Savitribai Phule Pune University

Faculty of Science and Technology

Syllabus for

T.E (Electronics & Telecommunication Engineering)

(Course 2019)

(w.e.f. June 2021)

Savitribai Phule Pune University, Pune
T.E. (Electronics& Telecommunication Engineering) 2019 Course
(With effect from Academic Year 2021-22)

Semester-V

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit			
		Theory	Practical	Tutorial	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR	TUT	Total
304181	Digital Communication	03	-	-	30	70	-	-	-	100	03	-	-	03
304182	Electromagnetic Field Theory	03	-	01	30	70	25	-	-	125	03	-	01	04
304183	Database Management	03	-	-	30	70	-	-	-	100	03	-	-	03
304184	Microcontrollers	03	-	-	30	70	-	-	-	100	03	-	-	03
304185	Elective - I	03	-	-	30	70	-	-	-	100	03	-	-	03
304186	Digital Communication Lab	-	02	-	-	-	-	50	-	50	-	01	-	01
304187	Database Management Lab	-	02	-	-	-	-	-	25	25	-	01	-	01
304188	Microcontroller Lab	-	02	-	-	-	-	50	-	50	-	01	-	01
304189	Elective I Lab	-	02	-	-	-	-	25	-	25	-	01	-	01
304190	Skill Development	-	02	-	-	-	25	-	-	25	-	01	-	01
304191A	Mandatory Audit Course 5 [&]	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	**15**	**10**	**01**	**150**	**350**	**50**	**125**	**25**	**700**	**-**		-	-
										Total Credit	**15**	**05**	**01**	**21**

Elective -I

1) Digital Signal Processing
2) Electronic Measurements
3) Fundamentals of JAVA Programming
4) Computer Networks

Savitribai Phule Pune University, Pune
T.E. (Electronics& Telecommunication Engineering) 2019 Course
(With effect from Academic Year 2021-22)

Semester-VI

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit			
		Theory	Practical	Tutorial	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR	TUT	Total
304192	Cellular Networks	03	-	-	30	70	-	-	-	100	03	-	-	03
304193	Project Management	03	-	-	30	70	-	-	-	100	03	-	-	03
304194	Power Devices & Circuits	03	-	-	30	70	-	-	-	100	03	-	-	03
304195	Elective-II	03	-	-	30	70	-	-	-	100	03	-	-	03
304196	Cellular Networks Lab	-	02	-	-	-	-	-	50	50	-	01	-	01
304197	Power Devices & Circuits Lab	-	02	-	-	-	-	50	-	50		01		01
304198	Elective-II Lab	-	02	-	-	-	-	25	-	25	-	01	-	01
304199	Internship**	-	-	-	-	-	100	-	-	100	-	-	04	04
304200	Mini Project	-	04	-	-	-	25	-	50	75	-	02	-	02
304191 B	Mandatory Audit Course 6 &	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	**12**	**10**	**00**	**120**	**280**	**125**	**75**	**100**	**700**				
										Total Credit	**12**	**05**	**04**	**21**

Abbreviations:
In-Sem: In semester End-Sem: End semester TH: Theory TW : Term Work
PR: Practical OR: Oral TUT: Tutorial

Note: Students of T.E. (Electronics & Telecommunications) have to opt any one of the audit course from the list of audit courses prescribed by BoS (Electronics & Telecommunications Engineering)

Elective -II

1) Digital Image Processing
2) Sensors in Automation
3) Advanced JAVA Programming
4) Embedded Processors
5) Network Security

SEMESTER - V

Savitribai Phule Pune University

Third Year of E & Tc Engineering (2019 Course)

304181: Digital Communication

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

Prerequisite Courses, if any:

1. Principles of Communication Systems
2. Signals & Systems
3. Control Systems
4. Digital Circuits
5. Electronic Circuits.

Companion Course, if any: Digital Communication Lab

Course Objectives: To make the students understand

- To familiarize students with various digital modulation techniques used in digital communication systems.
- To equip students the students with tools required for performance analysis of digital communication systems.
- To introduce the students with the concept of information theory & coding techniques.

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

CO1: Apply the statistical theory for describing various signals in a communication system.

CO2: Understand and explain various digital modulation techniques used in digital communication systems and analyze their performance in presence of AWGN noise.

CO3: Describe and analyze the digital communication system with spread spectrum modulation.

CO4: Analyze a communication system using information theoretic approach.

CO5: Use error control coding techniques to improve performance of a digital communication system.

Course Contents		
Unit I	**Random Processes & Noise**	**(07 Hrs.)**
Random Processes: Introduction, Mathematical definition of a random process, Stationary processes, Mean, Correlation and Covariance function, Ergodic processes, Transmission of a random process through a LTI filter, Power spectral density. **Mathematical Representation of Noise:** Some Sources of Noise, Frequency-domain Representation of Noise, Superposition of Noises, Linear Filtering of Noise, Quadrature Components of Noise, Representation of Noise using Orthonormal Coordinates.		
Mapping of Course Outcomes for Unit I	**CO1: Apply the statistical theory for describing various signals in a communication system.**	
Unit II	**Digital Modulation-I**	**(07 Hrs.)**
Baseband Signal Receiver: Probability of Error, Optimal Receiver Design. **Digital Modulation:** Generation, Reception, Signal Space Representation and Probability of Error Calculation for Binary Phase Shift Keying (BPSK), Binary Frequency Shift Keying (BFSK), Quadrature Phase Shift Keying (QPSK), M-ary Phase Shift Keying (MPSK).		
Mapping of Course Outcomes for Unit II	**CO2: Understand and explain various digital modulation techniques used in digital communication systems and analyze their performance in presence of AWGN noise.**	
Unit III	**Digital Modulation-II**	**(07 Hrs.)**
Generation, Reception, Signal Space Representation and Probability of Error Calculation for Quadrature Amplitude Shift Keying (QASK), M-ary FSK (MFSK), Minimum Shift Keying (MSK), Pulse Shaping to reduce Interchannel and Intersymbol Interference, some Issues in transmission and reception, Orthogonal Frequency Division Multiplexing (OFDM), Comparison of digital modulation systems.		
Mapping of Course Outcomes for Unit III	**CO2: Understand and explain various digital modulation techniques used in digital communication systems and analyze their performance in presence of AWGN noise.**	
Unit IV	**Spread Spectrum Modulation**	**(06 Hrs.)**
Use of Spread Spectrum , Direct Sequence (DS) Spread Spectrum, Spread Spectrum and Code Division Multiple Access (CDMA), Ranging Using DS Spread Spectrum , Frequency Hopping (FH) Spread Spectrum, **Pseudorandom (PN) Sequences:** Generation and Characteristics, Synchronization in Spread Spectrum Systems		
Mapping of Course Outcomes for Unit IV	**CO3: Describe and analyze the digital communication system with spread spectrum modulation.**	

