, Portfolio, Gallery and Contact Us Page, Google Analytics Tracking Code, Designing Wordpress Website. Mobile Friendly Website, Payment Gateway like UPI, e-Commerce

Mapping of Course Outcomes for Unit I	CO1: Design websites using free tools like Wordpress and explore it for digital marketing.

Unit II	Search Engine Optimization (SEO)	7 Hrs.

Fundamentals; Keywords and SEO Content Plan; SEO & Business Objectives; Writing SEO Content; On-site & off-site SEO; Optimize Organic Search Ranking, Website SEO Auditing, Web Analytics: Data and Traffic Analysis. Study and analyze the Competitor's Website and their traffic sources.

Mapping of Course Outcomes for Unit II	CO2: Apply various keywords for a website & to perform SEO.

Unit III	Search Engine Marketing	7 Hrs.
Importance of Adwords, Google Ad Types, PPC Cost Formula, Ad Page Rank, Billing and Payments, Adwords User Interface, Keyword Planner, Creating Ad Campaigns, Creating Text Ads, Creating Ad Groups, Search Engine Marketing (SEM) Tools, Bidding Strategy for CPC, Case Studies. Conversion Tracking Code, Designing Image Ads, Creating Video Ads, Youtube Video Promotion, Hi-Jack Competitor's Video Audience, Case Studies. Remarketing Strategies, Remarketing Tracking Code, Website or Blog Linking Google Analytics, Designing Remarketing Images, Shared Budget, Mobile Advertising.		
Mapping of Course Outcomes for Unit III	**CO3: Understand the various SEM Tools and implement the Digital Marketing Tools.**	
Unit IV	**Social Media Marketing (SMM) Part 1**	**8 Hrs.**
B to C Perspective, B to B Perspective: Introduction; Major Social Media Platforms for Marketing; Developing Data-driven Audience & Campaign Insights; Social Media for Business; Facebook & Instagram Marketing: Understanding of Facebook Marketing, Types of Facebook Advertising, Creating first ad on Facebook, Setting Campaign and optimization, Facebook Power Editor, Facebook Video Marketing, Facebook App & Shopping Marketing Youtube Marketing: YouTube Account Setup (Create a business account with a personal account), YouTube Monetization, YouTube Ads, YouTube Analytics.		
Mapping of Course Outcomes for Unit IV	**CO4: Illustrate the use of Facebook, Instagram and Youtube for Digital Marketing in real life.**	
Unit V	**Social Media Marketing (SMM) Part 2**	**8 Hrs.**
LinkedIn Advertising: How to use Linkedin Professionally, Types of LinkedIn Advertising, LinkedIn New feed Advertising, LinkedIn Message Pitching, Traffic and Leads Generation, Billing and Report. **Email Marketing:** Email Software and Tools, Importing Email Lists, Planning Email Campaign, Email Templates and Designs, Sending HTML Email Campaigns, Web Forms Lead Importing, Integrating Landing Page Forms, Campaign Reports and Insights, Segmentation Strategy, Responder Tracker		
Mapping of Course Outcomes for Unit V	**CO5: Use Linked in platform for various campaigning.**	
Unit VI	**Upcoming Trends in Digital Marketing**	**6 Hrs.**
Podcast, OTT Platforms, Mob-Ad, No Click Searches, Google Verified Listing, Voice Search, Visual Search, Online Reviews, Automated and Smart Bidding, Chatbots, Affiliate Marketing		
Mapping of Course Outcomes for Unit VI	**CO6: Understand the importance of recent trends in digital marketing.**	

Learning Resources

Text Books:

1. Cory Rabazinsky, "Google-Ad words for Beginners: A Do-It-Yourself Guide to PPC Advertising"
2. Ian Brodie, "Email Persuasion: Captivate and Engage Your Audience, Build Authority and Generate More Sales With Email Marketing"
3. Jan Zimmerman and Deborah, "Social Media Marketing All-In-One for Dummies"
4. Dave Chaffey, Fiona Ellis-Chadwick, Kevin Johnston, Richard Mayer, "Internet Marketing", Pearson Education.
5. Oliver J Rich, "Digital Marketing"
6. Gerry T. Warner and Joe Wilson Schaefer "Online Marketing"

