Savitribai Phule Pune University
Faculty of Science and Technology

Syllabus for

B.E. (Electronics Engineering)

(Course 2019)

(w.e.f. June 2022)

Savitribai Phule Pune University, Pune														
B.E. (Electronics Engineering) 2019 Course (With effect from Academic Year 2022-23)														
Semester-VII														
Course code	Course Name	Teaching Scheme			Examination Scheme and Marks						Credit			
		Theory	Practical	Tutorial	Insem	End sem	TW	PR	OR	Total	Theory	Practical	Tutorial	Total
404201	VLSI Design	03	-	-	30	70	-	-	-	100	03	-	-	03
404202	Advanced Power Electronics	03	-	-	30	70	-	-	-	100	03	-	-	03
404203	Electronic System Design	03	-	-	30	70	-	-	-	100	03	-	-	03
404204	Elective- III	03	-	-	30	70	-	-	-	100	03	-	-	03
404205	Elective -IV	03	-	-	30	70	-	-	-	100	03	-	-	03
404206	Lab Practice I (APE+ESD)	-	04	-	-	-	25		50	75	-	02	-	02
404207	Lab Practice II (VLSI+Elective III)	-	04	-	-	-	25	50		75	-	02	-	01
404208	Project Phase I	-	02	-	-	-	50		-	50	-	01	-	02
404209	Mandatory Audit Course 7	-		-	-	-	-							
	Total	**15**	**10**	**-**	**150**	**350**	**100**	**50**	**50**	**700**				-
	Total Credits										**15**	**05**		**20**

Elective-III	**Elective-IV**
1.Speech Processing * 404184 (A)	1.Mobile Communication 404205 (A)
2.Internet of Things 404204 (A)	2.Embedded Systems 404205 (B)
3.Software Defined Radio 404204 (B)	3.Optimization Techniques 404205 (C)
4.Testing and Verification for SOC design 404204 (C)	4.Low power CMOS* 404185 (D)
5.Java Script* 404184 (C)	5.Smart Antennas* 404185 (E)

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

* Subjects common with BE E&TC 2019 course

Savitribai Phule Pune University, Pune														
B.E. (Electronics Engineering) 2019 Course (With effect from Academic Year 2022-23)														
Semester-VIII														
Course code	Course Name	Teaching Scheme			Examination Scheme and Marks						Credit			
		TH	PR	Tut	Insem	Endsem	TW	PR	OR	Total	TH	PR	TUT	Total
404210	Process Instrumentation	03	-		30	70	-	-	-	100	03	-	-	03
404211	Elective -V	03	-	-	30	70	-	-	-	100	03	-	-	03
404212	Elective -VI	03	-	-	30	70	-	-	-	100	03	-	-	03
404193*	Innovation & Entrepreneurship	-	-	02	-	-	50	-	-	50	-	-	02	02
404194*	Digital Business Management	-	-	02	-	-	50	-	-	50	-	-	02	02
404215	Process Instrumentation Lab	-	02	-	-	-	25		50	75	-	01	-	01
404216	Lab Practice III (Elective V)	-	02	-	-	-	25	50		75	-	01	-	01
404217	Project Phase II	-	10		-	-	100		50	150	-	05		05
	Total	**09**	**14**	**04**	**90**	**210**	**250**	**50**	**100**	**700**				-
	Total Credits										**09**	**07**	**04**	**20**

Elective-V	**Elective-VI**
1.Biomedical Electronics 404211 (A)	1.Renewable Energy System & DSM 404212 (A)
2.Artificial Intelligence and Neural Network 404211 (B)	2.Wireless Sensor Network 404212 (B)
3. Android Development* 404191 (C)	3.Remote Sensing* 404192 (C)
4.Audio Video Engineering 404211 (C)	4.Digital Marketing* 404192 (D)
5.Automotive Electronics 404211 (D)	5.Open Elective 404192 (E)

* Subjects common with BE E&TC 2019 course

Savitribai Phule Pune University Final Year of Electronics Engineering (2019 Course) 404201 VLSI Design		
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 II

Course Objectives:

1. To understand CMOS technology and its application in VLSI Circuits.
2. To design digital circuits using HDL.
3. Describe the various types of semiconductor memories and issues involved in them.
4. To Understand the concept of Physical Design.
5. To implement digital circuits using FPGA.
6. To design using CAD tools.

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

CO1: Describe the Fundamentals of CMOS Technology in Digital Domain &Explain the application of CMOS Technology.
CO2: Design an Advanced digital circuit using HDL.
CO3: Describe the concept of design of semiconductor memories.
CO4: Describe the concepts of Physical design Process such as floor planning, placement and routing.
CO5: Describe & Construct digital circuit using PLD & FPGA and Understand the importance of testability in chip design.
CO6: Illustrate the importance of CAD tools in VLSI Circuits.

Course Contents

Unit I	**Introduction to VLSI Circuits**	**(06 Hrs)**

MOS Transistors Theory: Structure and Operation of n-channel enhancement MOSFET, MOSFET Current-Voltage Characteristics, CMOS Inverter- DC Characteristics, Voltage Transfer Characteristics, Noise Margin, Power Dissipation: Static and Dynamic Dissipation, Combinational MOS Logic Circuits: Pass Transistors/Transmission Gates; Designing with transmission gates.

Mapping of Course Outcomes for Unit I	**CO1: Describe the Fundamentals of CMOS Technology in Digital Domain & Explain the application of CMOS Technology.**

Unit II	**Digital Circuit Design and testing using HDL**	**(06 Hrs)**

Module, Entity, Architecture, Modelling styles, Design of sequential circuits, asynchronous and synchronous design issues, state machine modelling (Moore and Mealy machines),attributes, Generics, Basic test benches, Test bench structure, constrained random stimulus generation.

Mapping of Course Outcomes for Unit II	**CO2: Design an Advanced digital circuit using HDL.**

Unit III	CMOS Subsystem Design	(06 Hrs)
Semiconductor memories, memory array organization, Random Access Memories (RAM), Static RAM (SRAM): 6T SRAM cell, sense amplifier, Dynamic RAM (DRAM), different DRAM cells, refresh circuits, timings.		
Mapping of Course Outcomes for Unit III	**CO3: Describe the concept of design of semiconductor memories.**	
Unit IV	**Floor Planning and Placement**	**(06 Hrs)**
Floor planning Methods: Chip-Level Physical Design, Block Placement and Channel Definition, Global Routing, Switchbox Routing, Interconnect Properties and Wiring Plans, Power Distribution, Clock Distribution, Packages, The I/O Architecture, Pad Design.		
Mapping of Course Outcomes for Unit IV	**CO4: Describe the concepts of Physical design Process such as floor planning, placement and routing.**	
Unit V	**Design and Verification with PLD's**	**(06 Hrs)**
Implementing Functions in FPGAs, Implementing Functions Using Shannon's Decomposition, Carry Chains in FPGAs, Cascade Chains in FPGAs, Examples of Logic Blocks in Commercial FPGAs, Dedicated Memory in FPGAs, Dedicated Multipliers in FPGAs, JTAG, Boundary scan, TAP Controller.		
Mapping of Course Outcomes for Unit V	**CO5: Describe & Construct digital circuit using PLD & FPGA and understand the importance of testability in chip design.**	
Unit VI	**CAD Tools**	**(06 Hrs)**
MOS Layers Stick/Layout Diagrams: Layout Design Rules, Issues of Scaling, Scaling factor for device parameters. Layout editors, Design rule checkers, circuit extractors – Hierarchical circuit extractors – Automatic layout tools, modeling and extraction of circuit parameters from physical layout.		
Mapping of Course Outcomes for Unit VI	**CO6: Illustrate the importance of CAD tools in VLSI Circuits.**	

Learning Resources

Text Books:

1. Neil H. Weste and Kamran, Principles of CMOS VLSI Design, Pearson Publication.
2. John F. Wakerly, Digital Design, Principles and Practices, Prentice Hall Publication.

Reference Books:

1. Wayne wolf, Modern VLSI Design - IP Based Design, Pearson Education, 4th Edition.
2. Sung-Mo (Steve) Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits, Tata McGraw
3. Hill Publication.
4. Charles Roth, Digital System Design using VHDL, McGraw Hill Publication.
5. Douglas Perry, VHDL, McGraw Hill Publication.
6. Samir Palnitkar, Verilog HDL 2/e, Pearson Education.
7. Preas, M. Lorenzatti, "Physical Design and Automation of VLSI Systems", The Benjamin
8. Cummins Publishers, 1998.
9. R. Jacob Baker; Harry W.Li., David E. Boyce, CMOS Circuit Design, Layout and Simulation, IEEE Press, Prentice Hall of India.
10. M.Ciletti, Advanced Digital Design with Verilog HDL, Second Edition Pearson Education.
11. Computer Aided Logical Design with Emphasis on VLSI – Hill & Peterson, Wiley, 1993.

MOOC / NPTEL Courses:

1. NPTEL Course on "**Advanced VLSI Design**"
Link: https://archive.nptel.ac.in/courses/117/101/117101004/
2. NPTEL Course on "**VLSI Physical Design**"
Link: https://nptel.ac.in/courses/106105161

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Savitribai Phule Pune University Final Year of Electronics Engineering (2019 Course) 404202 Advanced Power Electronics		
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. Power and Industrial Electronics

Companion Course, if any:
1. Lab Practice I

Course Objectives:
1. Study operation and implementation of dual converters, Multilevel Inverters and Cycloconverter.
2. Study and understand the operation of electric motor drives controlled from a power electronic converter and to introduce the design concepts of controllers for closed loop operation.
3. Specify appropriate power circuit configuration amongst the phase controlled rectifiers and Choppers for DC drive system, Induction motor drive and Special purpose motor drive.
4. To understand the role of Power Electronics in Solar and Wind power systems.

Course Outcomes: On completion of the course, learner will be able to
CO1: **Understand** operation of dual converters and power factor improvement techniques for controlled rectifiers.
CO2: **Understand** operation of Multilevel inverters & Cycloconverter.
CO3: **Select and Design** a suitable power converter to meet the demand of DC drive system.
CO4: **Select and Design** a suitable power converter to meet the demand of 3 phase induction motor drive.
CO5: **Understand** working of BLDC, Stepper, and Servo drive system.
CO6: **Recognize** role of Power Electronics in Solar and Wind Power System.

Course Contents

Unit I	**Dual Converters and Power factor improvement of converters**	**(06 Hrs)**

Single-phase and three-phase dual converters: Ideal and practical dual converter, control schemes for non-circulating current type dual converter.

Power factor improvement of converters: Phase angle control: EAC, SAC, PWM, sequence control of series converters, comparative evaluation of schemes.

Mapping of Course Outcomes for Unit I	**CO1: Understand operation of dual converters and power factor improvement techniques for controlled rectifiers.**

Unit II	**Multilevel Inverters and Cycloconverters**	**(06 Hrs)**

Cycloconverters: Single phase to single phase cycloconverters, three phase to Single phase cycloconverters, three phase to three phase cycloconverters.

Multilevel Inverters: Concept of multilevel inverter, Types of multilevel inverter: Diode clamped, Flying Capacitor and Cascade Multilevel inverters.

Mapping of Course Outcomes for Unit II	**CO2: Understand operation of Multilevel inverters & Cycloconverters.**

Unit III	DC Motor Drives	(06 Hrs)
Basic characteristics of DC motors, Operating modes, Motor performance parameters, 1ϕ & 3ϕ converter drives for separately excited DC motors for continuous & discontinuous operations, Chopper fed DC drives, Comparison of converter fed drive & chopper fed drive, Microprocessor based control of dc drives, Dynamic and regenerative braking of DC motors		
Mapping of Course Outcomes for Unit III	**CO3: Select and Design a suitable power converter to meet the demand of DC drive system.**	
Unit IV	**Induction Motor Drives**	**(06 Hrs)**
Induction motor Characteristics, Control strategies like stator voltage control, stator frequency control, v/f control, Variable frequency Square wave VSI Drives, Variable frequency SPWM VSI Drives ,Variable frequency CSI Drives , Open loop & closed loop control of 3 phase induction motor drive, Breaking of induction motor.		
Mapping of Course Outcomes for Unit IV	**CO4: Select and Design a suitable power converter to meet the demand of 3 phase induction motor drive.**	
Unit V	**Special Purpose Motor Drive**	**(06 Hrs)**
Brushless DC drives, Stepper motor drive, Servo motor drive, Switched reluctance motor drive, Synchronous reluctance motor drive.		
Mapping of Course Outcomes for Unit V	**CO5: Understand working of BLDC, Stepper, and Servo drive system.**	
Unit VI	**Solar and Wind power System**	**(06 Hrs)**
Solar Power System: PV characteristics, working of solar power system, Types of PV system: Stand-alone PV systems, Grid connected PV systems. Case study to implement solar power system: Selection of Solar panel, inverter, battery, charge controller, Metering of solar based system. **Wind Power System:** Working of wind power system, Types: Standalone wind energy systems, Grid connected wind energy systems, types of wind generator Control of wind turbines.		
Mapping of Course Outcomes for Unit VI	**CO6: Recognize the role of Power Electronics in Solar and Wind Power System.**	

Learning Resources

Text Books:

1. M H Rashid, “Power Electronics – circuits, devices and applications”, 3rd edition, Pearson Education.
2. Power Electronics, M.D. Singh & K.B.Khanchandani, TMH

Reference Books:

1. Ned Mohan, T. Undeland& W. Robbins, “Power Electronics Converters applications and design” 2nd edition, John Willey & sons, Singapore.
2. P.C. Sen, “Modern Power Electronics”, S Chand & Co New Delhi
3. Dr. P. S. Bimbhra, “Power Electronics”, Khanna Publishers, Delhi.
4. Nagrath Kothari, “Electrical Machines”, TMH. 5. M. H. Rashid, "Handbook of Power Electronics.