Unit V	Information Theoretic Approach to Communication System	(07 Hrs.)
Introduction to information theory, Entropy and its properties, Source coding theorem, Huffman coding, Shannon-Fano coding, Discrete memory less channel, Mutual information, Channel capacity, Channel coding theorem, Differential entropy and mutual Information for continuous ensembles, Information Capacity theorem.		
Mapping of Course Outcomes for Unit V	**CO4: Analyse a communication system using information theoretic approach.**	
Unit VI	**Error-Control Coding**	**(06 Hrs)**
Linear Block Codes: Coding, Syndrome and error detection, Error detection and correction capability, Standard array and syndrome decoding. Cyclic Codes: Coding & Decoding, Convolutional Codes: Coding & Decoding, Introduction to Turbo Codes & LDPC Codes.		
Mapping of Course Outcomes for Unit VI	**CO5: Use error control coding techniques to improve performance of a digital communication system.**	

Learning Resources

Text Books:

1. Taub, Schilling and Saha, "Principles of Communication Systems", McGraw-Hill, 4th Edition,
2. B.P. Lathi, Zhi Ding , "Modern Analog and Digital Communication System", Oxford University Press, 4th Edition.

Reference Books:

1. Bernard Sklar, Prabitra Kumar Ray, "Digital Communications Fundamentals and Applications", Pearson Education, 2nd Edition
2. Wayne Tomasi, "Electronic Communications System", Pearson Education, 5th Edition
3. A.B Carlson, P B Crully, J C Rutledge, "Communication Systems", Tata McGraw Hill Publication, 5th Edition
4. Simon Haykin, "Communication Systems", John Wiley & Sons, 4th Edition
5. Simon Haykin, "Digital Communication Systems", John Wiley & Sons, 4th Edition.

MOOC / NPTEL Courses:

1. NPTEL Course on **"Digital Communications"**

Link of the Course: **https://nptel.ac.in/courses/108/102/108102096/**

Savitribai Phule Pune University

Third Year of E & Tc Engineering (2019 Course)

304182: Electromagnetic Field Theory

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 hrs. / week **Tutorial: 01 hr. / week**	**03 + 01 = 04**	**In-Sem (Theory): 30 Marks** **End Sem (Theory): 70 Marks** **Term Work: 25 Marks**

Prerequisite Courses, if any:

1. Vectors, Vector Calculus
2. Coordinate Geometry, Cartesian, Cylindrical, Spherical
3. Engineering Mathematics III

Companion Course, if any: Electromagnetic Field Theory Tutorials

Course Objectives:

- Provide the foundation and rudiments of Electromagnetic theory essential to subsequent courses of radiation, microwave and wireless communications.
- Expose the students to basic laws of electro statics, magneto statics leading to the Maxwell Equations for static and dynamic fields.
- Extend these laws to Uniform Plane waves, transmission line theory and some of the case studies of applications of engineering electromagnetic field theory.
- The main focus will be on the physical interpretation of all the mathematical formulations and extend these concepts to real time applications in the field Electronics and Telecommunication Engineering.

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

CO1: Apply the basic electromagnetic principles and determine the fields (E & H) due to the given source.

CO2: Apply boundary conditions to the boundaries between various media to interpret behavior of the fields on either sides.

CO3: State, Identify and Apply Maxwell's equations (integral and differential forms) in both the forms (Static, time-varying or Time-harmonic field) for various sources, Calculate the time average power density using Poynting Theorem, Retarded magnetic vector potential.

CO4: Formulate, Interpret and solve simple uniform plane wave (Helmholtz Equations) equations, and analyze the incident/reflected/transmitted waves at normal incidence.

CO5: Interpret and Apply the transmission line equation to transmission line problems with load impedance to determine input and output voltage/current at any point on the Transmission line, Find input/load impedance, input/load admittance, reflection coefficient, SWR, Vmax/Vmin, length of transmission line using Smith Chart.

CO6: Carry out a detailed study, interpret the relevance and applications of Electromagnetics.

Course Contents		
Unit I	**Electrostatics**	**(08 Hrs.)**
Review of 3D Coordinate Geometry, Vector Calculus, Physical significance of Gradient, Divergence, Curl, Electric field intensity(E), Displacement Flux Density(D), Gauss's law, Electric potential(V), Potential Gradient, E/D/V due to uniform sources (point charge, infinite line charge, infinite surface charge) , Maxwell Equations for Electrostatics, Current, Current Density, physical interpretation. **Application Case Study:** Electrostatic Discharge, Cathode Ray Oscilloscope.		
Mapping of Course Outcomes for Unit I	**CO1: Apply the basic electromagnetic principles and determine the fields (E & H) due to the given source.** **CO6: Carry out a detailed study, interpret the relevance and applications of Electromagnetics.**	
Unit II	**Magneto statics**	**(06 Hrs)**
Lorentz force, magnetic field intensity (H), Magnetic Flux Density(B), – Biot–Savart's Law – Ampere's Circuit Law – H due to straight conductors, circular loop, infinite sheet of current, Maxwell Equations for Magneto Statics, physical interpretation. **Application Case Study:** Lightning, Magnetic Resonance Imaging (MRI).		
Mapping of Course Outcomes for Unit II	**CO1: Apply the basic electromagnetic principles and determine the fields (E & H) due to the given source.** **CO6: Carry out a detailed study, interpret the relevance and applications of Electromagnetics.**	
Unit III	**Boundary Conditions**	**(06 Hrs)**
Electric Dipole, Dielectric Polarization, Properties of Conductors, Dielectric Materials, Boundary conditions (dielectric-dielectric, conductor –dielectric), significance and applications of Poisson's and Laplace's equations - Capacitance, Energy density. Magnetization, magnetic materials, Boundary conditions for Magnetic Fields, Magnetic force, Torque. **Application Case Study:** RF MEMS, Magnetic Levitation, Electromagnetic Pump.		
Mapping of Course Outcomes for Unit III	**CO2: Apply boundary conditions to the boundaries between various media to interpret behavior of the fields on either sides.** **CO6: Carry out a detailed study, interpret the relevance and applications of Electromagnetics.**	