Reference Books:

1. Prof. Seema Gupta, "Digital Marketing", Mcgraw Hill Publications.
2. Judy Strauss, Adel Ansary, Raymond Frost, Prentice Hall, "E- Marketing"
3. Dr. Andy Williams ,"WordPress for Beginners 2020: A Visual Step-by-Step Guide to Mastering WordPress"
4. Cecilia Figueroa, "Introduction To Digital Marketing 101", BPB Publications.

MOOCs / NPTEL:

1. Digital Tools Certification- By Google
   Link of the Course: https://skillshop.exceedlms.com/student/catalog

2. Swayam Certification course on, "**Digital Marketing**", by Dr. Tejindarpal Singh Panjab University Chandigarh
   Link of the Course: https://swayam.gov.in/nd2_ugc19_hs26/preview

Savitribai Phule Pune University

Fourth Year of E & Tc Engineering (2019 Course)

404193: Innovation and Entrepreneurship

Examination Scheme:	Credit	Examination Scheme:
Tutorial: 02 Hrs. / Week	02	Term Work: 50 Marks

Prerequisite Courses, if any:

1. Project Management

Companion Course, if any:

Course Objectives:

1. To know innovation and entrepreneurship.
2. To be trained in design thinking.
3. To comprehend idea generation.
4. To gain knowledge of starting a venture.
5. To study about patents and patent filing.
6. To become skilled at digital marketing

Course Outcomes: On completion of the course, learner will be able to

CO1: Understand Innovation, Entrepreneurship and characteristics of an entrepreneur.

CO2: Develop a strong understanding of the Design Process and its application in variety of business settings.

CO3: Generate sustainable ideas.

CO4: Explore various processes required to be an entrepreneur.

CO5: Understand patents and its process of filing.

CO6: Choose and use appropriate social media for marketing.

Course Contents

Unit I	Introduction to Innovation and Entrepreneurship	3 Hrs.

Role of innovation and entrepreneurship, what it takes to be an entrepreneur, Business fundamentals, Leadership & team building, relation between innovation and entrepreneurship.

Mapping of Course Outcomes for Unit I	CO1: Understand Innovation, Entrepreneurship and characteristics of an entrepreneur.

Unit II	Design Thinking	3 Hrs.

Introduction to Design Thinking, Design Research Strategies, Design Research - tools for observation and immersion, Visualizing ideas, Communicating ideas.

Mapping of Course Outcomes for Unit II	CO2: Develop a strong understanding of the Design Process and its application in variety of business settings.

Unit III	Idea Generation	3 Hrs.

The seed of innovation, Innovation domains, Innovation sustainable conditions, Design factors, Types of innovations and their market impact.

Mapping of Course Outcomes for Unit III	**CO3: Generate sustainable ideas.**	
Unit IV	**Becoming an Entrepreneur**	**4 Hrs.**
Creating a business plan, Preparing a Pitching presentation, Building business strategy		
Mapping of Course Outcomes for Unit IV	**CO4: Explore various processes required to be an entrepreneur.**	
Unit V	**Creating a Startup**	**3 Hrs.**
Types of companies, legal processes for registering companies, registering as startup		
Mapping of Course Outcomes for Unit V	**CO5: Understand patents and its process of filing.**	
Unit VI	**Indian Patents**	**2 Hrs.**
Fundamentals of IP, Patent basics, Patent analytics, Role in R&D and business planning, Patents to profits, IP asset management, Technology transfer.		
Mapping of Course Outcomes for Unit VI	**CO6: Choose and use appropriate social media for marketing.**	

Learning Resources

Reference Books:

1. Badhai, B, "Entrepreneurship for Engineers", Dhanpat Rai & Co. (p) Ltd.
2. "The Field Guide to Human-Centered Design", by IDEO.org
3. Kalyan C. Kankanala, A.K. Narasani, V. Radhakrishnan, "Indian Patent Law and Practice", Oxford Press.
4. Eric Ries, "The Lean Startup", Penguin Books Limited **(E-Book).**