MOOC / NPTEL Courses:

1. NPTEL Course on Advance power electronics and Control, IIT Roorkee
https://nptel.ac.in/courses/108107128

2. NPTEL Course on Fundamentals of Electric drives
https://archive.nptel.ac.in/courses/108/104/108104140/

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Savitribai Phule Pune University Final Year of Electronics Engineering (2019 Course) 404203 Electronic System Design		
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. Microcontroller.

Companion Course, if any: Lab Practice I

Course Objectives:
1. To understand the stages of hardware system design and development.
2. To learn the different considerations of analog circuit design.
3. To learn the different considerations of digital circuit design.
4. To understand different approaches for development of application software for electronic product.
5. To be acquainted with methods & issues of PCB design of analog, digital & mixed signal circuits
6. To understand the need of environmental testing & different testing tools for fault finding of electronic products.

Course Outcomes: On completion of the course, learner will be able to
CO1: Understand various stages of hardware system design.
CO2: Interpret various specifications of component for design of analog systems.
CO3: Understand the selection criteria of microcontroller, various peripherals & buses/protocol used in digital systems
CO4: Discuss various approaches for development of application software for electronic product and various tools/techniques required for testing & debugging
CO5: Discuss PCB design practices for analog, digital & mixed signal circuits. Also explain EMI/EMC testing standards and compliance for PCB design.
CO6: Interpret the need of environmental testing & propose different testing tools for fault finding in electronic products.

Course Contents

Unit I	**Introduction**	**(06 Hrs)**
Stages in product design- Market survey, Product Specifications (Electrical, Mechanical, Environmental), R&D and Engineering Prototypes, Pilot Production Batch, Environmental testing, Documentation, Manufacturing. Electronic Products Classification: Consumer, Industrial and Military, their peculiarities in terms of Cost/performance ratio and Reliability. Case study of a typical Industrial Product. Reliability: Bath tub curve, Measures taken (at Component and Product level and various soldering techniques including Surface Mount Technology) to improve reliability.		
Mapping of Course Outcomes for Unit I	**CO1:Understand various stages of hardware system design**	
Unit II	**Hardware Design- Analog Circuits**	**(06 Hrs)**

Analog signal conditioning: Factors affecting choice of Op-Amps in signal conditioning, applications, Need for Instrumentation Amplifiers- Case study of an Instrumentation amplifier circuit designed using discrete components and special purpose IC. Error budget analysis with case study. Interpretation of ADC and DAC specifications from design point of view, considerations in selecting references (V_{ref} for ADC).		
Mapping of Course Outcomes for Unit II	**CO2:Interpret various specifications of component for design of analog systems**	
Unit III	**Hardware Design- Digital Circuits**	**(06 Hrs)**
Interfacing of LED,LCD, Keyboard, Relays, (Electromagnetic and Solid State),Sensors(temperature ,humidity, gas)with Microcontrollers. Comparative study of different Microcontroller architectures, Factors affecting choice of Microcontroller for particular application with case study of one application. Comparison of buses and protocols used in electronic products- I2C, SPI, CAN, LIN, and FlexRay.		
Mapping of Course Outcomes for Unit III	**CO3:Understand the selection criteria of microcontroller, various peripherals & buses/protocol used in digital systems.**	
Unit IV	**Software Design and Testing for Electronic Product**	**(06 Hrs)**
Different approaches for development of application software for Electronic Product. Assemblers, factors affecting choice between Assembly language and High level languages like C and C++. Documentation practices and templates for above software. Debugging tools and techniques for software- Features of Simulators, ICE, IDE.		
Mapping of Course Outcomes for Unit IV	**CO4: Discuss various approaches for development of application software for electronic product and various tools/techniques required for testing & debugging.**	
Unit V	**PCB Design and EMI/EMC**	**(06 Hrs)**
PCB Design practices for Analog and Mixed signal circuits: Ground Loops, Precision circuits, shielding and guarding. PCB Design Practices for High speed digital circuits, Signal integrity and EMC, EMI/EMC testing standards and compliance for PCB design		
Mapping of Course Outcomes for Unit V	**CO5:Discuss PCB design practices for analog , digital & mixed signal circuits. Also explain EMI/EMC testing standards and compliance for PCB design**	

Unit VI	**Fault Finding and Testing**	**(06 Hrs)**
Analysis- DC/ Operating Point Analysis, AC (Frequency Response), Transient, Sensitivity, Monte Carlo. Debugging/Fault finding- Features and limitations of DSO, Spectrum analyzer, Logic Analyzer and Mixed Signal Oscilloscopes in finding hardware/software faults. Environmental Testing: Need for Environmental Testing. Temperature, Humidity, Vibration and Shock tests.		
Mapping of Course Outcomes for Unit VI	**CO6:Interpret the need of environmental testing & propose different testing tools for fault finding in electronic products.**	

Learning Resources

Text Books:

1. Bernhard E. Bürdek, History, Theory and Practice of Product Design, Springer Science, 2005.
2. Paul Horowitz, Art of Electronics, Cambridge University Press.

Reference Books:

1. Howard Johnson, Martin Graham, High-speed Digital design- A Handbook of Black Magic, Prentice Hall Publication.
2. G. Pahl and W. Beitz J. Feldhusen and K.-H. Grote, Engineering Design – A Systematic Approach_, Springer, 2007.
3. Tim Williams, EMC for Product Designers, Elsevier, Fourth edition 2007
4. Jerry C Whitaker, The Electronics Handbook, CRC Press, IEEE Press, ISBN 0- 8493- 8345-
5. David Bailey, Practical Radio Engineering and Telemetry for Industry, Elsevier, ISBN 07506 58037.
6. Pressman, Software Engineering - A Practitioner's Approach.
7. David Bailey, Practical Radio Engineering & Telemetry for Industry, Elsevier, ISBN 07506 58037.
8. Domine Lenders, Johan van der Tang, Cicero S. Vaucher, Circuit Design for RF Transceivers, Kluwer Academic Publishers, 2003.

MOOC / NPTEL Courses:

1. NPTEL Course “Circuits for Analog System Design, ” https://nptel.ac.in/courses/117108038
2. NPTEL Course “Sensors and Actuators” https://nptel.ac.in/courses/108108147

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Savitribai Phule Pune University
Final Year of Electronics Engineering (2019 Course)
404184 (A) Speech Processing* (Elective III)
(Subject common with BE E&TC (2019 Course)

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

Companion Course, if any:
1. Lab Practice – II

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	(06 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.	(06 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**	**(06 Hrs)**
Basic principles of linear predictive analysis, Linear prediction of speech, auto correlation, formulationof 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**	**(06 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**	**(06 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**	**(06 Hrs)**
Comparisonofspeechprocessingapplications**AutomaticSpeechRecognition**and**SpeechSynthesis-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” 1stEdition 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. UdayKamath, 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

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Savitribai Phule Pune University Final Year of Electronics Engineering (2019 Course) 404204 (A) Internet of Things (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. **Embedded Processor**
2. **Microcontroller**

Companion Course, if any:
1. Lab Practice II

Course Objectives:
1. Introduction to different aspects of the IoT, including end devices, networks, programming, and security and privacy implications.
2. Understand protocols used for IoT design solution.
3. To understand concept of WSN and cloud computing
4. To understand the Arduino and Raspberry Pi and their application in IoT
5. To learn real world application scenarios of IoT along with its societal and economic impact using case studies.

Course Outcomes: On completion of the course, learner will be able to
CO1: Demonstrate and identify building blocks of Internet of things.
CO2: Identify and analyze Internet of Things protocol and security for various applications.
CO3: Identify, analyze challenges of WSN and cloud computing in IoT.
CO4: Develop interface of sensors and actuators with Arduino and Raspberry Pi and develop the program for the same
CO5: Demonstrate Big data architecture and identify components of Big Data Solution.
CO6:Apply the knowledge and skills to design and develop basic IoT applications on embedded platform.

Course Contents

Unit I	**Fundamentals of Embedded System and IOT**	**(06 Hrs.)**
Introduction to Embedded System, Characteristics, Introduction to Internet of Things and its architecture, Emerging Trends, Economic Significance, Technical Building Blocks, Physical design of IoT, Logical design of IoT, Sensors and actuators, Introduction to IOT networking: Gateways and routing, IoT enabling technologies, IoT Issues and Challenges, Applications.		
Mapping of Course Outcomes for Unit I	**CO1: Demonstrate and identify building blocks of Internet of things.**	
Unit II	**IoT Protocols and Security**	**(06 Hrs.)**
SCADA and RFID Protocols, IEEE 802.15.4, BAC Net Protocol, Modbus, HART, Zigbee, MQTT, IoT Security and privacy: Security Requirements, Challenges for Secure IoT, Key elements of IoT Security: Identity establishment, Access control, Data and message security, Security model for IoT.		
Mapping of Course Outcomes for Unit II	**CO2: Identify and analyze Internet of Things protocol and security for various applications..**	
Unit III	**WSN & Cloud Computing**	**(07 Hrs.)**

WSN: introduction to WSN technology, Basic components of WSN, Characteristic features of WSNs, challenges, Application of WSN in: smart homes, healthcare, intelligent transportation, agriculture, etc.

Cloud Computing: Cloud architecture standards and interoperability, Business concerns in the cloud, characteristics, Cloud types; IaaS, PaaS, SaaS, Public cloud, Private cloud, Benefits and challenges of cloud computing, Development environments for service: Amazon, Azure, Thingspeak, Google App-cloud platform in industry (Features and services provided).

Mapping of Course Outcomes for Unit III	**CO3: Identify, analyze challenges of WSN and cloud computing in IoT.**

Unit IV	**Implementation of IoT**	**(08 Hrs.)**

Implementation of IoT with Arduino: Introduction to Arduino, Arduino board overview, Programming environment, Arduino UNO board, Interfacing LED, LDR, LM 35, DC motor, Ultrasonic sensor and DHT 11 with Arduino, Sending data to Cloud, analysis using any IoT platform. Introduction to Raspberry Pi, Raspberry Pi board overview, Programming environment, introduction to python programming, Simple assignments/programs using Raspberry Pi, interfacing of LED, ultrasonic sensor with Raspberry Pi, Sending data to cloud, analysis of data using any IoT platform.

Mapping of Course Outcomes for Unit IV	**CO4: Develop interface of sensors and actuators with Arduino and Raspberry Pi and develop the program for the same**

Unit V	**Big Data - Data Storage and Analytics**	**(06 Hrs.)**

Types of data,What is Big Data (BD), Characteristics of Big data, Main components of Big Data Solution, Basic Architecture of BD Solution, Introduction to Hadoop, Introduction to data Analytics, Types of Data analytics, Statistical Models, Analysis of Variance, Data Dispersion, Contingence and Correlation, Regression Analysis, Precision and Error limits.

Mapping of Course Outcomes for Unit V	**CO5: Demonstrate Big data architecture and identify components of Big Data Solution.**

Unit VI	**Technological Aggregation & Applications of IoT**	**(06 Hrs.)**

Modern trends in IOT: Wearable, industrial standards. Case studies using IoTs, connected use cases in Real-life and smart cities, Case studies: Greenhouse monitoring, smart health care monitoring, smart home automation, smart car parking, Smart Agriculture Monitoring, air pollution monitoring, smart industrial automation.