Unit IV	Time Varying Electromagnetic Fields: Maxwell Equations	(06 Hrs)
Scalar and Vector Magnetic Potential, Poisson's and Laplace Equations, Faraday's law, Translational and motional emf, Displacement current density, Continuity Equation, Time varying Maxwell's equations - point form, integral form, Power and Poynting theorem, concept of Retarded magnetic vector potential, **Application Case Study:** Memristor, Electric Motors, Generators.		
Mapping of Course Outcomes for Unit IV	**CO3: State, Identify and Apply Maxwell's equations (integral and differential forms) in both the forms (Static, time-varying or Time-harmonic field) for various sources, Calculate the time average power density using Poynting Theorem, Retarded magnetic vector potential.** **CO6: Carry out a detailed study, interpret the relevance and applications of Electromagnetics**	
Unit V	**Uniform Plane Waves**	**(6 Hrs)**
Maxwell's equation using phasor notations, Electromagnetic wave equations (Helmholtz equation), Relation between E and H, depth of penetration, concept of polarization, Reflection by perfect conductor-normal incidence, reflection by perfect dielectric- normal incidence, Snell's law. **Application Case Study:** Comparison of Circuit Theory at low frequency and Field theory at High frequencies, Antenna Radiation Mechanism, Propagation of EM energy.		
Mapping of Course Outcomes for Unit V	**CO4: Formulate, Interpret and solve simple uniform plane wave (Helmholtz Equations) equations, and analyze the incident/reflected/transmitted waves at normal incidence.** **CO6: Carry out a detailed study, interpret the relevance and applications of Electromagnetics.**	
Unit VI	**Transmission Line Theory**	**(06 Hrs)**
Line parameters, skin effect, general solution, physical significance of the equations, wavelength, velocity of propagation, the distortion less line, Reflection on a line not terminated in Z0, reflection coefficient, open and short circuited lines, reflection coefficient and reflection loss, standing waves; nodes; standing wave ratio, Input impedance of dissipation less line, Smith Chart and its applications in solving the transmission line parameters. **Application Case Study:** Coaxial Cable, Twisted Pair, Microwave Waveguides		

Mapping of Course Outcomes for Unit VI	**CO5: Interpret and Apply the transmission line equation to transmission line problems with load impedance to determine input and output voltage/current at any point on the Transmission line, Find input/load impedance, input/load admittance, reflection coefficient, SWR, Vmax/Vmin, length of transmission line using Smith Chart.** **CO6: Carry out a detailed study, interpret the relevance and applications of Electromagnetics.**

Learning Resources

Text Books:

1. M.N.O. Sadiku and S.V. Kulkarni, "Principles of Electromagnetics", Oxford University Press, India, 2015 (Asian adaptation of 'M.N.O. Sadiku, Elements of Electromagnetics, Sixth International Edition, Oxford University Press'), 6th Edition
2. William H. Hayt and John A. Buck, "Engineering Electromagnetics", Tata McGraw Hill, 8th Revised Edition.

Reference Books:

1. Kraus and Fleish, "Electromagnetics with Applications", McGraw Hill International Editions, 5th Edition.
2. Jordan and Balmain, "Electromagnetic Waves and Radiating Systems", PHI, 1964.

MOOC / NPTEL Courses:

1. NPTEL Course "Transmission Lines and EM Waves -Video course" Prof. R.K. Shevgaonkar
   Link of the Course: https://nptel.ac.in/courses/117/101/117101056/

2. NPTEL Course on "Electromagnetic theory - Video course" Dr. Pradeep Kumar K
   Link of the Course: https://nptel.ac.in/courses/108/104/108104087/

3. David Staelin. 6.013 Electromagnetics and Applications. Spring 2009. Massachusetts Institute of Technology: MIT Open Course Ware
   Link:https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-013-electromagnetics-and-applications-spring-2009/index.htm#

List of Tutorials to be carried out

At least 5 Assignments should be conducted using Virtual Electromagnetic Lab, https://www.ee.iitb.ac.in/course/~vel/	
1.	Vector analysis, Electric field Intensity(E): Due to Q, ρ_L, ρ_S
2.	Gauss's Law, Electric flux Density(D) & Electrical Potential (V) : Due to Q, ρ_L, ρ_S,
3.	Electrostatic Boundary Conditions: dielectric-dielectric, conductor –dielectric
4.	Poisson's and Laplace's Equation: Capacitance, Energy density.
5.	Magnetic field Intensity (H)- Biot-Savart: Due to I dL, K dS, J dV, and Ampere's circuital law
6.	Magnetic Boundary Conditions, Inductance, Force, Torque, Energy density.
7.	Faradays Law, Maxwell's Equations
8.	Poynting Theorem, Retarded Magnetic Potential
9.	Transmission line: Primary & Secondary Constants , V & I
10	Reflection Coefficient, SWR, etc using Smith Chart
11	Uniform Plane Waves: Wave parameters, Incidence/Reflection /transmission of UPW.
12	All-important derivations
13	Case Study of EMF Applications to real life and wireless communication

Savitribai Phule Pune University

Third Year of E & Tc Engineering (2019 Course)

304183: Database Management

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. Data Structures

Companion Course, if any: Database Management Lab

Course Objectives:

- To understand fundamental concepts of database from its design to its implementation.
- To analyze database requirements and determine the entities involved in the system and with one another.
- To manipulate database using SQL Query to create, update and manage Database.
- Be familiar with the basic issues of transaction processing and concurrency control.
- To learn and understand Parallel Databases and its Architectures.
- To learn and understand Distributed Databases and its applications.