MOOCs / NPTEL:

1. Swayam Course on "**Entrepreneurship**" by Prof. C. Bhaktvatsala Rao IIT Madras
   Link of the Course: https://onlinecourses.nptel.ac.in/noc21_mg70/preview

2. Swayam Course on "**Design Thinking-A Primer**" by Prof. A. Mahalingam, Prof. B. Ramadurai IIT Madras
   Link of the Course: https://onlinecourses.nptel.ac.in/noc22_mg32/preview

3. Swayam Course on "Patent Law for Scientists and Engineers" by Prof. Feroz Ali IIT Madras
   Link of the Course: https://onlinecourses.nptel.ac.in/noc20_hs55/preview

4. NPTEL Course on " Innovation, Business Models and Entrepreneurship" by Prof. Rajat Agarwal, Prof. Vinay Sharma IIT Roorkee
   Link of the Course: https://nptel.ac.in/courses/110107094

List of Tutorials to be carried out

1.	Design a strategy by writing steps to market the project you are building.
2.	Generate an idea having novelty.
3.	Prepare a business plan.
4.	Create a pitching deck.
5.	Preparing a business strategy.
6.	Write a patent draft.

Savitribai Phule Pune University Fourth Year of E & Tc Engineering (2019 Course) 404194: Digital Business Management		
Examination Scheme:	**Credit**	**Examination Scheme:**
Tutorial: 02 Hrs. / Week	**02**	**Term Work: 50 Marks**

Prerequisite Courses, if any:
1. Project Management

Companion Course, if any:
1. Digital Marketing

Course Objectives:
1. To familiarize with digital business concept.
2. To acquaint with E-commerce.
3. To give insights into E-business and its strategies.

Course Outcomes: On completion of the course, learner will be able to
CO1: Identify drivers of digital business.
CO2: Illustrate various approaches and techniques for E-business and management.
CO3: Prepare E-business plan.

Course Contents

Unit I	Introduction to Digital Business	4 Hrs.

Introduction, Background and current status, E-market places, structures,mechanisms, economics and impacts. Difference between physical economy and digital economy.
Drivers of digital business: Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things (digitallyintelligent machines/services), Opportunities and Challenges in Digital Business,

Mapping of Course Outcomes for Unit I	CO1: Identify drivers of digital business.

Unit II	Overview of E-Commerce	8 Hrs.

E-Commerce: Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement, B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals. Other E-C models and applications, innovative EC System-From E- government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e- commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC

Mapping of Course Outcomes for Unit II	CO2: Illustrate various approaches and techniques for E-business and management.

Unit III	Digital Business Support Services	3 Hrs.

e-CRM, e-SCM, ERP as e –business backbone, Knowledge Tope Apps, Information and referral system:
Application Development: Building Digital business Applications and Infrastructure

Mapping of Course Outcomes for Unit III	CO2: Illustrate various approaches and techniques for E-business and management.

Unit IV	Managing E-Business	4 Hrs.
Managing Knowledge, Management skills for e- business, Managing Risks in e –business. Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications.		
Mapping of Course Outcomes for Unit IV	**CO2: Illustrate various approaches and techniques for E-business and management.**	
Unit V	**E-Business Strategy**	**3 Hrs.**
E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition		
Mapping of Course Outcomes for Unit V	**CO2: Illustrate various approaches and techniques for E-business and management.** **CO3: Prepare E-business plan.**	
Unit VI	**Materializing e-business:**	**2 Hrs.**
From Idea to Realization-Business plan, Case Studies.		
Mapping of Course Outcomes for Unit VI	**CO3: Prepare E-business plan.**	

Learning Resources

Text Books:

1. Urmi Dutta, Neha Somani, "E-Commerce & Business Communication", Oxford University Press
2. Elias M. Awad, "E-commerce from vision to fulfilment" 3rd Edition, Prentice Hall India
3. Dave Chaffey, "Digital Business and E-Commerce Management", 6th Edition, Pearson
4. Colin Combe, "Introduction to E-business: Management and Strategy", 1st Edition , Elsvier
5. Eloise Coupey, "Digital Business Concepts and Strategy", 2nd Edition , Pearson