Mapping of Course Outcomes for Unit VI	**CO6: Apply the knowledge and skills to design and develop basic IoT applications on embedded platform.**

Learning Resources

Text Books:

1. Hakima Chaouchi, The Internet of Things Connecting Objects to the Web, Wiley Publications,1st Edition
2. Olivier Hersent, David Boswarthick, and Omar Elloumi ,"The Internet of Things: Key Applications and Protocols", Wiley Publications, 1st Edition
3. Internet of Things (A Hands-on-Approach), "Vijay Madisetti and Arshdeep Bahga", VPT, 1st Edition
4. ArshdeepBahga, Vijay Madisetti,, Internet of Things, A hands-on approach, Universities Press
5. Honbo Zhou, The Internet of Things in the Cloud: A Middleware Perspective, CRC Press, 2012

Reference Books:

1. David Easley and Jon Kleinberg, Networks, Crowds, and Markets: Reasoning About a Highly Connected World, Cambridge University Press, 2010

2. Lyla B. Das, Embedded Systems: An Integrated Approach, Pearson
3. Dieter Uckelmann, Mark Harrison, Florian Michahelles, Architecting the Internet of Things, Springer, 2011
4. Olivier Hersent, Omar Elloumi and David Boswarthick, The Internet of Things: Applications to the Smart Grid and Building Automation, Wiley, 2012
5. Barrie Sosinsky, Cloud Computing Bible, Wiley-India, 2010.
6. Adrian McEwen, Hakim Cassimally, Designing the Internet of Things, Wiley, 2014
7. Pethuru Raj and Anupama C. Raman "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press

MOOC / NPTEL Courses:

1. NPTEL course on Introduction To Internet of Things By Prof. SudipMisra , IIT Kharagpur https://onlinecourses.nptel.ac.in/noc22_cs53/preview

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Savitribai Phule Pune University Final Year of Electronics Engineering (2019 Course) 404204 (B) Software Defined Radio(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. Principles of Communication Systems

Companion Course, if any:
1. Lab Practice II

Course Objectives:
1. The course gives students knowledge of fundamental and state-of the-art concepts in software-defined radio.
2. Learn the design of the wireless networks based on the cognitive radios
3. Understand the concepts of wireless networks and next generation network

Course Outcomes: On completion of the course, learner will be able to
CO1: Describe the basics of the software defined radios.
CO2: Define different terminologies of Software defined radio.
CO3: Describe an ability to implement modern wireless system such as systems based on OFDM
CO4: Design the wireless networks based on the cognitive radios.
CO5: Define cognitive radio architecture.
CO6: Explain the benefits and application of cognitive radio.

Course Contents

Unit I	**Introduction to Software Defined Radio**	**(06 Hrs)**
Definitions and potential benefits, software radio architecture evolution, technology tradeoffs and architecture implications.		
Mapping of Course Outcomes for Unit I	**CO1: Describe the basics of the software defined radios**	
Unit II	**SDR Architecture**	**(06 Hrs)**
Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, software architecture, top level component interfaces, interface topologies among plug and play modules.		
Mapping of Course Outcomes for Unit II	**CO2: Define different terminologies of Software defined radio.**	
Unit III	**Multi Rate Signal Processing**	**(06 Hrs)**
Sample timing algorithms, Frequency offset estimation and correction, Channel Estimation, Basics of Multi Rate, Multi Rate DSP, Multi Rate Algorithm, DSP techniques in SDR, OFDM in SDR		
Mapping of Course Outcomes for Unit III	**CO3: Describe an ability to implement modern wireless system such as systems based on OFDM**	

Unit IV	Introduction to Cognitive Radios	(06 Hrs)
Defining CR: History, Applications and Related Concepts, A Brief History of Elastic Spectrum Management,A View of Wireless Network Futurists, Ambiguity in CR Definitions, Definition of Cognitive Radio Network, Spectrum Management, Computational Platforms. CR Terminology Standardization - IEEE 1900.1,IEEE 1900.2, IEEE 1900.3, IEEE 1900.4, IEEE 1900.5,IEEE 1900.6, Related Standardization Efforts		
Mapping of Course Outcomes for Unit IV	**CO4: Design the wireless networks based on the cognitive radios**	
Unit V	**Cognitive Radio Architecture**	**(06 Hrs)**
Cognitive Radio network architecture– Resource manager frame work, architecture for spectrum sensing, network optimization through utilities , Value of Perfect Information ,Policy Support as a Part of the Architecture ,Spectrum Brokering Services Information Modeling, Topology Aware CRN Architectures - Statistical Characterization of Node Locations, Spatial Statistics of Spectrum Usage, Publish-Subscribe CRN Architecture.		
Mapping of Course Outcomes for Unit V	**CO5: Define cognitive radio architecture**	
Unit VI	**Public safety and cognitive radio**	**(06 Hrs)**
Introduction - Requirements, Commercial Wireless Communication Networks, Economic Value of the Spectrum, Benefits of Cognitive Radio. Standards for Public Safety Communication-TETRA ,C2000 Applications of Cognitive Radio – Disaster management, Bandwidth Requirements ,Spectrum Organization , Propagation Conditions White Space Assessment , System Spectral Efficiency, Anti-jamming .		
Mapping of Course Outcomes for Unit VI	**CO6: Explain the benefits and application of cognitive radio**	

Learning Resources

Text Books:

1. Jeffrey.H.Reed ,Software Radio : A Modern Approach to Radio Engineering , Pearson , LPE
2. Simon Haykin, “Cognitive Radio: Brain –Empowered Wireless Communications”, IEEE Journal on selected areas in communications, Feb 2005

Reference Books:

1. Markus Dillinger , Kambiz Madani ,Nancy Alonistioti, Software Defined Radio : Architectures , Systems and Functions ,Wiley
2. Tony .J. Rouphael , RF and DSP for SDR, Elsevier Newness Press ,2008
3. Dr. Taj Struman ,Evaluation of SDR –Main Document
4. SDR –Handbook , 8th Edition , PENTEK
5. Bruce a. Fette , Cognitive Radio Technology, Newness, Elsevier

MOOC / NPTEL Courses:

NPTEL course on Basics of software defined Radios and Practical Applications By Prof. MeenakshiRawat, IIT Roorkee
https://onlinecourses.nptel.ac.in/noc21_ee95/preview

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Savitribai Phule Pune University Final Year of Electronics Engineering (2019 Course) 404204 (C) Testing and verification for SOC design (Elective III)		
Teaching Scheme:	**Credit:03**	**Examination Scheme:**
Theory: 3Hrs/week		**In-Sem (Theory): 30 Marks** **End Sem (Theory): 70 Marks**

Prerequisite Courses, if any:
1.VLSI Design

Companion Course, if any:
1. Lab Practice II

Course Objectives:

- To introduce design process in VLSI
- To understand the logical and Fault simulation models
- To learn techniques for design of testability
- To study hardware and software verification issues for testing

Course Outcomes: On completion of the course, learner will be able to
CO1: Accept challenges in VLSI Testing at different abstraction levels
CO2: Understand fault models for generation of test vectors.
CO3: Calculate observability and controllability parameters of circuit
CO4: Enhance testability of a circuit.
CO5: Use simulation techniques for designing and testing of VLSI circuits
CO6: Identify characteristics of verification methods.

Course Contents

Unit I	**Introduction to Testing**	**(6Hrs)**
Testing Philosophy, Role of Testing , Digital and Analog VLSI Testing, VLSI Technology Trends Affecting Testing, VLSI testing process and test equipment: How to Test Chips?, Automatic Test Equipment, Electrical Parametric Testing		
Mapping of Course Outcomes for Unit I	**CO1: Accept challenges in VLSI Testing at different abstraction levels**	
Unit II	**Fault Modeling**	**(7Hrs)**
Defects, Errors, and Faults, Functional Versus Structural Testing, Levels of Fault Models, A Glossary of Fault Models, Single Stuck-at Fault		
Mapping of Course Outcomes for Unit II	**CO2: Understand fault models for generation of test vectors.**	
Unit III	**Logic and Fault Simulation**	**(7Hrs)**
Simulation for Design Verification, Simulation for Test Evaluation, Modeling Circuits for Simulation, Algorithms for True-Value Simulation , Algorithms for Fault Simulation, Statistical Methods for Fault Simulation		
Mapping of Course Outcomes for Unit III	**CO3: Calculate observability and controllability parameters of circuit**	
Unit IV	**Combinational & Sequential Circuit Test Generation**	**(6Hrs)**

Algorithms and Representations, Redundancy Identification, Testing as a Global Problem, Significant Combinational ATPG Algorithms, Simulation-Based Sequential Circuit ATPG		
Mapping of Course Outcomes for Unit IV	**CO4: Enhance testability of a circuit.**	
Unit V	**Digital DFT and scan design**	**(6Hrs)**
Ad-Hoc DFT Methods, Scan Design, Partial-Scan Design, Variations of Scan, Random Logic BIST		
Mapping of Course Outcomes for Unit V	**CO5: Use simulation techniques for designing and testing of VLSI circuits**	
Unit VI	**Boundary Scan Standard**	**(7Hrs)**
Memory BIST, Motivation, System Configuration with Boundary Scan, Boundary Scan Description Language		
Mapping of Course Outcomes for Unit VI	**CO6: Identify characteristics of verification methods.**	

Learning Resources

Text Books:

1. M. L. Bushnell and V.D. Agrawal, Essentials of Electronic Testing for Digital Memory and Mixed Signal VLSI Circuits, Springer, 2005
2. M. Abramovici, M. Breuer, and A. Friedman, Digital System Testing and Testable Design, IEEE Press, 1994

Reference Books:

1. H. Fujiwara, Logic Testing and Design for Testability, MIT Press, 1985
2. M. Huth and M. Ryan, Logic in Computer Science, Cambridge Univ. Press, 2004
3. T. Kropf, Introduction to Formal Hardware Verification, Springer Verlag, 2000

MOOC / NPTEL Courses:

1. NPTEL Course “VLSI Design Verification and test”, Dr. Santosh Biswas, Prof. Jatindra Kumar Deka, Prof. Arnabsarkar, IIT Guwahati.
   Link of the Course:https://nptel.ac.in/courses/117103125

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Savitribai Phule Pune University
Final Year of Electronics Engineering (2019 Course)
404184 (C) Java Script* (Elective III)
(Subject common with BE E&TC (2019 Course)

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. Advanced Java Programming

Companion Course, if any:
1. Lab Practice II

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	(06 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	(06 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 type of 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**	**(06 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**	**(06 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**	**(06 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**	**(06 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:

3. Jon Duckett, "JavaScript & J Query: Interactive Front-End Web Development", John Wiley & Sons.
4. David Flanagan, "JavaScript: The Definitive Guide", 7th Edition, O'Reilly Media.
5. Mike Mackgrath, "Java scripts 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/

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Savitribai Phule Pune University Final Year of Electronics Engineering (2019 Course) 404205 (A) Mobile Communication (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. Analog Communication
2. Digital Communication

Companion Course, if any:

Course Objectives:
1. To introduce the concepts and techniques associated with wireless cellular communication systems.
2. To give an exposure to students of various techniques used for modulation, equalization,• diversity, coding & multiple access in cellular communication system.
3. To familiarize with state of art systems•& standards used in wireless cellular systems.

Course Outcomes: On completion of the course, learner will be able to
CO1: Understand the fundamentals of cellular system & radio propagation.
CO2: Design mobile communication system by appropriately selecting necessary techniques.
CO3: Analyse different wireless networking & communication systems & standards.