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

CO1: Ability to implement the underlying concepts of a database system.

CO2: Design and implement a database schema for a given problem-domain using data model.

CO3: Formulate, using SQL/DML/DDL commands, solutions to a wide range of query and update problems.

CO4: Implement transactions, concurrency control, and be able to do Database recovery.

CO5: Able to understand various Parallel Database Architectures and its applications.

CO6: Able to understand various Distributed Databases and its applications.

Course Contents

Unit I	Introduction to DBMS	(07 Hrs.)

Introduction to Database Management Systems, Purpose of Database Systems, Database-System Applications, Data Abstraction and Database System Structure.

Relational Model: Structure of relational databases, Domains, Relations, Relational algebra – fundamental operators and syntax, relational algebra queries, tuple relational calculus.

Entity-Relationship model: Basic Concepts, Entity Set, Relationship Sets and Weak Entity Sets, Mapping Cardinalities, Keys, E-R diagrams, Design Issues, Extended E-R Features, Converting E-R & EER diagram into tables.

Mapping of Course Outcomes for Unit I	**CO1: Ability to implement the underlying concepts of a database system.**

Unit II	Relational Database Design	(06 Hrs.)
Basic concepts, CODD's Rules, Relational Integrity: Domain, Referential Integrities, Enterprise Constraints, Database Design: Features of Good Relational Designs, Normalization, Atomic Domains and First Normal Form, Decomposition using Functional Dependencies, Algorithms for Decomposition, 2NF, 3NF, 4NF and BCNF.		
Mapping of Course Outcomes for Unit II	**CO2: Design and implement a database schema for a given problem-domain using data model.**	
Unit III	**Basics of SQL**	**(07 Hrs.)**
DDL, DML, DCL, Structure: Creation, Alteration, Defining constraints – Primary key, Foreign key, Unique key, Not null, Check, IN operator, Functions - Aggregate Functions, Built-in Functions –Numeric, Date, String Functions, Set operations, sub-queries, correlated subqueries, Use of group by, having, order by, join and its types, Exist, Any, All, view and its types. **Transaction control commands**: Commit, Rollback, Save-point PL/SQL Concepts: Cursors, Stored Procedures, Stored Function, Database Triggers.		
Mapping of Course Outcomes for Unit III	**CO3: Formulate, using SQL/DML/DDL commands, solutions to a wide range of query and update problems.**	
Unit IV	**Database Transactions Management**	**(07 Hrs.)**
Basic concepts of a Transaction, Transaction Management, Properties of Transactions, Concept of Schedule, Serial Schedule, Serializability: Conflict and View, Cascaded Aborts, Recoverable and Non-recoverable Schedules, Concurrency Control: Need, Locking Methods, Deadlock handling and Time-stamp based Protocols.		
Mapping of Course Outcomes for Unit IV	**CO4: Implement transactions, concurrency control, and be able to do Database recovery.**	
Unit V	**Parallel Databases**	**(06 Hrs.)**
Introduction to Database Architectures: Multi-user DBMS Architectures, Case study- Oracle Architecture. **Parallel Databases:** Performance Parameters for Parallel Databases, Types of Parallel Database Architecture, Evaluating Parallel Query in Parallel Databases and Virtualization on Multicore processors.		
Mapping of Course Outcomes for Unit V	**CO5: Able to understand various Parallel Database Architectures and applications.**	
Unit VI	**Distributed Databases**	**(07 Hrs.)**
Distributed Databases: Distributed Database Management System, Factors Encouraging DDBMS, Advantages of Distributed Databases, Types of Distributed Databases, Architecture of Distributed Databases, Distributed Database Design, Distributed Data Storage, and Distributed Transaction: Basics, Failure modes, Commit Protocols, Concurrency Control in Distributed Database.		
Mapping of Course Outcomes for Unit VI	**CO6: Able to understand various Distributed Databases and its applications.**	

Learning Resources

Text Books:

1. A. Silberschatz, H.F. Korth and S. Sudarshan , "Database System Concepts", McGraw Hill, 6th Edition.
2. C.J. Date, A. Kannan, S. Swamynathan "An introduction to Database Systems", Pearson, 8th Edition.

Reference Books:

1. Martin Gruber, "Understanding SQL", Sybex Publications.
2. Ivan Bayross, "SQL- PL/SQL", BPB Publications, 4th Edition.
3. S.K. Singh, "Database Systems: Concepts, Design and Application", Pearson, Education, 2nd Edition.

MOOC / NPTEL Courses:

1. NPTEL Course **"Database Management System"**

   Link of the Course: https://nptel.ac.in/courses/106/106/106106220/

Savitribai Phule Pune University Third Year of E & Tc Engineering (2019 Course) 304184: Microcontroller		
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 Logic Design
2. Electronic Components and Hardware
3. Basics of C Language.

Companion Course, if any: Microcontroller Lab

Course Objectives: During the course study students will be able to

- Understand architecture and features of 8051 and PIC18FXX Microcontroller.
- Learn interfacing of real-world peripheral devices with microcontroller.
- Explore different features of PIC 18F Microcontroller with Architecture.
- Use concepts of timers and interrupts of PIC 18 in programming.
- Design and develop microcontroller based embedded application.
- Demonstrate real life applications using PIC 18.

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

CO1: Understand the fundamentals of microcontroller and programming.