Reference Books:

1. Vinocenzo Morabito,"Trend and Challenges in Digital Business Innovation" Springer
2. Erika Darics, "Digital Business Discourse", Palgrave Macmillan
3. "E-Governance-Challenges and Opportunities", Proceedings in 2nd International Conference theory and practice of Electronic Governance
4. "Perspectives the Digital Enterprise –A framework for Transformation", TCS Consulting Journal Vol. 5
5. "Measuring Digital Economy-A new perspective" , OECD Publishing
   DOI: 10.1787/9789264221796-en

MOOCs / NPTEL:

1. Coursera Course on "**Digital Business Specialization**"
   Link of the course: **www.coursera.org/specializations/digital-business**

2. NPTEL Course on "**E-Business**" by Prof. Mamta Jenamani IIT Kharagpur
   Link of the course: **https://nptel.ac.in/courses/110105083**

List of Tutorials to be carried out

1.	Compare conventional business with e- business based on structure, mechanisms and economics.
2.	Discuss the role of Big Data and Data Analytics in Digital Business Management.
3.	Review various Opportunities and Challenges in Digital Business.
4.	Prepare a report on societal impacts of Digital Business.
5.	Review various security aspects of Digital Business.
6.	Discuss the various steps for executing the business plan digitally.
7.	Develop a strategy for E-Business for selling a product online.
8.	Discuss a typical case study of any one Digital Business.

Savitribai Phule Pune University Fourth Year of E & Tc Engineering (2019 Course) 404195: Fiber Optic Lab		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 Hrs. / Week	**01**	**Term Work: 25 Marks** **Oral: 50 Marks**

Prerequisite Courses, if any: -

Companion Course, if any:

List of Laboratory Experiments (Hardware/Programs/Simulation Software)

Group A

1.	To estimate the numerical aperture of given MMSI optical fiber.
2.	To plot electrical and optical characteristics of any one optical source LED/Laser.
3.	To measure attenuation coefficient and bending losses in optical fibers.
4.	To plot characteristics of any one photo detector pn/pin/phototransistor.
5.	Tutorial on optical key components: numerical on optical fiber, optical source and photodetector.

Group B

1.	Establish a digital optical link.
2.	Simulate optical power budget and rise time budget analysis of optical fiber systems.
3.	Study of any one field instrument such as optical power meter, OTDR, splicing machine etc
4.	Tutorial on optical link budget: Optical power budget & rise time budget analysis to comment on the viability of the systems.

Group C

1.	Simulation of WDM system to compute OSNR using *any* simulation software.
2.	Study of current trends in: optical sources, detectors, fibers for telecommunication, mux-demux, filters, isolators, circulators, couplers, connectors, optical amplifiers etc and the measuring instruments and standards.

Virtual LAB Links:

http://vlabs.iitb.ac.in/vlabs-dev/labs/physics-basics/labs/numerical-aperture-measurement- iitk/index.html

(**Physical Sciences Lab)**

Savitribai Phule Pune University Fourth Year of E & Tc Engineering (2019 Course) 404196: Lab Practice – 3		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 Hrs. / Week	**01**	**Term Work: 25 Marks** **Practical: 50 Marks**

Prerequisite Courses, if any:

Companion Course, if any:

1. Biomedical Signal Processing (Elective - V)
2. Industrial Drives and Control (Elective - V)
3. Android Development (Elective - V)
4. Embedded System Design (Elective - V)
5. Mobile Computing (Elective - V)

Guidelines for Student's Lab Journal

The student's Lab Journal can be experimental write-ups. It should include following as applicable: Assignment No, Title of Assignment, Date of Performance, Date of Submission, Aims & Objectives, Theory, Description of data used, Results, Conclusion.