Course Contents

Unit I	Fundamentals of Wireless Communication	(06 Hrs)
Evolution of mobile radio communication, Examples of mobile radio system, Overview of 2G, 2.5G, 3G ,4G ,5Gwireless networks, Cellular fundamentals: frequency reuse, channel assignment strategies, handoff strategies, Interference & system capacity, Trunking & grade of service, Techniques of improving coverage & capacity of cellular system.		
Mapping of Course Outcomes for Unit I	**CO1: Understand the fundamentals of cellular system & radio propagation**	
Unit II	**Mobile Radio Propagation**	**(06 Hrs)**
Radio wave propagation, Free space propagation model, Propagation mechanisms: reflection, ground reflection model, diffraction, scattering. Small scale multipath propagation, Impulse response model of multipath channel, Small scale multipath measurements, Parameters of mobile multipath channels, Types of small scale fading.		
Mapping of Course Outcomes for Unit II	**CO1: Understand the fundamentals of cellular system & radio propagation.**	
Unit III	**Modulation, Equalization & Diversity Techniques**	**(06 Hrs)**
Linear modulation techniques, Constant envelope modulation techniques, Combined linear & constant envelope modulation techniques, Spread spectrum modulation techniques. Equalization: fundamentals, training & survey of equalization techniques, Linear & Nonlinear Equalization, Algorithms for Adaptive Equalization, Fractionally spaced equalizers, Diversity Techniques, RAKE receiver, Interleaving.		
Mapping of Course Outcomes for Unit III	**CO2: Design mobile communication system by appropriately selecting necessary techniques.**	

Unit IV	First and Second Generation Mobile Systems	(06 Hrs)
First Generation Cellular Systems, AMPS, GSM Cellular Telephony: Introduction, Basic GSM Architecture, Basic radio transmission parameters in GSM system, Logical Channels GSM time hierarchy, GSM burst structure, Description of call setup procedure, Handover, Modifications and derivatives of GSM.		
Mapping of Course Outcomes for Unit IV	**CO3: Analyse different wireless networking & communication systems & standards.**	
Unit V	**Third and fourth Generation Mobile Systems**	**(06 Hrs)**
3G Wireless Standards: CDMA2000: Overview, Radio & Network Components, Network Structure, Packet - Data Transport Process Flow, Radio Network, EVDO, BCMCS, EVDV, CDMA Channel Allocation.TD-CDMA: Overview, Generic Architecture, Core Network, Radio Network, Interference – Mitigation Techniques, RAN Traffic Planning, Handover, Implementation TD-SCDMA: Overview, Generic Architecture, Core Network, Radio Network, Interference – Mitigation Techniques, RAN Traffic Planning, Handover, Implementation. 4G Wireless Standards- LTE: Network Architecture and Interfaces, FDD Air Interface and Radio Network, TD-LTE Air Interface, Scheduling , Mobility Management and Power Optimization, LTE Security Architecture Overview of WiMAX.		
Mapping of Course Outcomes for Unit V	**CO3: Analyse different wireless networking & communication systems &standards.**	
Unit VI	**Wireless Networking**	**(06 Hrs)**
Wireless Networks: Introduction, Development, Fixed network transmission hierarchy, Traffic routing in wireless networks, Wireless data services, Common channel signalling , ISDN, SS7, PCS/PCN, Protocols for network access, Network databases, UMTS.		
Mapping of Course Outcomes for Unit VI	**CO3: Analyse different wireless networking & communication systems & standards.**	

Learning Resources

Text Books:

1. T. S. Rappaport, “Wireless Communications: Principles & Practice” Second Edition, Pearson Education.
2. A. Goldsmith, “Wireless Communications”, First Edition, Cambridge University Press.

Reference Books:

1. A. F. Molisch, “Wireless Communications”, Second Edition, Wiley India. 2. W. C. Y. Lee, “Wireless and Cellular Telecommunications”, Third Edition, Tata McGrawHill Education. 3.Clint Smith, P. E. Daniel Collins ,”3G Wireless Networks” ,Second Edition, Tata Mc-Graw Hill 4. Martin Sauter From ,”GSM To LTE: An Introduction To Mobile Networks And Mobile Broadband”, First Edition, Wiley

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Savitribai Phule Pune University Final Year of Electronics Engineering (2019 Course) 404202 (B) Embedded Systems (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. Microcontroller and Applications
2. Embedded Processor & Applications

Companion Course, if any:

Course Objectives:
1. To understand embedded system ,its design metrics and architecture
2. To learn real time operating system concepts
3. To understand the Embedded Linux environment
4. To apply concept RTOS for different embedded system application

Course Outcomes: On completion of the course, learner will be able to
CO1: Define, classify embedded systems and understand its design metrics
CO2:Explain the hardware/software architecture, development and testing tools of embedded system
CO3: Understand Real time operating systems concepts.
CO4: Compare and Analysis different Real time operating system.
CO5: Understand the embedded systems design, management, action plan and testing steps.
CO6: Understand applications of different embedded RTOS system

Course Contents

Unit I	Introduction to Embedded Systems	(06 Hrs)
Introduction to Embedded Systems, Application areas, Categories of Embedded systems, Overview of embedded system architecture, Classification and Characteristics of Embedded System, Design Process, Design Metrics and optimization of various parameters of embedded system. Recent trends in embedded systems.		
Mapping of Course Outcomes for Unit I	**CO1: Define, classify embedded systems and understand its design metrics**	
Unit II	**Architecture of Embedded Systems**	**(06 Hrs)**
Hardware Architecture, in detail, Software architecture, Application software, Communication Software,- TCP/IP protocol suit, Process of generating Executable image, Hardware and software Development/Testing tools. Embedded processor technology, IC technology, Design technology. Software development life cycle.		
Mapping of Course Outcomes for Unit II	**CO2: Explain the hardware/software architecture, development and testing tools of embedded system**	

Unit III	RTOS Concepts	(06 Hrs)
Architecture of Kernel, Foreground and background systems, Critical Session, Shared resources, Tasks and Task scheduler, Multitasking, Context switching, Pre-emptive and non-preemptive Schedulers, Semaphore, Mutex, Mutual exclusion, Mailbox, Message queue, Event Register, Pipes, Signals, Timers, Priority inversion problems, Inter task communication mechanisms, Interrupts: ISR, Latency, Response and Recovery, Clock Tick, Memory management.		
Mapping of Course Outcomes for Unit III	**CO3: Understand Real time operating systems concepts.**	
Unit IV	**Overview of Embedded / RTOS**	**(06 Hrs)**
Difference between OS and RTOS, Types of RTOS, Selection criteria for RTOS, Embedded Operating System: Embedded Linux, overview, advantages, disadvantages. Real Time Operating Systems: QNX Neutrino, VxWorks, MicroC/OS, features, advantages, disadvantages. Comparison of given Embedded / RTOS.		
Mapping of Course Outcomes for Unit IV	**CO4:Compare and Analysis different Real time operating system.**	
Unit V	**Hardware-Software Co-design in an Embedded System**	**(06 Hrs)**
Embedded System Project Management. Design and Co-design issues in the development Process of Embedded System. Design cycle in the Development Phase of Embedded System, Use of Emulator and In Circuit Emulator (ICE), Scopes and Logic Analyzer. Use of Software tools for development of an Embedded System		
Mapping of Course Outcomes for Unit V	**CO5: Understand the embedded systems design, management, action plan and testing steps.**	
Unit VI	**Case Studies of Programming with RTOS**	**(06 Hrs)**
Case study of Coding steps for an Automatic Chocolate Vending Machine, Case study of Coding steps for transmission of stream on a TCP/IP Network using RTOS, Case study of Coding steps for Adaptive Cruise Control System in a car, Case study of Coding steps for Smart Card.		
Mapping of Course Outcomes for Unit VI	**CO6:Understand applications of different embedded RTOS 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:

3. Dr. K.V.K.K. Prasad “Embedded / Real Time Systems Programming Black Book” Dreamtech Press
4. Frank Vahid and Tony Givargis, “Embedded System Design – A Unified hardware/ Software introduction” 3rd edition, Wiley.

MOOC / NPTEL Courses:

1. “Embedded Systems Design”, Prof. Anupam Basu, IIT Kharagpur
https://nptel.ac.in/courses/106105159

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Savitribai Phule Pune University Final Year of Electronics Engineering (2019 Course) 404205(C) Optimization Techniques (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. Linear Algebra and Probability

Companion Course, if any:

Course Objectives:
To study basic concept of optimization technique and problems.
To understand classical optimization techniques.
To solve problems on linear programming and non-linear programming.
To study various algorithms for solving optimization techniques problems.

Course Outcomes: On completion of the course, learner will be able to
CO1: Understand basic concept of optimization technique and problems.
CO2:Understand classical optimization techniques.
CO3:Solve problems on linear programming and non-linear programming.
CO4:Analyze various algorithms for solving optimization techniques problems.

Course Contents

Unit I	**Introduction to Optimization**	**(06 Hrs)**
Motivation, mathematical review, Basic Concepts of Optimization-Convex and Concave Functions, Necessary and sufficient conditions for Stationary Points, Formulation of Various Optimization Problems, Classification of optimization problems.		
Mapping of Course Outcomes for Unit I	**CO1: Understand basic concept of optimization technique and problems.**	
Unit II	**Classical optimization Techniques**	**(06 Hrs)**
Optimization of one-dimensional Functions, Multivariable Optimization with no constraints: semi defined case, saddle point, Multivariable Optimization with equality constraints: Solution by direct substitution, solution by method of constrained variation. Multivariable Optimization with inequality constraints: Kuhn-Tucker conditions.		
Mapping of Course Outcomes for Unit II	**CO2: Understand classical optimization techniques.**	
Unit III	**Linear Programming**	**(06 Hrs)**
Standard form of Linear Programming problem, Definitions and theorems, Solution of a linear simultaneous equation, Pivotal reduction of general system of equation, Simplex algorithm: Identifying an optimal point, improving a non optimal basic feasible solution.		
Mapping of Course Outcomes for Unit III	**CO3: Solve problems on linear programming and non-linear programming.**	

Unit IV	Nonlinear Programming I	(06 Hrs)
One dimensional minimization methods: Elimination Methods, Unrestricted search, Exhaustive search, Dichotomous search, interval halving method. Interpolation methods: Quadratic interpolation, Cubic interpolation. Direct root method: Newton's method, Quasi Newton's method, Secant Method.		
Mapping of Course Outcomes for Unit IV	**CO3: Solve problems on linear programming and non-linear programming.**	
Unit V	**Nonlinear Programming II**	**(06 Hrs)**
Unconstrained optimization Techniques: Direct Search Methods, Random Search, Grid Search, Univariate search, Powell‟s method. Indirect Search: Gradient of a function, steepest descent method, Conjugate gradient Method		
Mapping of Course Outcomes for Unit V	**CO3: Solve problems on linear programming and non-linear programming.**	
Unit VI	**Nonlinear Programming III**	**(06 Hrs)**
Constrained optimization Techniques: Necessary and Sufficient Conditions for Constrained Optimum, Quadratic Programming, Generalized Reduced Gradient Method.		
Mapping of Course Outcomes for Unit VI	**CO3: Solve problems on linear programming and non-linear programming.**	

Learning Resources

Text Books:

1 Singiresu S. Rao, “Engineering Optimization- Theory and Practice” Fourth Edition, 2009 by John Wiley & Sons, Inc.

2 G.V.Rekllaitis, A.Ravindran, Schechter and K.M.Ragsdell, "Engineering OptimizationMethods and Applications", John Wiley, New York (1983)

Reference Books:

1. Hadley, G. ―Linear programming‖, Narosa Publishing House, New Delhi.

2.Ashok D Belegundu, Tirupathi R Chandrupatla, ―Optimization concepts and Application inEngineering‖, Pearson Education.

3. KantiSwarup, P.K.Gupta and Man Mohan, Operations Research, Sultan Chand and Sons.

4. J. S. Arora, Introduction to Optimum Design, McGraw-Hill Book Company.

5. David Lay, Steven L Lay, ―Linear Algebra and its Applications‖, Pearson Education.

6. Papalambros& Wilde, Principles of Optimal Design, Cambridge University Press, 2008

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Savitribai Phule Pune University
Final Year of Electronics Engineering (2019 Course)
404185 (D): Low Power CMOS* (Elective - IV)
(Subject common with BE E&TC (2019 Course)

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 andReorganization, 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

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Savitribai Phule Pune University
Final Year of Electronics Engineering (2019 Course)
404185 (E) Smart Antennas* (Elective IV)
(Subject common with BE E&TC (2019 Course)

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 and Field Theory

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	(08Hrs)
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**	**(06 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	(08Hrs)
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**	**(06 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**	**(06 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**	**(06 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”, 4 th 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, HuiZhao ,KanZheng, Wei Xiang,“Massive MIMO in 5G Networks: Selected Applications”, Springer.
5. Jian Li and PetreStoica,“ Robust adaptive Beamforming”, John Wiley.

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Savitribai Phule Pune University Final Year of Electronics Engineering (2019 Course) 404206 Lab Practice –I (APE+ESD)		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 04 hrs. / week	**02**	**Oral: 50 Marks**

Advanced Power Electronics	
List of Laboratory Experiments	
[Any 8 to be performed]	
1.	Dual converter (Single phase/ Three phase)
2.	Power Factor improvement techniques for single phase converters (SAC, EAC, PWM)
3.	Study of 1 phase to 1 phase/ 3 phase to 1 phase Cycloconverter
4.	Feedback Controlled DC Motor Drive.
5.	Chopper fed 4-Quadrant reversible DC drive.
6.	Microcontroller based DC drive.
7.	V/F controlled three phase induction motor drive.
8.	Stepper motor drive.
9.	Servo motor drive.
10.	BLDC motor drive.
11.	Simulation of closed loop controlled DC drive using PSIM/MATLAB.
12.	Simulation of three phase induction motor drive using PSIM / MATLAB/ MathCad
13.	Wind Power System
14.	Solar Power System.

Electronic System Design	
List of Laboratory Experiments	
[Any 8 to be performed]	
1.	Design and implement low dropout regulated power supply (Estimation of current requirement)
2.	Design of SPAN ZERO circuit.
3.	Design and implement Transducer interface using Wheatstone bridge.
4.	Study of Error budget analysis of instrumentation amplifier or any other complicated circuit using ADC/ DAC.
5.	Design Data Acquisition System (DAS) using appropriate Microcontroller.
6.	PCB Design for Mixed Signal Circuit (Involving ADC and Signal Conditioning). Test the circuit using MSO.
7.	DC and AC analysis of given circuit.
8.	Sensitivity analysis for given circuit.
9.	Reliability calculations from given data.
10.	Visit to product based industry to study various processes.