CO2: Interface various electronic components with microcontrollers.

CO3: Analyze the features of PIC 18F XXXX.

CO4: Describe the programming details in peripheral support.

CO5: Develop interfacing models according to applications.

CO6: Evaluate the serial communication details and interfaces.

Course Contents

Unit I	Introduction to Microcontroller Architecture	(06 Hrs.)

Difference between microprocessor and microcontroller Introduction to the Microcontroller classification, Feature and block diagram of 8051 and explanation, Program Status Word (PSW), 8051. Overview of Instruction set, memory organization, Interrupt structure, timers and its modes, Serial communication: concept of baud rate, Data transmission and reception using Serial port. Sample programs of data transfer, Delay using Timer (0&1) and interrupt, Data transmission and reception using Serial port. I/O Port Programming, All programs in C language.

Mapping of Course Outcomes for Unit I	CO1: Understand the fundamentals of microcontroller and programming

Unit II	IO Port Interfacing-I	(06 Hrs.)
Pin diagram and its functioning Port structure, IO Interfacing Requirements, Interfacing of: LEDS, Keys, 7-segment multiplexed display, DAC 0808, ADC 0809 Stepper motor, Relay, Buzzer, Opto-isolators, \ Design of Data acquisition System (DAS): All programs in C language		
Mapping of Course Outcomes for Unit II	**CO2: Interface various electronic components with microcontrollers**	
Unit III	**PIC 18F XXXX Microcontroller Architecture**	**(06 Hrs.)**
Comparison of PIC family, Criteria for Choosing Microcontroller, features, PIC18FXX architecture with generalized block diagram. MCU, Program and Data memory organization, Bank selection using Bank Select Register, Pin out diagram, Reset operations, Watch Dog Timers, Configuration registers and oscillator options (CONFIG), Power down modes , Brief summary of Peripheral support, Overview of instruction set.		
Mapping of Course Outcomes for Unit III	**CO3: Analyze the features of PIC18F XXXX**	
Unit IV	**Peripheral Support in PIC 18FXXXX**	**(06 Hrs.)**
Timers and its Programing (mode 0 &1), Interrupt Structure of PIC18F with SFR, PORTB change Interrupts, use of timers with interrupts, CCP modes: Capture, Compare and PWM generation, DC Motor speed control with CCP, Block diagram of in-built ADC with Control registers, Sensor interfacing using ADC: All programs in embedded C.		
Mapping of Course Outcomes for Unit IV	**CO4: Describe the programming details in peripheral support**	
Unit V	**Real Word Interfacing With 18FXXXX**	**(06 Hrs.)**
Port structure with programming, Interfacing of LED, LCD and Key board, Motion Detectors, DAC for generation of waveform, Design of PIC test Board and debugging, Home protection System: All programs in embedded C.		
Mapping of Course Outcomes for Unit V	**CO5: Develop interfacing models according to applications**	
Unit VI	**Serial Port Programming interfacing with 18FXXXX**	**(06 Hrs.)**
Basics of Serial Communication Protocol: Study of RS232, RS 485, I2C, SPI, MSSP structure (SPI & I2C), USART (Receiver and Transmitter), interfacing of RTC (DS1307) with I2C and EEPROM with SPI. Design of Traffic Light Controller; All programs in embedded C.		
Mapping of Course Outcomes for Unit VI	**CO6: Evaluate the serial communication details and interfaces**	

Learning Resources

Text Books:

1. Mahumad Ali Mazadi, Janice Gillispie Mazadi, Rolin D McKinlay, "The 8051 Microcontroller & Embedded Systems (Using Assembly and C)", PHI, 2nd Edition
2. Mahumad Ali Mazadi, Rolin D McKinlay and Danny Causey, "PIC Microcontroller & Embedded System", Pearson Education, 3rd Edition

Reference Books:

1. Kenneth J. Ayala, 'The 8051 Microcontroller Architecture, Programming and Applications', Cengage Learning, 3rd Edition
2. Ajay Deshmukh, "Microcontrollers Theory and Applications", TATA McGraw Hill, 4th Edition
3. Peatman, John B, "Design with PIC Microcontroller", Pearson Education PTE, 1st Edition
4. Data Sheet of PIC 18Fxxxx series

MOOC / NPTEL Courses:

1. NPTEL Course **"Microcontroller and Applications"**

   Link of the Course: **https://nptel.ac.in/courses/117/104/117104072/**

   https://nptel.ac.in/courses/108/105/108105102/

Savitribai Phule Pune University Third Year of E & Tc Engineering (2019 Course) 304185 (A): Digital Signal Processing (Elective - I)		
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: Digital Signal Processing Lab

Course Objectives:

- Understand the sampling, aliasing and block schematic of digital signal processing.
- Introduction of transforms for analysis of systems using Z transform.
- Introduction of DFT, FFT, DCT transforms for analysis of DT signals.
- Design and implementation of IIR digital filters.
- Design and implementation of FIR digital filters.
- Apply DSP algorithms/techniques.

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

CO1: Interpret and process discrete/ digital signals and represent DSP system.

CO2: Analyze the digital systems using the Z-transform techniques.

CO3: Implement efficient transform and its application to analyze DT signals.

CO4: Design and implement IIR filters.

CO5: Design and implement FIR filters.

CO6: Apply DSP techniques for speech/ biomedical/ image signal processing.

Course Contents

Unit I	DSP Preliminaries	(06 Hrs.)

Discretization of Analog Signals: Sampling theorem in time domain, recovery of analog signals, and analytical treatment with examples, mapping between analog frequencies to digital frequency, Concept of Interpolation and decimation in signal processing, Representation of signals as vectors, concept of Basis function and orthogonality, Basic elements of DSP and its requirements, advantages of Digital over Analog signal processing, Introduction to DSP processor (TMS 320 XX 6713).

Mapping of Course Outcomes for Unit I	CO1: Interpret and process discrete/ digital signals and represent DSP system.

Unit II	Z-Transform	(06 Hrs.)