Guidelines for Lab /TW Assessment

The oral examination will be based on the work carried out by the student in the Lab course. Suitable rubrics can be used by the internal & external examiner for assessment.

Subject: Biomedical Signal Processing (Elective - V)

Part A (All Compulsory)

1.	Use discrete Fourier transform (DFT) to describe the signals in the frequency domain. Determine the dominant frequency.
2.	Determine the PP interval and the RR interval for ECG signals. Use DFT to describe the signals in the frequency. Determine the heart rate using the ECG signal
3.	Import the EMG signal. Determine the dominant frequency in the signal.
4.	Import the EEG signal and plot the 10 channels. Determine the dominant frequency of channel 0 and compare this to the dominant frequency of channel 8

Part B (Any 2 to be performed)

1.	Import the EMG signal Calculate the AVR value of the EMG signal.
2.	Import the EMG signal Determine the frequency spectrum or power spectrum.
3.	Isolate one typical period of the signal, i.e., one cycle containing P-QRS-T. Calculate the duration of P, T, and QRS waves. For ECG signal.

Part C (Any 1 to be Performed)	
1.	Import the EEG signal and Determine the onset of the epileptic EEG pattern. Plot the power spectrum of the signal.
2.	Design a Filter to remove the noise in the ECG signal.
3.	Implement LMS adaptive algorithm for noise cancellation.

VIRTUAL LAB LINKS:

1. **https://bmsp-coep.vlabs.ac.in/List%20of%20experiments.html** (**Biomedical and Signal Processing Lab.)**

2. **https://bmi-iitr.virtuallabs.ac.in/** (**Biomedical Instrumentation Lab.)**

Subject: Industrial Drives and Control (Elective - V)	
List of Experiments	
1.	DC motor control using full singlephase converter.
2.	Dual converter single phase controlled dC drives
3.	Microprocessor/microcontroller based single phase controlled dc drives.
4.	Four quadrant chopper reversible dc drives.
5.	Three phase induction motor control using PWM inverters.
6.	Microprocessor/microcontroller based single phase control AC drive.
7.	Simulation of DC drives using of power SIM.
8.	Simulation of AC drives using of power SIM.
9.	Case study on drive application **(Industrial Visit)** Industrial visit to company dealing with Variable Speed DC Drive replacing an existing troublesome DC control system, resulting in increased production and reduced downtime.

Subject: Android Development (Elective - V)

Guidelines for Instructor's Manual

The instructor's manual is to be developed as a hands-on resource and reference. The instructor's manual need to include prologue (about University/program/ institute/ department/foreword/ preface etc), University syllabus, conduction & Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.

Guidelines for Student Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each assignment (Title, Objectives, Problem Statement, Outcomes, software & Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory-Concept in brief, features of tool/framework/language used, Design, test cases, conclusion.

Program codes with sample output of all performed assignments are to be submitted as softcopy.

As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided. Use of DVD containing students programs maintained by lab In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory.

Guidelines for Assessment

Continuous assessment of laboratory work is done based on overall performance and lab assignments performance of student. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness.

Guidelines for Laboratory Conduction

1. The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic.
2. The assignment framing policy need to address the average students and inclusive of an element to attract and promote the intelligent students.
3. The instructor may set multiple sets of assignments and distribute among batches of students.
4. It is appreciated if the assignments are based on real world problems/applications. Encourage students for appropriate use of Hungarian notation, proper indentation and comments.
5. Use of open source software is to be encouraged.
6. In addition to these, instructor may assign one real life application in the form of a mini-project based on the concepts learned.
7. Instructor may also set one assignment or mini-project that is suitable to respective branch beyond the scope of syllabus.