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Savitribai Phule Pune University Final Year of Electronics Engineering (2019 Course) 404207 Lab Practice II		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical:04 Hrs./Week	**02**	**TermWork:25Marks** **Practical: 50Marks**

VLSI Design	
List of Laboratory Experiments (Perform any four experiments from each group)	
Part- A Modelling and Functional Simulation, synthesis and implementation on PLDs of the following digital circuits (with Xilinx/ ModelSim tools/Pyxis) using VHDL/Verilog Hardware Description Languages.(Two experiments are to be performed using VHDL and two using Verilog.)	
1.	Parity generator
2.	Cyclic Encoder / Decoder
3.	Read Only Memory (ROM)/ Random Access Memory (RAM) implementation
4.	Mealy State Machine/Moore State Machine-examples
5.	Arithmetic Multipliers using FSMs
6.	Digital calculator
PART-B Experiments shall be carried out using Mentor Graphics/Cadence Tools/Microwind.	
Schematic Entry/ Simulation / Layout/ DRC/PEX/Post Layout Simulation of:	
1.	CMOS Inverter
2.	NAND Gate/ OR Gate
3.	2:1 Multiplexer
4.	D- Latch / Flip Flop
5.	Single bit SRAM Cell

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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 (Any7 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 narrowband and wideband spectrogram. Comment on the time and frequency resolution of wideband and narrowband 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 rolloff.
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).

VirtualLab:

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/

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Internet of Things (Elective - III)	
List of Laboratory Experiments	
Group A (Perform any 5 experiments from group A)	
1.	Interfacing of LED with Arduino and program for blinking LED.
2.	Interfacing touch sensor, LDR, Gas sensor with Arduino board and program for the same.
3.	Interfacing of DC motor with Arduino and program for speed control of dc motor using PWM.
4.	Interfacing of Interfacing of 16x2 LCD with Arduino board for display of message or information.
5.	Interfacing temperature sensor LM35 with Arduino board and program to display temperature.
6.	Interfacing IR sensor with Arduino board and program to turn on buzzer when intruder detected.
7.	Wireless communication between Arduino and PC using Bluetooth protocol.
8.	Interfacing Wifi module with Arduino.
9.	Interfacing Xbee module with Arduino.
Group B (Perform any 4 from Group B)	
10.	Study of different operating systems for Raspberry-Pi /Beagle board. Understanding the process of OS installation on Raspberry-Pi /Beagle board.
11	Study of Connectivity and configuration of Raspberry-Pi /Beagle board circuit with basic peripherals, LEDS. Understanding GPIO and its use in program.
12	Understanding the connectivity of Raspberry-Pi /Beagle board circuit with ultrasonic sensor. Write an application program of for measurement of distance.
13	Understanding the connectivity of Raspberry-Pi /Beagle board circuit with IR sensor. Write an application to detect obstacle and notify user using LEDs.
14	Understanding GPIO and its use in program. Interface buzzer using relay with Raspberry-Pi /Beagle board. Write an application to turn ON/OFF buzzer with certain delay.
15	Understanding and connectivity of Raspberry-Pi /Beagle board with a Zigbee module. Write a network application for communication between two devices using Zigbee.
16	Write a server application to be deployed on Raspberry-Pi /Beagle board. Write client applications to get services from the server application.
Group C (Perform any 1 from Group C)	
17	Study& Survey of various development boards for IoT.
18	Develop a Real time application like smart home with following requirements: When user enters into house the required appliances like fan, light should be switched ON. Appliances should also get controlled remotely by a suitable web interface. The objective of this application is student should construct complete Smart application in group.

Virtual LAB Links:

1.Lab Name:
www.thingspeak.com/login:

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Software Defined Radio (Elective - III)	
List of Laboratory Experiments	
Group A	
1.	To observe SNR clipping.
2.	To generate multi tone
3.	To implement AM transmitter and receiver
4.	To implement FM transmitter and receiver
5.	To generate and measure bit error rate.
6.	To implement FFT filter
7.	To generate BPSK signal
8.	To generate QAM signal
9.	To generate OFDM signal.
Group B MATLAB Code	
10.	Spectrum sensing of Cognitive radio
11.	Optimization in cooperative spectrum sensing in Cognitive radio network
12.	Energy Detection Simulation: Cognitive Radio.
Virtual LAB Links: **1.Lab Name:** www.gnuradio.org	

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Testing and Verification for SoC Design (Elective - III)

Prerequisite Courses, if any:-
1.VLSI Lab

Companion Course, if any:
1. Lab Practice II

List of Laboratory Experiments

1.	Write VHDL/Verilog code for MUX -D scan cell and Level Sensitive/edge triggered MUX - D scan cell.
2.	Write a VHDL/Verilog code to realize functioning of clocked scan cell and LSSD scan cell design.
3.	To develop an exhaustive test bench for lower level combinational designs: a. Adder b. Multiplexer.
4.	To prepare a complete Test vector set for all possible stuck at faults for parity checker where the data word is of 2-bit.
5.	Design and implement ATPG for given combinational circuit
6.	To prepare a complete Test vector set for all possible stuck at faults for a 8-line- to-1-line multiplexer
7.	To prepare a complete Test vector set for all possible stuck at faults for a 3- to-8 decoder
8.	Implement a full adder using AND, OR, and NOT gates and determine the total number of single stuck-at-faults
9.	Implement a full adder using AND, OR, and NOT gates and determine the total number of multiple stuck-at-faults
10.	Generate and implement a minimum set of test vectors to detect all single-stuck at faults for an n-bit parity checker

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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 isan 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.)**	Back

Savitribai Phule Pune University Final Year of Electronics Engineering (2019 Course) 404208 Project Phase – I		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical:02 Hrs./Week	**01**	**TermWork: 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 andMultidisciplinary 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 likesto 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 thejustification 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 selectedproject, 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 reviewremarks by the guide and committee.
8. A certified copy of report preferably using LATEX is required to be presented to externalexaminer at the time of Fourth examination.
9. The project report must undergo by plagiarism check and the similarity index must be less than15%. The plagiarism report should be included in the project report.

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Savitribai Phule Pune University
Final Year of Electronics Engineering (2019 Course)
404209 Mandatory Audit Course -7

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.

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Savitribai Phule Pune University Final Year of Electronics Engineering (2019 Course) 404210 Process Instrumentation		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Theory: 03 hrs. / week	**03**	**In-Sem (Theory):30 Marks** **End Sem (Theory):70 Marks**

Prerequisite Courses, if any: 204192 Control Systems

Companion Course, if any: Process Instrumentation Lab (404215)

Course Objectives:

1. To make the students familiar with different types of processes and process characteristics.
2. To make students understand the basic principles and importance of process control in industrial process plants
3. To introduce control actions and process loop tuning methods.
4. To make students understand the basic and advanced process control schemes and the methods for process monitoring and diagnosis.
5. To make students understand the importance and application of good process control design for environmental protection and industrial safety.

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

1. **Describe** types of processes and **identify** dynamic elements in process control loop.
2. **Compare** various discontinuous and continuous control actions.
3. **Design** an Op-amp circuit that will implement the P, P+I, P+D and PID control modes to meet stated specifications.
4. **Compare** feedback, feed-forward, cascade, ratio and selective control strategies.
5. **Understand** the advanced process control schemes.
6. **Understand** the importance and application of good process control design for environmental protection and industrial safety.

Course Contents

Unit I	**Fundamentals of Processes**	**(08Hrs)**
Process control block diagram and dynamic elements in process control loops, Process characteristics, Types of processes (dead time, single and multi-capacity, self and non-self-regulating, interacting and non-interacting, Linear and non-linear), Process model parameters (process gain, process time constant, process dead time), Constant step analysis method for finding time constant.		
Mapping of Course Outcomes for Unit I	**CO1: Describe types of processes and identify dynamic elements in a process control loop.**	
Unit II	**Process Controller**	**(06 Hrs)**
Control system evaluation, Controller principles - Control system parameters, Controller modes (Discontinuous, Continuous and Composite controller modes (P,I,D,PI,PDand PID)), General features, Construction and working of Electronic, Pneumatic and Hydraulic controllers.		
Mapping of Course Outcomes for Unit II	**CO2: Compare various discontinuous and continuous control actions.**	
Unit III	**Controller Design and Tuning**	**(08Hrs)**

Op-amp realization of control actions (P, P+I,P+D and PID), Design of Op-amp based controller circuits (P, P+I,P+D and PID),Process loop tuning (Process reaction curve method, Ziegler-Nichols method, Cohen-coon correction for quarter amplitude, Frequency response method, Relay based tuning).		
Mapping of Course Outcomes for Unit III	**CO3: Design an OP-AMP circuit that will implement the P, P+I, P+D and PID control modes to meet stated specifications.**	
Unit IV	**Control Schemes**	**(08Hrs)**
Concept of Feedback, Feed-forward, Combined Feedback and Feed-forward, Ratio control, Control schemes with multiple loops (Cascade control, Split range, Selective control), Applications of Feedback, Feed-forward, Combined Feedback and Feed-forward, Cascade control, Ratio control, Split range, Selective control schemes.		
Mapping of Course Outcomes for Unit IV	**CO4: Compare feedback, Feed-forward, cascade, ratio and selective control strategies.**	
Unit V	**Advanced Control Schemes**	**(08Hrs)**
Adaptive control (Model Reference Adaptive Control (MRAC), Self-Tuning Regulator (STR)), Model Based Control (MBC), Model Predictive Control (MPC), Internal Model Control (IMC).		
Mapping of Course Outcomes for Unit V	**CO5: Understand the advanced process control schemes.**	
Unit VI	**Process Control Design and Control for Safety**	**(06 Hrs)**
Defining the design problem (Measurements, Final Elements, Process Operability, Control Structure, Control Algorithm, Performance Monitoring), Control for safety (Layers of protection-BPCS, Alarms, Safety Interlock Systems, Safety Valves, containment), Performance monitoring, Managing the Design Process (Sequence of design steps, hierarchy of control structure, process Decomposition, Integrating the control design methods, key guidelines).		
Mapping of Course Outcomes for Unit VI	**CO6: Understand the importance and application of good process control design for environmental protection and industrial safety.**	

Learning Resources

Text Books:

1. Curtis D. Johnson, Process Control Instrumentation Technology, Eight Edition,Pearson Education, 2014.
2. George Stephanopoulos, Chemical Process Control, Pearson Education-2015

Reference Books:

1. Bela G. Liptak, Instrument Engineers Handbook, Vol. - II, Process Control, CRC Press.
2. Thomas E. Marlin, Process Control,2nd Edition,McMaster University, 2015.
3. Deshpande P.B and Ash R.H, Elements of Process Control Applications, ISA Press, New York,1995.
4. D. Patranabis, Principles of Process Control, Second edition, TMH.
5. N.E. Battikha,Condensed Handbook of Measurement and Control,3rd Ed., ISA Publication.

MOOC / NPTEL Courses:

1. Process Control and Instrumentation, https://nptel.ac.in/courses/103103037
2. Chemical Process Control, https://nptel.ac.in/courses/103101142
3. Process Control - Design, Analysis and Assessment, https://nptel.ac.in/courses/103106148

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Savitribai Phule Pune University Final Year of ElectronicsEngineering (2019 Course) 404211(A) Biomedical Electronics (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. Sensors & Transducer
2. Concept of basic Electronics

Companion Course, if any: Lab Practice III(404216)

Course Objectives:
1. To familiarize students with various medical equipments and their technical aspects.
2. Analyze how noise from the environment, instruments and other physiologic systems can create artifacts in instrumentation.
3. To introduce students to the measurements involved in some medical equipments like ECG, EEG, and EMG etc.
4. To learn and understand principles of different clinical lab instrumentation and Radiology Instrumentation.

Course Outcomes: On completion of the course, learner will be able to
CO1: Understand the basics of Bio-Signals and its measurement.
CO2: Understand Cardiovascular System and ECG measurement techniques.
CO3: Understand Nervous System & EEG measurement techniques.
CO4: Understand and design of various medical instrumentation systems.
CO5: Understand various clinical lab equipments and their applications.
CO6: Understand working principle and applications of Radiology Instrumentation.

Course Contents

Unit I	**Introduction to Biomedical System**	**(06 Hrs)**

Biomedical Instrumentation System, Cell structure, Bio-Cell potential, Concept of Bio-electrodes, Types of Bio-electrodes, Transducers and Sensors to measure Bio signals (For EEG, ECG, EMG, PCG, Respiration, Body temperature, SPO2, Pulse), Artifacts in Bio signal Acquisition: Noise, Power line, Baseline, Skin contact impedance and Motion Artifacts.