Need for Z-transform, relation between Laplace transform and Z transform, relation between Fourier transform and Z transform, Concept of ROC and Properties of ROC, Relation between pole locations and time domain

behavior, causality and stability considerations for LTI systems,Solution of difference equations using Z transform.		
Mapping of Course Outcomes for Unit II	**CO2: Analyze the digital systems using the Z-transform techniques.**	
Unit III	**Transforms (DFT-FFT)**	**(08 Hrs.)**
Frequency domain sampling , DFT, Properties of DFT, circular convolution, Computation of linear convolution using circular convolution, FFT, decimation in time (DIT) and decimation in frequency(DIF) using Radix-2 FFT algorithm for 4 point and 8 point sequences, DFT & FFT computation complexity for 4 point and 8 point sequences, Linear filtering (Block convolution or Long sequence convolution) using overlap add and overlap save method.		
Mapping of Course Outcomes for Unit III	**CO3: Implement efficient transform and its application to analyze DT signals.**	
Unit IV	**IIR Filter Design**	**(06 Hrs.)**
Concept of analog filter design, IIR filter design by approximation of backward derivatives, IIR filter design by impulse invariance method, Bilinear transformation method, warping effect. Butterworth filter design, Characteristics of Butterworth filters and Chebyshev filters, IIR filter realization using direct form, cascade form and parallel form, Finite word length effect in IIR filter design.		
Mapping of Course Outcomes for Unit IV	**CO4: Design and implement IIR filters.**	
Unit V	**FIR Filter Design**	**(06 Hrs.)**
Windowing techniques: Gibbs phenomenon, characteristics and comparison of different window functions, Linear phase conditions: impulse and phase and group delays, Design of linear phase FIR filter using windows: Rect, Hanning, Hamming, Blackmann & Kaiser, Magnitude and Phase response of Digital filters, Frequency response of Linear phase FIR filters, FIR filter realization using Direct Form, Cascade and linear phase structure.		
Mapping of Course Outcomes for Unit V	**CO5: Design and implement FIR filters.**	
Unit VI	**Introduction to 1D & 2D Signal Processing**	**(06 Hrs.)**
Dimensionality of signals, Introduction of 1D signals **Speech:** Basics of speech signal and its features, LTI representation of speech signal, Estimation of fundamental frequency, identification of voiced and unvoiced speech and noise removal **Biomedical Signal:** Basics of ECG and its features, Spectral Analysis using FFT, Artifacts suppression, Algorithms for R peak detection **Fundamentals of image processing:** Representation of digital image, Spatial and Temporal resolution, 2D convolution for feature extraction.		

Mapping of Course Outcomes for Unit VI	CO6: Apply DSP techniques for speech/ biomedical/ image signal Processing.

Learning Resources

Text Books:

1. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Pearson Prentice Hall, 4th Edition.
2. Dr. Shaila Apte , "Digital Signal Processing", Wiley India Publication, 2nd Edition.
3. S. Salivahanan, C. Gnanapriya , "Digital Signal Processing", McGraw Hill, 2nd Edition.

Reference Books:

1. Ifeachor E.C, Jervis B. W, "Digital Signal Processing : Practical approach", Pearson Publication, 2nd Edition.
2. Li Tan , "Digital Signal Processing : Fundamentals and Applications", Academic Press, 3rd Edition.
3. Schaum's Outline of "Theory and Problems of Digital Signal Processing", 2nd Edition.
4. Oppenheim, Schafer , "Discrete-time Signal Processing", Pearson Education, 1st Edition.
5. K.A. Navas, R. Jayadevan , "Lab Primer through MATLAB", PHI, Eastern Economy Edition.

MOOC / NPTEL Courses:

1. NPTEL Course on "**Digital Signal Processing**"

   Link of the Course: https://nptel.ac.in/courses/117/102/117102060/

2. NPTEL Course on "**Digital Signal Processing**"

   Link of the Course: https://nptel.ac.in/courses/108/105/108105055/

Savitribai Phule Pune University

Third Year of E & Tc Engineering (2019 Course)

304185 (B): Electronic Measurements (Elective - I)

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

Prerequisite Courses, if any:
1. Basic Electronics Engineering
2. Electronic Skill Development Lab

Companion Course, if any: Electronic Measurements Lab

Course Objectives: To make the students understand

- Fundamental principles of measurement systems.
- Basic electronics measuring instruments and analyzers.
- Use of different types of Signal Generators.
- Working principle and use of different types of Oscilloscopes.
- Use of other display devices, recorders and timer/counter.
- Advanced measurement systems.

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

CO1: Understand the metrics for the measurement system

CO2: Select and use the instruments for measurement & analysis of basic electronic parameters

CO3: Identify and use the different signal generators for specific applications

CO4: Understand the principles of different Oscilloscopes for specific applications

CO5: Identify the use of other display devices, recorders and timer/counter in measurement systems

CO6: Use the advanced measurement systems for electronics parameter measurement

Course Contents

Unit I	Basics of Measurements	(06 Hrs.)

Units Systems, Standards, Measurement system characteristics (static and dynamic), Statistical metrics in measurement systems, probability of errors, Calibration of measurement system.

Mapping of Course Outcomes for Unit I	CO1: Understand the metrics for the measurement system.

Unit II	Electronics Measurements	(07 Hrs.)

Voltage & current measurement, Digital Voltmeter (DVM), types of DVM, Digital Multi meter, true r.m.s. voltmeter, Vector voltmeter, Impedance meter, Q-meter, Harmonic Distortion analyzers, Wave analyzer, Spectrum Analyzer, Network Analyzer, Logic Analyzer.