List of Laboratory Assignments (Any 10 to be Performed)	
1.	Download Install and Configure Eclipse / Android Studio on Linux/windows platform.
2.	Design a mobile application using implicit intent and explicit intent
3.	Design a mobile application to create two fragment and pass the data from one fragment to another
4.	Design a mobile application to create home page using grid layout
5.	Design a mobile application to create the login page using sqlite / firebase
6.	Design a mobile application to share data in the app.
7.	Design a mobile application to create registration application which having spinner (subject), radio button (gender), qualification (check box), first insert the value and then show the data in show activity.
8.	Design a mobile application to create different dialog boxes and menu (popup, option , context)
9.	Design a mobile application to show list using Recycler View
10.	Design a mobile application to Show any website using web view
11.	Design a mobile application to Activity using fragment
12.	Design a mobile application using imageslider to show images.
13.	Design a mobile application for media player.
14.	Design a mobile app to store data using internal or external storage.
15.	Design a mobile app using Google Map and GPS to trace the location.

Subject: Embedded System Design (Elective - V)	
Group A (Any 4 to be Performed)	
1.	Interface LED with STM32F4 and Toggle the LED by using delay functions
2.	Make the LED ON when the input switch interfaced with STM32F4 is pressed
3.	Interface LCD with STM32F4
4.	Transmit/Receive a string "SPPU" using interrupt
5.	Measure period and frequency using capture mode of PWM
Group B (Any 2 to be Performed)	
1.	Write TIMER drivers using HAL functions
2.	Write Analog-to-Digital Converter (ADC) drivers using HAL functions
3.	Write PWM drivers using HAL functions
4.	Displaying an image/graph on the SPI based LCD
Group C (Any 2 to be Performed)	
1.	Learn how to Configure FreeRTOS Using CubeMX.
2.	Examine the STM32F4 board thoroughly and prepare a detail report
3.	Study the interfacing of LoRaWAN with STM32F4
4.	Installation of android packages for embedded application

Virtual LAB Links:

1. **https://docs.simuli.co/getting-started/stm32/using-virtual-lab-and-theia**
2. **https://docs.jumper.io/docs/install.html**

Subject: Mobile Computing (Elective - V)	
List of Experiments (Any 8 to be performed)	
1.	Simulate to elaborate operation of multiple access techniques for CDMA.
2.	Study of GSM architecture and signaling techniques.
3.	Study of GPRS services.
4.	Simulate BER performance over Rayleigh Fading wireless channel with BPSK transmission for SNR 0 to 60 dB.
5.	Configuring a Cisco Router as a DHCP Server.
6.	To understand the handover mechanism. **http://vlabs.iitkgp.ernet.in/fcmc/exp8/index.html**
7.	To study the outage probability, LCR & ADF in SISO for Selection Combining and MRC (Flat Fading). **http://vlabs.iitkgp.ernet.in/fcmc/exp9/index.html**
8.	To Perform File Transfer in Client & Server Using TCP/IP.
9.	Case Study on different real time mobile computing services.

Virtual LAB Links:

1. **http://vlabs.iitkgp.ernet.in/fcmc/** (**Fading Channels and Mobile Communication Lab.)**

Savitribai Phule Pune University Fourth Year of E & Tc Engineering (2019 Course) 404197: Project Phase – II		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 10 Hrs. / Week	**05**	**Term Work: 100 Marks** **Oral: 50 Marks**

Project phase 2 is extension of Project phase 1 carried out in seventh semester. The student shall prepare the duly certified Fourth report of project work in standard format preferably in LATEX for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

GUIDELINES

1.	The project TW/OR assessment shall be based on Live Project Demonstration and presentation by the students. The assessment parameters shall be Innovative Idea of selected project, literature survey, Depth of understanding, Applications, Individual contributions, presentations, project report, timely completion of work (Project review presentations), participation in project competition, publication of research work in journal/conference, publication in the form of patent and copyright etc. The college can prepare the rubrics based on these parameters
2.	Certified hard bound project report to be submitted by the students in prescribed format.
3.	Students must preferably publish at least one technical paper on project work in the conference or peer reviewed Journals or publish patent or copyright or should participate into one of the project competition at university/State/National/International level.
4.	A log book of work carried out during the semester should be maintained with weekly review remarks by the guide and committee.
5.	A certified copy of report preferably using LATEX is required to be presented to external examiner at the time of Fourth examination.
6.	The project report must undergo by plagiarism check and the similarity index must be less than 10%. The plagiarism report should be included in the project report.