Mapping of Course Outcomes for Unit I	**CO1: Understand the basics of BioSignals and its measurement.**

Unit II	**Cardiovascular System**	**(06 Hrs)**

Introduction to Heart, Physiology and anatomy of Heart, Einthoven's triangle, Vectocardiography, ECG Machine, Lead Configurations, Preamplifiers, Recorder, Heart Sounds and Murmurs, Phonocardiography.

Mapping of Course Outcomes for Unit II	**CO2: Understand Cardiovascular System and ECG measurement techniques.**

Unit III	Nervous System	(06 Hrs)
Nerve Cell and nerve potential, Neural Communication, Brain structure, 10-20 electrode placement for EEG, Types of Montage configuration, Types of EEG signals and its significance, EEG machine, EEG applications.		
Mapping of Course Outcomes for Unit III	**CO3: Understand Nervous System & EEG measurement techniques.**	
Unit IV	**Medical Instrumentation**	**(06 Hrs)**
Design of Instrumentation system for ECG acquisition, Life Saving Devices: Pacemakers, Defibrillators, Ventilators, Introduction to Blood pressure measurement (Direct and Indirect), Blood flow measurement, Finger Plethysmography, Echo cardiograph, Stress test, Bedside and central monitoring system.		
Mapping of Course Outcomes for Unit IV	**CO4: Understand and design of various medical instrumentation systems.**	
Unit V	**Clinical Lab Instruments**	**(06 Hrs)**
Blood Cell Counter, Electron Microscope, Colorimeter, Autoanalyser, Flame photometer, PH measurement/Blood Gas Analyzer for measurement of pH, pO2 & pCO2, Pulse Oximeter, Introduction to Dialysis System. Electrical Safety of Instruments: Grounding and Shielding, Issues of Noise Pollution around Hospitals.		
Mapping of Course Outcomes for Unit V	**CO5: Understand various clinical lab equipments and their applications.**	
Unit VI	**Radiology Instrumentation & Biotelemetry**	**(06 Hrs)**
Introduction to Radiology Instrumentation such as X-Ray Machine, Computer Tomography, PET, MRI Machine, Ultrasonic Doppler Machine, 2D echo, Fitness band. Laser applications in Biomedical. **Biotelemetry:** Introduction to Biotelemetry, Physiological Parameters adaptable to biotelemetry, components of Biotelemetry system, Implantable Units, Application of Telemetry in Patient Care.		
Mapping of Course Outcomes for Unit VI	**CO6: Understand working principle and applications of Radiology Instrumentation.**	

Learning Resources

Text Books:

1. Cromwell, Biomedical Instrumentation and Measurement, PHI.
2. R. Rangayan, Biomedical Signal Analysis‖, Wiley 2002.

Reference Books:

1. Joseph J. Carr and John M. Brown, ―Introduction to Biomedical Equipment Technology‖, 4thEdition, Prentice Hall, 2000.
2. R.S.Khandpur, Handbook of Biomedical Instrumentation‖, Tata McGraw Hill, New Delhi, 2003, Edition-II.

MOOC / NPTEL Courses:

"Biomedical Signal Processing"https://www.digimat.in/nptel/courses/video/108105101/L12.html

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Savitribai Phule Pune University
Final Year of Electronics Engineering (2019 Course)
404211(B) Artificial Intelligence and Neural Network (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. Machine Learning
2. 2. Python

Companion Course, if any: Lab Practice III(404216)

Course Objectives:
1. To understand and acquire knowledge of artificial neural network and its different learning and computing mechanism
2. To study how to model complex problems using deep learning network.
3. To learn and design a solution by applying the principles of CNN and RNN to solve diversified complex problem

Course Outcomes: On completion of the course, learner will be able to
CO1: Summarize the neural networks working and its types
CO2: Discuss introduction to deep learning along with the libraries used for different applications of DL
CO3: Design and implement feed forward neural network.
CO4: Apply CNN to solve diversified complex real world problems
CO5: Apply RNN to solve diversified complex real world problems
CO6: Analyze the applications of deep learning

Course Contents

Unit I	Neural Network	(06 Hrs)

Biological Neurons and Model of Artificial Neuron. What is ANN? Neural Network Architectures: Single Layer Network, Multi-Layer Feed Forward Neural Networks, and Feedback Networks. Learning rules, Perceptron Model and Learning in Perceptron, Limitation of Learning in Perceptron. Learning rules and activation functions, Single layer and multilayer Perceptron , Self Organizing Map.

Mapping of Course Outcomes for Unit I	CO1: Summarize the neural networks working and its types

Unit II	Introduction to Deep Learning	(06 Hrs)

Introduction to Deep Learning, Difference between Artificial intelligence, Machine learning and Deep learning, Supervised and Unsupervised learning, Architecture of Deep Neural Network, Tensor Flows and Keras, Deep Learning libraries, Building the Simplest Neural Network in Simple Python: AND gate, OR Gate, NOR gate, NAND, EX-OR etc. Deep Learning Tools: Caffe, Theano, Torch.

Mapping of Course Outcomes for Unit II	CO2: Discuss introduction to deep learning along with the libraries used for different applications of DL

Unit III	Deep Feed forward Networks	(06 Hrs)
Artificial Neural Network, activation function, multi-layer neural network. Parameters Affecting Deep Learning: Normalization, Data Size, Regularization, Weight Initialization, Training Neural Network: Risk minimization, loss function, Back propagation, regularization, model selection, and optimization, Back propagation networks, Architecture of Back propagation (BP) Networks, loss function, hyper parameter and its tuning during training, Overfitting and Underfitting, Methods to avoid Overfitting and Underfitting, Vanishing Gradient Problem		
Mapping of Course Outcomes for Unit III	**CO3: Design and implement feed forward neural network.**	
Unit IV	**CNN**	**(06 Hrs)**
Introduction to Convolution Neural Network (CNN), Basic architecture of CNN, Components of CNN Convolution Layer — The Kernel (Filter), Stride and padding in CNN, Calculation of image size after application of filter, Pooling layer, Classification — Fully Connected Layer (FC Layer), Softmax Classification, various architectures of CNNs Designing a Convolutional Neural Network, Various Nonlinear activation function used in ANN like Sigmoid Function, Threshold Function, ReLU (rectified linear unit) Function, Hyperbolic Tangent Function, Applications of CNNs.		
Mapping of Course Outcomes for Unit IV	**CO4: Apply CNN to solve diversified complex real world problems**	
Unit V	**Recurrent Neural Network (RNN)**	**(06 Hrs)**
Introduction to Recurrent Neural Network (RNN), Architecture of RNN, Why RNN? Types of recurrent neural networks, Forward Propagation and Back Propagation in a Recurrent Neural network, Training through RNN, different RNN architecture: Bidirectional recurrent neural networks (BRNN), Long Short Term Memory (LSTM)Advantages and disadvantage of Recurrent Neural Network, Two Issues of Standard RNNs, Applications of RNN		
Mapping of Course Outcomes for Unit V	**CO5: Apply RNN to solve diversified complex real world problems**	
Unit VI	**Application of Deep Learning**	**(06 Hrs)**
Various application areas of deep learning, Large Scale Deep Learning, how to build and train of Convolutional Neural Network in Python, Speech Recognition using deep learning, Natural Language Processing using deep learning, Object/Image classification using deep learning, Deep Learning Applications in Agriculture, Handwritten Digit Recognition using CNN		
Mapping of Course Outcomes for Unit VI	**CO6: Analyze the applications of deep learning**	

Learning Resources

Text Books:

1. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S.Rajasekaran, G. A. Vijayalakshami, PHI, 2007
2. Deep Learning By Ian Goodfellow, YoshuaBengio and Aaron Courville
3. Neural Networks and Learning Machines, 3d Edition Book by Simon S. Haykin

Reference Books:

1. Deep Learning with Python 1st Edition by Francois Chollet
2. Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems by GeronAurelien

3. Foundations of Neural Networks, Fuzzy Systems, and Knowldge Engineering, Nikola K. Kasabov, MIT Press, 1998
4. Grokking Deep Learning by Andrew W. Trask
5. https://towardsdatascience.com/convolutional-neural-networks-explained-9cc5188c4939
6. https://www.geeksforgeeks.org/introduction-to-recurrent-neural-network/
7. https://www.simplilearn.com/tutorials/deep-learning-tutorial/rnn
https://www.simplilearn.com/tutorials/deep-learning-tutorial

MOOC / NPTEL Courses:

NPTEL Course "*Neural Networks and Application*", Prof. SomnathSengupta, IIT Kharagpur
https://nptel.ac.in/courses/117105084

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Savitribai Phule Pune University
Final Year of Electronics Engineering (2019 Course)
404191 (C) Android Development* (Elective V)
(Subject common with BE E&TC (2019 Course)

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: Lab Practice III(404216)

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**	**(05Hrs)**
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**	**(05Hrs)**
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		**(08Hrs)**
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**	**(08Hrs)**

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**	**(08Hrs)**
Using Basic Views: Text View, Button, Image Button, Edit Text, Check Box, Switch, Toggle Button, Radio Button, and Radio Group Views, Progress Bar View, Auto Complete Text View View, Using Picker Views, Using Recycler View to Display Long Lists, Understanding Specialized Fragments, Displaying Pictures and Menus, Video View. 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**	**(08Hrs)**
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”, 2 nd Edition, Shroff / O’Reily Publication
2. Barry Burd, “Java Programming for Android Developers for Dummies”, 2 nd Edition, Dummies.
3. Wei-Meng Lee, “Beginning Android 4 Application Development”, WROX Publication

Reference Books:

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

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Savitribai Phule Pune University Final Year of Electronics Engineering (2019 Course) 404211 (C) Audio Video Engineering (Elective V)		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Theory: 03 hr/week	**03**	**In-Sem (Theory): 30 Marks** **End Sem (Theory): 70 Marks**

Prerequisite Courses, if any:
1.Analog communication
2. Digital communication

Companion Course, if any: Lab Practice III(404216)

Course Objectives:

1. Provide students with a strong understanding of the fundamental principles and practical applications of audio and video engineering with latest updates.
2. Make students familiar with basics of Digital television, High Definition Television and various display Devices.
3. Provide the latest developments in audio-video engineering with emphasis on HDTV, DTV, LCD, Plasma etc.
4. Provide hands-on practice on TV kits to study normal operation and fault diagnosis.

Course Outcomes: On completion of the course, learner will be able to
CO1: Understand the concept of basic television signal processing.
CO2: Identify globally accepted color TV standards.
CO3: Describe and differentiate working principles of advanced TV systems and techniques.
CO4: Analyze various video processing methods required for Digital TV.
CO5: Apply the principles of Acoustics to the real life audio video systems.
CO6: Apply the Fundamentals of Audio-Video Recording for practical applications.

Course Contents

Unit I	**Vision Characteristics, Scanning System and Analog Video**	**(06 Hrs)**
Introduction To Basic Television Systems, Characteristics of Human Eye, Resolution Of Brightness, Perception, Persistence of Vision Scanning, Aspect Ratio, Flicker, The Keel Factor, Horizontal And Vertical Resolution, Video Bandwidth, Interlaced Scanning, Composite Video Signal: Video Signal Components, Video Modulation, Vestigial Side Band Signal, Sound Modulation and Inter-Carrier System, Reception of Vestigial Side Band Signal, Television Broadcast Channels And Standards.		
Mapping of Course Outcomes for Unit I	Understand the concept of basic television signal processing.	
Unit II	**Colour Television and standards**	**(06 Hrs)**
Color television: Compatibility considerations, Perception of brightness and color, Color theory, chromaticity diagram, Luminance signal (Y), Color difference signal, Formation of chrominance signal, Color subcarrier frequency. Standards: NTSC, PAL, SECAM colour system, generalized colour TV receiver block diagram, study of functionality of each block, alignment issues. Digital video: Concept, sampling of video signal, Digitization, pixel array, Viewing distance and angle, composite vs component video.		
Mapping of Course Outcomes for Unit II	Identify globally accepted color TV standards.	
Unit III	**Advanced TV systems and techniques**	**(06 Hrs)**

Introduction to UHDTV: 4K and 8K, IPTV/web TV, smart TV, Wi-Fi TV, digital surveillance, 3D TV concept, over view of H.264 features, camcorders, webcams, HD Video projectors, Video Intercom systems/ Video door phones. Display techniques: LED, LCD, OLED, 3D, 4D, 5D, 7D, 9D, Smart whiteboard		
Mapping of Course Outcomes for Unit III	Describe and differentiate working principles of advanced TV systems and techniques.	
Unit IV	**Digital TV**	**(06 Hrs)**
Introduction to Digital TV, Digital TV signals and parameters, Digital TV Transmitters, MAC signals, advanced MAC signal transmission, Digital TV receivers, Video compression: MPEG 2, MPEG 4. Video restoration, Video streaming, DTH, comparison of SDTV, EDTV and HDTV		
Mapping of Course Outcomes for Unit IV	Analyze various video processing methods required for Digital TV.	
Unit V	**Acoustics**	**(06 Hrs)**
Human Hearing and sound, frequency range, dynamic range, masking, digital representation of sound wave, intensity, decibel sound level, sound waves in rooms, reverberation, room/studio acoustics as a component in speech system, PA systems, special types of microphones and speakers.		
Mapping of Course Outcomes for Unit V	Apply the principles of Acoustics to the audio video systems.	
Unit VI	**Audio Engineering**	**(06 Hrs)**
Fundamentals of Audio-Video Recording: Methods of sound recording & reproduction, optical recording, CD recording, audio standards. Digital Sound Recording, CD/ DVD player, MP3 player, Blue Ray DVD Players, MPEG, MP3 Player. Characteristics of Sound, Noise Distrotion and High Fidelity, Stereo Control, Surround Sound System, multichannel/Dolby 5.1 sound in DTV.		
Mapping of Course Outcomes for Unit VI	Apply the Fundamentals of Audio-Video Recording for practical applications.	