Mapping of Course Outcomes for Unit II	**CO2: Select and use the instruments for measurement & analysis of basic electronic parameters.**	
Unit III	**Signal Generators**	**(06 Hrs.)**
Audio, RF, Micro wave signal generators, Frequency synthesis techniques, Synthesizers, digital signal generators, Noise generators, characteristics of Pulse, signal and noise.		
Mapping of Course Outcomes for Unit III	**CO3: Identify and use different signal generators for specific applications.**	
Unit IV	**Special purpose CRO**	**(07 Hrs.)**
Dual trace CRO, DSO, Sampling CRO, curve Tracer, Power Oscilloscopes, Delayed sweep CRO, Component Test, Z-modulation and X-Y mode operations, Measurements on oscilloscope, Oscilloscope accessories.		
Mapping of Course Outcomes for Unit IV	**CO4: Understand the principles of different Oscilloscopes for specific applications.**	
Unit V	**Display devices, Recorders and universal counter / Timer**	**(06 Hrs.)**
LCD Display, LED/OLED Display, Plasma Display, X-Y Plotters, Strip Chart Recorders, Universal counter/ Timers (**for time period, time interval, frequency, frequency ratio and pulse measurement**), Communication buses PC / instruments (**EIA/TIA 232, 423, 422, 488**), Internal & external acquisition cards.		
Mapping of Course Outcomes for Unit V	**CO5: Identify the use of other display devices, recorders and timer/counter in measurement system.**	
Unit VI	**Advanced measurement systems**	**(06 Hrs.)**
Automatic Test Equipments, Microwave measurements using Network Analyzer, EMI/EMC test instruments, OTDR, Field Strength Meter, Industrial revolutions & their impact on Industrial Automation, Case study of Electronics Measurement Systems (e.g. **DSO, Multi trace CRO, Spectrum Analyzer, Logic Analyzer**)		
Mapping of Course Outcomes for Unit VI	**CO6: Use the advanced measurement systems for electronics parameter measurement.**	

Learning Resources

Text Books:

1. Oliver-Cage, “Electronic Measurements and Instrumentation”, TMH.
2. Cooper & Helfrick, “Modern Electronics Instrumentation & Measurement Techniques”, PHI, 3rd Edition.

Reference Books:

1. M.M.S. Anand, "Electronics Instruments and Instrumentation Technology", PHI, Eastern Economy Edition.
2. A.K. Sawhney, Puneet Sawhney "A Course in Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai & Co.
3. Allen Moris, Reza Langari, "Measurement and Instrumentation Theory & Applications", Elsevier, Academic Press, 2nd Edition
4. H. S. Kalsi, "Electronics Instrumentation" TMH, 2nd Edition.
5. Elena Popkova, Yulia V. Ragulina, Aleksei V. Bogoviz, "Industry 4.0_ Industrial Revolution of the 21st Century: Studies in Systems, Decision and Control", Springer Volume 169

MOOC / NPTEL Courses:

1. NPTEL Course on **"Electrical Measurements & Electronics Instruments "**
   Link of the Course: https://nptel.ac.in/courses/108/105/108105153/

2. NPTEL Course on **"Introduction to Industry 4.0 and Industrial Internet of Things"**
   Link of the Course: https://onlinecourses.nptel.ac.in/noc21_cs66/preview

3. NPTEL Course on **"Design Principles of RF and Microwave Filters and Amplifiers"**
   Link of the Course: https://nptel.ac.in/courses/117/105/117105138/

4. NPTEL Course **"Optical communications"**
   Link of the Course: https://nptel.ac.in/courses/117/104/117104127/

Savitribai Phule Pune University

Third Year of E & Tc Engineering (2019 Course)

304185 (C): Fundamentals of JAVA Programming (Elective - I)

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. Data Structures
2. Object Oriented Programming concept

Companion Course, if any: Fundamentals of JAVA Programming Lab

Course Objectives:

- Make the students familiar with basic concepts and techniques of object oriented programming in Java.
- Develop an ability to write various programs in Java for problem solving.

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

CO1: Understand the basic principles of Java programming language

CO2: Apply the concepts of classes and objects to write programs in Java

CO3: Demonstrate the concepts of methods & Inheritance

CO4: Use the concepts of interfaces & packages for program implementation

CO5: Understand multithreading and Exception handling in Java to develop robust programs

CO6: Use Graphics class, AWT packages and manage input and output files in Java

Course Contents

Unit I	**JAVA Fundamentals**	**(08 Hrs.)**

Review of Object oriented concepts, Evolution of Java, Comparison of Java with other programming languages, Java features, Java and World Wide Web, Java Run Time Environment. JVM architecture. Overview of Java Language, Simple Java Program, Java Program Structure. Installing and Configuring Java.

Java Tokens, Java Statements, Constants, variables, data types. Declaration of variables, Giving values to variables, Scope of variables, arrays, Symbolic constants, Typecasting, Getting values of variables, Standard default values, Operators, Expressions, Type conversion in expressions, Operator precedence and associatively, Mathematical functions, Control statements- Decision making & looping.

Mapping of Course Outcomes for Unit I	**CO1: Understand the basic principles of Java programming language.**

Unit II	Classes and Objects	(06 Hrs.)
Class Fundamentals, Creating Objects, Accessing Class members, Assigning Object reference variables, Methods, Constructors, using objects as parameters, Argument passing, returning objects, Method Overloading, static members, Nesting of Methods , this keyword, Garbage collection, finalize methods, , final variables and methods, final class.		
Mapping of Course Outcomes for Unit II	**CO2: Apply the concepts of classes and objects to write programs in Java**	
Unit III	**Methods & Inheritance in JAVA**	**(06 Hrs.)**
Abstract Methods and classes, Strings ,One dimensional and two dimensional arrays , wrapper classes, enumerated types, Command line arguments **Inheritance:** Inheritance in Java, Creating Multilevel hierarchy, Constructors in derived class, Method overriding, Dynamic method dispatch.		
Mapping of Course Outcomes for Unit III	**CO3: Demonstrate the concepts of methods & Inheritance.**	
Unit IV	**Interfaces & Packages**	**(06 Hrs.)**
Interfaces: Define, implement and extend, Accessing Interface variables, Default interface methods, Using static method in interface **Packages:** Java API Packages, Using System Packages, Creating accessing and using a package, Importing packages, Adding a class to a Package, Hiding classes.		
Mapping of Course Outcomes for Unit IV	**CO4: Use the concept of interfaces & packages for program implementation.**	
Unit V	**Multithreading & Exception Handling**	**(06 Hrs.)**
Introduction to multithreading: Introduction, Creating thread and extending thread class. Concept of Exception handling: Introduction, Types of errors, Exception handling syntax, Multiple catch statements. I/O basics, Reading console inputs, Writing Console output. Applets: Concepts of Applets, differences between applets and applications, life cycle of an applet, types of applets, creating a simple applet.		
Mapping of Course Outcomes for Unit V	**CO5: Understand multithreading and Exception handling in Java to develop robust programs**	