Learning Resources

Text Books:

1. A.M. Dhake, Television and video Engineering, TMH Publication, 2nd Edition,2001

2. R.G.Gupta, Audio and Video Systems, McGraw Hill l Education (India), 2nd Edition,2010.

Reference Books:

1. S. P. Bali, Color Television Theory and Practice, McGraw Hill Education (India),1994

2. A.M. Tekalp,Digital Video, Prentice Hall, 1995

3. R.P. Gulathi, Modern Television Practice, 4th edition, New Age International Publisher, 2014

4. Kelth jack, Video Demystified: A Handbook for the Digital Engineer, 5th Edition, Newnes, 2007.

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Savitribai Phule Pune University Final Year of Electronics Engineering (2019 Course) 404211(D) Automotive Electronics (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: Lab Practice III(404216)

Course Objectives:

- To understand the concepts of Automotive Electronics and it's evolution and trends in automotive systems and subsystems.
- To understand sensors and sensor monitoring mechanisms aligned to automotive systems.
- To understand role of Microcontrollers in ECU design and choice of appropriate Hardware and Software.
- To describe various communication systems, wired and wireless protocols used in vehicle networking.
- To understand, design and model various automotive control systems using Model based development technique.
- To understand safety and diagnostics systems in automobiles.

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

CO1: Obtain an overview of automotive components, subsystems and design cycles.
CO2: Develop applications using sensors and actuators.
CO3: Interface automotive sensors and actuators with microcontrollers /microprocessors.
CO4: Use various communication protocols, interfacing techniques and interfacing with infotainment gadgets
CO5: Design and model various automotive control systems using various Model based development/technique.
CO6: Use various safety standards and diagnostics systems in automobiles.

Course Contents

Unit I	Automotive Systems and Industry Overview	(06 Hrs)

Overview of Automotive Industry: Leading players, Automotive supply chain, Global challenges, Role of technology in Automotive Electronics and interdisciplinary design, Tools and processes.

Introduction to Modern Automotive Systems and need for electronics in automobiles and application areas of electronic systems in modern automobiles. Spark and Compression Ignition Engines: Ignition systems, Fuel delivery systems, Engine control functions, Fuel control, Electronic systems in engines.

ECU Design Cycle: V-Model development cycle, Components of ECU, Examples of ECU on chassis, and in body electronics, infotainment and clusters. Overview of hybrid vehicles.

Mapping of Course Outcomes for Unit I	CO1: Obtain an overview of automotive components, subsystems and design cycles.

Unit II	Automotive Sensors and Actuators	(06 Hrs)
Systems Approach to Control and Instrumentation: Concept of a system, Sensors, Sensor error, Redundancy of sensors in ECUs, Avoiding redundancy, Sensor modeling, Smart Nodes. Examples of Sensors: Accelerometers, Wheel speed, Brake pressure, Seat occupancy, Engine speed, Steering wheel angle, Vehicle speed, Differential exhaust gas pressure and Air bag sensors. Actuators used: Solenoids, Various types of electric motors and piezoelectric force generators. Examples of Actuators: Relays, Solenoids and motors. Chassis control systems and Automatic transmission control systems.		
Mapping of Course Outcomes for Unit II	**CO2: Develop applications using sensors and actuators.**	
Unit III	**Microcontrollers/Microprocessors in Automotive domain**	**(06 Hrs)**
Critical review and overview of development within the automotive context of microprocessors, microcontrollers and digital signal processors (architecture of 8/16 bit microcontrollers with emphasis on Ports, Timer/Counters, Interrupts, Watchdog timers and PWM). Criteria to choose the right microcontroller/processor for various automotive applications. Understanding various architectural attributes relevant to automotive applications. Automotive grade processors viz. Renesas, Quorivva, Infineon. Understanding and working on tool chains for different processors. Development of control algorithms for different automotive subsystems, Look-up tables and maps, Need of maps, Procedure to generate maps, Fuel maps/tables, Ignition maps/tables, Engine calibration, Torque table, Dynamometer testing.		
Mapping of Course Outcomes for Unit III	**CO3:Interface automotive sensors and actuators with microcontrollers /microprocessors.**	
Unit IV	**Communication protocols, Infotainment systems**	**(06 Hrs)**
Communication protocols: Overview of automotive communication protocols, CAN, LIN , Flex Ray, MOST , Ethernet, D2B and DSI, Communication interface with ECUs, Interfacing techniques and Interfacing with infotainment gadgets, Relevance of Protocols such as TCP/IP for automotive applications, Wireless LAN standards such as Bluetooth, IEEE 802.11x communication protocols for automotive applications. Infotainment Systems: Application of telematics in automotive domain, Global positioning systems (GPS) and General packetradio service (GPRS).		
Mapping of Course Outcomes for Unit IV	**CO4: Use various communication protocols, interfacing techniques and interfacing with infotainment gadgets**	
Unit V	**Automotive Control Systems and Model Based Development**	**(06 Hrs)**
Automotive Control System & Model Based Development: Control system approach in Automotive Electronics, Analog and digital control methods, Modelling of linear systems, System responses, Modelling of Automotive Systems with simple examples. Model based Development: Introduction to MATLAB, Simulink and SIMSCAPE tool boxes, Model-Based Design for a small system, Motor Model, Generator Model, Controller Model, SimDriveline, Introduction to Simulink simulations, Exploring the system response using different control methods, Tuning the system,Exploring system limitations, Understanding and refining motor models, Study of modeling and simulation of any one Automotive System		
Mapping of Course Outcomes for Unit V	**CO5: Design and model various automotive control systems using various Model based development/technique.**	

Unit VI	Safety Systems in Automobiles and Diagnostic Systems	(06 Hrs)
Active Safety Systems: ABS, TCS, ESP, Brake assist, etc. Passive Safety Systems: Airbag systems, Advanced Driver Assistance Systems (ADAS): Combining computer vision techniques as pattern recognition, feature extraction, learning, tracking, 3D vision, etc. to develop real-time algorithms able to assist the driving activity. Examples of Assistance Applications: Lane Departure Warning, Collision Warning, Automatic Cruise Control, Pedestrian Protection, Headlights Control, Connected Cars technology and trends towards Autonomous vehicles. Diagnostics: Fundamentals of Diagnostics, Basic wiring system and Multiplex wiring system, Preliminary checks and adjustments, Self-diagnostic system, Fault finding and corrective measures, Electronic transmission checks and Diagnosis, Diagnostic procedures and sequences, On-board and off-board diagnostics inAutomobiles.		
Mapping of Course Outcomes for Unit VI	**CO6: Use various safety standards and diagnostics systems in automobiles.**	

Learning Resources

Text Books:

1. Williams. B. Ribbens: “Understanding Automotive Electronics”, 6th Edition, Elsevier Science, Newnes Publication, 2003.
2. Robert Bosch: “Automotive Electronics Handbook”, John Wiley and Sons, 2004.

Reference Books:

1. James D. Halderman: “Automotive Electricity and Electronics", PHI Publication.
2. Terence Rybak& Mark Stefika: “Automotive Electromagnetic Compatibility (EMC)”, Springer, 2004.
3. Allan Bonnick: “Automotive Computer Controlled Systems, Diagnostic Tools and Techniques”, Elsevier Science, 2001.
4. UweKieneke and Lars Nielsen: “Automotive Control Systems: Engine, Driveline and Vehicle”, 2nd Edition, Springer Verlag, 2005.
5. David Alciatore& Michael Histand: "Introduction to Mechatronics and Measurement Systems (SIE)”, TMH, 2007.
6. Iqbal Husain: "Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 2003.
7. Tom Denton: "Advanced Automotive Diagnosis”, 2nd Edition, Elsevier, 2006.
8. G. Meyer, J. Valldorf and W. Gessner: "Advanced Microsystems for Automotive Applications”, Springer, 2009.
9. Tracy Martin: “How to Diagnose and Repair Automotive Electrical Systems" Motor Books / MBl Publishing Company, 2005.
10. MehrdadEbsani, Ali Emadi&YiminGao: “Modern Electronic Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", 2nd Edition, CRC Press, 2009.
11. Marc E. Herniter and Zac Chambers: “Introduction to Model Based System Design”, Rose-Hulman Institute of Technology.

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Savitribai Phule Pune University
Final Year of Electronics Engineering (2019 Course)
404212(A) Renewable Energy System & DSM (Elective VI)

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

Prerequisite Courses : Basic Electronics.

Companion Course, if any:

Course Objectives:

1. To study energy generation, different energy sources and their utilization and impact on environment
2. To gain knowledge of solar radiation and its applications
3. To analyze the performance of solar collectors and wind turbines
4. To understand the wind energy and its nature
5. To understand principles of Energy Management and Demand Side Management

Course Outcomes: On completion of the course, learner will be able to
CO1: Interpret energy reserves of India and potential of different energy sources
CO2: Understand operation of Solar power system and **Select** the various components for ON Grid and OFF grid solar power system installation
CO3: Understand the operation of wind power system for constant power and variable power mode of operation
CO4: Understand the operation of various of biomass energy conversion systems
CO5: Implicit the importance and applications of geothermal and ocean energy.
CO6:Applyprinciple Demand Side Management (DSM) and Demand Response (DR) for efficient energy management

Course Contents

Unit I	Energy Resources and Utilization	(6 Hrs)

Conservation and forms of energy, energy reserves in India, nuclear power, hydroelectric power, renewable energy sources, energy parameters, rational energy use of energy, energy efficiency and conservation, new technologies, distributed energy systems and dispersed generation.

Mapping of Course Outcomes for Unit I	CO1: Interpret energy reserves of India and potential of different energy sources

Unit II	Solar Energy	(6 Hrs)

Solar Thermal: Spectral distribution of extraterrestrial radiation, terrestrial solar radiation, Solar Thermal energy collectors, Solar thermal applications: Solar water heating, solar distillation, solar pumping system.

Solar photovoltaic systems: Solar Cell characteristics, Fill Factor, Datasheet Study, Types of PV system: Stand-alone PV systems, Grid connected PV systems, System sizing: Power and energy estimates, battery sizing, Charge Controller Sizing, PV array sizing, Case study on online or offline Solar power system.

Mapping of Course Outcomes for Unit II	CO2: Understand operation of Solar power system and Select the various components for ON Grid and OFF grid solar power system installation

Unit III	Wind Energy	(6 Hrs)
Wind Energy Conversion, System component, Power vs speed and TSR, Maximum power operation, Types of wind turbines, Wind generators, Wind generator drives, Installation of wind power plant, stand alone and Grid connected wind power system, Wind data and energy estimation, Safety and environmental aspects		
Mapping of Course Outcomes for Unit III	**CO3: Understand the operation of wind power system for constant power and variable power mode of operation**	
Unit IV	**Biomass Energy**	**(6 Hrs)**
Biomass Classification, Biomass Resources and their Energy Potential, Biomass Conversion Technologies: Anaerobic Digestion, Ethanol Fermentation, Biomass Gasification: Gasifiers, Fluidized Bed Gasifier, Biogas Technologies and their factor affecting Biogas Production, Biogas Plants: Floating and Fixed Dome type, Municipal Solid Waste Management		
Mapping of Course Outcomes for Unit IV	**CO4: Understand the operation of various of biomass energy conversion systems**	
Unit V	**Ocean and Geothermal Energy**	**(6 Hrs)**
Ocean Energy: Tidal Energy, Tidal characteristics, Tidal Energy estimation, Development of a tidal power scheme, Wave energy- characteristics-energy and power from the waves. **Geothermal energy:** Structure of earth's interior, sites, field, gradient, resources, power generation, geothermal resources in India, utilization, global status of electricity generation from geothermal resources, advantages of geothermal energy		
Mapping of Course Outcomes for Unit V	**CO5: Implicit the importance and applications of geothermal and ocean energy.**	
Unit VI	**Demand Side Management**	**(6 Hrs)**
DSM and its relevance, load shape objectives in context to DSM, Electricity Act & regulatory framework, Technology options for DSM in Lightning, Space cooling (Ceiling Fan, AC system), Refrigeration and Water cooling), Demand Response, classification of various DR options, architecture for DR implementation, Energy management system, DR strategies for various load categories, role of communication infrastructure, MDMS, DRAS (Server & client)		
Mapping of Course Outcomes for Unit VI	**Co6: Apply principle Demand Side Management (DSM) and Demand Response (DR) for efficient energy management**	

Learning Resources

Text Books:

1. D.P. Kothari, K.C. Singal and Rakesh Ranjan, ―Renewable Energy Sources and Emerging Technologies‖, Prentice Hall of India, New Delhi
2. Biomass for Renewable Energy, Fuels, and Chemicals, Donald L. Klass, Elsevier

Reference Books:

1. Energy Technology –Non-Conventional, Renewable and Conventional, Rao, Dr. B. B. Parulekar, Khanna Publication

MOOC / NPTEL Courses:

1. NPTEL Course "Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems" , Prof. Vaibhav Vasant Goud, Prof. R. Anandlaxmi, IIT Guwahati
   Link of the Course:https://nptel.ac.in/courses/108105158

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Savitribai Phule Pune University Final Year of Electronics Engineering (2019 Course) 404212(B) Wireless Sensor Networks (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: Internet of Things

Companion Course, if any:

Course Objectives:

1. To learn basic concepts of Wireless sensor networks
2. To be familiar with architecture and protocols used in Wireless sensor networks
3. To provide knowledge of deployment and security issued of Wireless sensor networks

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

1. Explain various concepts and terminologies used in WSN
2. Describe importance and use of radio communication and link management in WSN
3. Explain various wireless standards and protocols associated with WSN
4. Recognize importance of localization and routing techniques used in WSN
5. Understand techniques of data aggregation and importance of security in WSN
6. Examine the issues involved in design and deployment of WSN

Course Contents

Unit I	**Introduction**	**(06 Hrs)**
What are Wireless Sensor Networks, Wireless Sensor Node, Anatomy of a Sensor Node, architecture of WSN , Performance metrics in WSNs, types of WSN		
Mapping of Course Outcomes for Unit I	**CO1: Explain various concepts and terminologies used in WSN**	
Unit II	**Radio Communication And Link Management**	**(06 Hrs)**
Radio Waves and Modulation/Demodulation, Properties of Wireless Communications, Medium Access Protocols, Wireless Links Introduction, Properties of Wireless Links, Error Control, Naming and Addressing, Topology Control		
Mapping of Course Outcomes for Unit II	**CO2: Describe importance and use of radio communication and link management in WSN.**	
Unit III	**Wireless Standards And Protocol Stack**	**(06 Hrs)**
WSN Standards- IEEE802.15.4 Low rate WPAN, Zigbee, Wireless HART, ISA 100.11a, 6LoWPAN,IEEE802.15.3, Wibree,BLE, Zwave, ANT, Insteon, Wavenis, Protocol stack of WSNs, Cross Layer Protocol Stack		
Mapping of Course Outcomes for Unit III	**CO3: Explain various wireless standards and protocols associated with WSN**	
Unit IV	**Localization And Routing**	**(06 Hrs)**

Localization : Localization Challenges and Properties, Deployment Schemes, Proximity Schemes. Ranging Schemes, Range-Based Localization, Range-Free Localization, Routing Basics, Routing Metrics, Routing Protocols, Full-Network Broadcast, Location-Based Routing, Directed Diffusion, Collection Tree Protocol, Zigbee, Multi-Hop Communications		
Mapping of Course Outcomes for Unit IV	**CO4: Recognize importance of localization and routing techniques used in WSN**	
Unit V	**Data Aggregation And Security**	**(06 Hrs)**
Clustering Techniques, In-Network Processing and Data Aggregation, Compressive Sampling, Security Issues in Wireless Sensor Networks, Attacks, Defensive Measures, Security requirements and threat model		
Mapping of Course Outcomes for Unit V	**CO5: Understand techniques of data aggregation and importance of security in WSN**	
Unit VI	**Designing And Deploying WSN Applications**	**(06 Hrs)**
Designing and Deploying WSN Applications ,Early WSN Deployments, General Problems, General Testing and Validation, Requirements Analysis, The Top-Down Design Process, Bottom-Up Implementation Process.		
Mapping of Course Outcomes for Unit VI	**CO6: Examine the issues involved in design and deployment of WSN**	

Learning Resources

Text Books:

1. KazemSohraby, Daniel Minoli and TaiebZnati, — Wireless Sensor Networks Technology, Protocols, and Applications—, John Wiley & Sons, 2007.
2. Holger Karl and Andreas Willig, —Protocols and Architectures for Wireless Sensor Networks‖, John Wiley & Sons, Ltd, 2005.

Reference Books:

1. HossamFahmy, —Wireless Senor Networks: Concepts, Application, experimentation and analysis‖, Springer Publication
2. Anna Forster, —Introduction to Wireless Sensor Networks‖, IEEE Press, Wiley Publication
3. Anna Hac, —Wireless Sensor Network Designs‖, John Wiley & Sons Ltd

MOOC / NPTEL Courses:

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Savitribai Phule Pune University
Final Year of Electronics Engineering (2019 Course)
404192 (C) Remote Sensing* (Elective VI)
(Subject common with BE E&TC (2019 Course)

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	(07Hrs)
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	(07Hrs)
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	(07Hrs)
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**	**(07Hrs)**
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**	**(06 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**	**(06 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, ElmarWasle, “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. NPTELCourse“**RemoteSensing:PrincipalandApplication**”,byProf.EswarRajasekaran,IITBombay
   LinkoftheCourse:https://nptel.ac.in/courses/105101206

2. NPTELCourse“**RemoteSensing Essentials**”,byDr.Arun.K.Saraf, IITRoorkee
   LinkoftheCourse:https://nptel.ac.in/courses/105107201

3. NPTEL Course “**Global Navigation Satellite Systems and Applications**”, by Dr.Arun.K.Saraf,IITRoorkee

LinkoftheCourse:https://nptel.ac.in/courses/105107194

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Savitribai Phule Pune University
Final Year of Electronics Engineering (2019 Course)
404192 (D) Digital Marketing* (Elective VI)
(Subject common with BE E&TC (2019 Course)

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

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Savitribai Phule Pune University
Final Year of Electronics Engineering (2019 Course)
404193: Innovation and Entrepreneurship*
(Subject common with BE E&TC (2019 Course)

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 andEntrepreneurship	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.

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Savitribai Phule Pune University
Final Year of Electronics Engineering (2019 Course)
404194: Digital Business Management*
(Subject common with BE E&TC (2019 Course)

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 andimpacts. Difference between physical economy and digital economy.
Drivers of digital business: Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things (digitally intelligent 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 andmanagement.**	
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 andmanagement.** **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 InternationalConference 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.

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Savitribai Phule Pune University Final Year of Electronics Engineering (2019 Course) 404215 Process Instrumentation Lab		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 hrs. / week	**01**	**Oral: 50 Marks** **Term Work: 25 Marks**

List of Laboratory Experiments

Any 8 to be performed

1.	Design and test of ON-OFF Controller (Simulation+Hardware)
2.	Testing of controller modes (pure and composite) on a PID controller (Simulation)
3.	Tuning of a PID controller (Simulation)
4.	Analysis of flow control loop Using PID controller (Simulation/ Hardware)
5.	Analysis of level control loop Using PID controller (Simulation/ Hardware)
6.	Analysis of temperature control loop Using PID controller (Simulation/ Hardware)
7.	Testing of cascade controller for a given application (Simulation)
8.	Study of various pneumatic and hydraulic system components
9.	Development, implementation and testing of pneumatic circuits(Simulation/ Hardware)
10.	Development, implementation and testing of hydraulic circuits (Simulation/ Hardware)

Virtual lab links:

1. PID control for desired transient response
   Link: http://vlabs.iitb.ac.in/vlab/maglev/exp8/index.html#
2. To understand working of PID function block.
   Link: https://plc-coep.vlabs.ac.in/exp/pid-controller/
3. Develop pneumatic circuit to operate direct single acting cylinder
   Link: https://pc-coep.vlabs.ac.in/exp/direct-single-acting-cylinder/theory.html
4. Identify various components of a pneumatically operated control valve
   Link:http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/COEP_KNOWLEDGE_SEEKERS/labs/exp1/simulation.html

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Savitribai Phule Pune University Final Year of Electronics Engineering (2019 Course) 404216 Lab Practice III (Elective V)		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 hrs. / week	**01**	**Practical: 50 Marks** **Term Work: 25 Marks**

Biomedical Electronics

Prerequisite Courses, if any: -

Companion Course, if any:

List of Laboratory Experiments

Any 8 to be performed.

1	To study ECG Machine (Single channel or Multichannel).
2	Interface of PC simulated waveform with ECG machine.
3	ECG \ QRS Detector + Counter to display heart rate
4	To study and measure pulse rate using finger plethesmography.
5	To study Defibrillator/pacemaker
6	To study and measure Blood Pressure using sphygmomanometer/ Digital BP Instrument
7	To study EEG/EMG Machine.
8	To study Blood cell counter.
9	Study of PH measurement System.
10	Study of CT Scan /MRI machine.
11	Study of Clinical Lab Instrumentation.
12	Study of Laser Treatments in Medicines.

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Artificial Intelligence and Neural Network

Prerequisite Courses, if any: -
1. Artificial Intelligence and Machine learning

Companion Course, if any:

List of Laboratory Experiments	
Group A (Perform Any 5)	
1.	Implementing Artificial Neural Network training process in Python
2.	Implementation of AND/NAND gate using feed forward Neural Network
3.	Implementation of OR/NOR gate using feed forward Neural Network
4.	Implementation of EX-OR gate using feed forward Neural Network
5.	Implementation of AND/OR/NOT Gate using Single Layer Perceptron
6.	Implementation of XOR Gate Using Multi-Layer Perceptron/ Error Back Propagation
Group B (Perform Any 2)	
7.	Implementation of XOR Gate Using Radial Basis Function Network
8.	Understanding the concepts of Perceptron Learning Rule
9.	Understanding the concepts of Hebbiann Learning Rule
10	Understanding the concepts of Correlation Learning Rule
Group C (Perform Any 2)	
11.	To Build and train of Convolutional Neural Network in Python
12.	Handwritten Digit Recognition using CNN
13.	Case study of Traffic Signs Recognition using CNN & Keras in Python
14.	Case study Chatbot implementation using CNN in Python

Virtual LAB Links:

1.Lab Name: Machine Learning Lab
http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/index.php

2.Lab Name: AI-Deep Learning Virtual Labs: AI Made Easy
Link of the Virtual Lab: https://vlab.spit.ac.in/ai/#/experiments

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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.

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Savitribai Phule Pune University Final Year of Electronics Engineering (2019 Course) 404211(C) Audio Video Engineering (Elective V)		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 2 Hrs/Week	**01**	**Practical: 50 marks** **TW: 25 marks**

List of Laboratory Experiments	
Group A	
1.	To evaluate the fault simulation and step by step fault finding procedure of different section in color TV Receiver.
2.	Study of Digital TV pattern generator.
3.	Study of HDTV/UHDTV
4.	Study of Wi-Fi TV system
Group B	
5.	To study DVD / Blu Ray player and observe various signal waveforms.
6.	Study of audio player: MP3 player
7.	Study of audio and video coding scheme
8.	To design and study PA system.
Group C	
9.	Directivity pattern of microphone/speakers.
10.	Visit to TV transmitter/ Digital TV studio/ All India Radio/ TV manufacturing factory.

Virtual LAB Links:

1.Lab Name:
Link of the Virtual Lab:

2.Lab Name:
Link of the Virtual Lab:

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Automotive Electronics	
List of Laboratory Experiments	
Group A (Any5)	
1.	Develop and implement wiper control system using microcontroller.
2.	Interface accelerometer sensor to microcontroller and display data.
3.	Simulate and implement Vehicle indoor lighting system.
4.	Study and implement CAN protocol to transmit data between two ECUs.
5.	Study the functional design aspects of Hybrid Automotive Systems.
6.	Implement any one automotive application using VM Lab software.
Group B (Using MATLAB Simulink/Stateflow design)(Any 3)	
7.	Fault-Tolerant Fuel Control System
8.	Automatic Climate Control System
9.	Vehicle Electrical System
10.	Manage the Data for a Fuel Control System
11.	Anti-Lock Braking System
12.	Power Window Control

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Savitribai Phule Pune University Final Year of Electronics Engineering (2019 Course) 404217 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.

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