Unit VI	Graphics Programming and File Handling	(06 Hrs.)
Graphics class, Introduction to AWT packages, Handling events on AWT components, Introduction to Swing package, components and containers. **Managing input/output files**: Concept of streams, Stream Classes, Byte stream, Character stream, Using Stream, creation of files, reading or writing characters / bytes, Concatenating and buffering files, Random access files.		
Mapping of Course Outcomes for Unit VI	**CO6: Use Graphics class, AWT packages and manage input and output files in Java**	

Learning Resources

Text Books:

1. E Balagurusamy, "Programming with JAVA", Tata McGraw Hill, 6th Edition.
2. Herbert Schildt, "Java: The complete reference", Tata McGraw Hill, 7th Edition.

Reference Books:

1. T. Budd, "Understanding OOP with Java", Pearson Education, 2nd Updated Edition.
2. Y. Daniel Liang (2010), "Introduction to Java programming", Pearson Education, India, 7th Edition.
3. Cay Horstmann , "Core Java Volume 1", Kindle, 11th Edition.

MOOC / NPTEL Courses:

1. NPTEL Course **"Programming in Java"**

Link of the Course: https://nptel.ac.in/courses/106/105/106105191/

Savitribai Phule Pune University

Third Year of E & Tc Engineering (2019 Course)

304185 (D): Computer Networks (Elective - I)

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
2. Digital Communication

Companion Course, if any: Computer Networks Lab

Course Objectives:

- To understand the concepts of networking, its standards and protocols.
- To learn controlling techniques in networking at different layers.
- To learn protocols at different layers of reference model.
- To understand routing and networking in inter and intra domain.
- To learn network programming.
- To understand applications, protocols and its implication in networks.

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

CO1: Design LAN using appropriate networking architecture, topologies, transmission media, and networking devices.

CO2: Understand the working of controlling techniques for flawless data communication using data link layer protocols.

CO3: Learn the functions of network layer, various switching techniques and internet protocol addressing.

CO4: Explore various interior and exterior, unicasting and multicasting protocols.

CO5: Analyze data flow using TCP/UDP Protocols, congestion control techniques for QoS.

CO6: Illustrate the use of protocols at application layer.

Course Contents

Unit I	**Basics of Network & Physical Layer**	**(07 Hrs.)**

Types of networks, Network topologies, Design issues for Layers, Network models, OSI model & TCP / IP protocol suite, Types of addressing.

Mapping of Course Outcomes for Unit I	**CO1: Design LAN using appropriate networking architecture, topologies, transmission media, and networking devices.**

Unit II	Data Link Layer	(06 Hrs.)
Data link control, Framing, Flow and error control, Protocols for Noiseless, and Noisy Channels, HDLC, Point to Point Protocol, Media Access Control: Random Access, Controlled Access- Reservation, Channelization protocols.		
Mapping of Course Outcomes for Unit II	**CO2: Understand the working of controlling techniques for flawless data communication using data link layer protocols**	
Unit III	**Network Layer -I**	**(07 Hrs.)**
Introduction to Network Layer: Network-Layer Services, Circuit switching, Packet Switching, Network-Layer Performance, IPv4 Addresses, Forwarding of IP Packets, Network Layer Protocols: Internet Protocol (IP), ICMPv4, Next Generation IP: IPv6 Addressing, The IPv6 Protocol, The ICMPv6 Protocol, Transition from IPv4 to IPv6.		
Mapping of Course Outcomes for Unit III	**CO3: Learn the functions of network layer, various switching techniques and internet protocol addressing.**	
Unit IV	**Network Layer - II**	**(07 Hrs.)**
Unicast & Multicast Routing: Introduction, Routing Algorithms, Unicast Routing Protocols, Introduction, Multicasting Basics, Intra-domain Multicast Protocols, Inter-domain Multicast Protocols, IGMP Distance Vector, Link State, Path Vector, Routing in Internet: RIP, OSPF, BGP.		
Mapping of Course Outcomes for Unit IV	**CO4: Explore various interior and exterior, unicasting and multicasting protocols.**	
Unit V	**Transport Layer**	**(06 Hrs.)**
Introduction to transport layer, User Datagram Protocol, Transmission Control Protocol, TCP Congestion Policy, Stream Control Transmission Protocol, Congestion control and QoS, socket programing .		
Mapping of Course Outcomes for Unit V	**CO5: Analyze data flow using TCP/UDP Protocols, congestion control techniques for QoS.**	
Unit VI	**Application Layer**	**(05 Hrs.)**
Introduction to Application Layer, Standard Client Server Protocols: World Wide Web and HTTP, Telnet, FTP, Email, SMTP, IMAP, POP, DNS, BOOTP, DHCP.		
Mapping of Course Outcomes for Unit VI	**CO6: Illustrate the use of protocols at application layer.**	

Learning Resources

Text Books:

1. Behrouz A. Foruzan, "Data communication and Networking", Tata McGraw-Hill, 5th Edition.
2. Achyut S Godbole, "Data Communication and Networking", Tata McGraw-Hill, 1st Edition.

Reference Books:

1. Andrew S. Tannenbaum, "Computer Networks", Pearson Education,4th Edition, 2003
2. Wayne Tomasi, "Introduction to Data Communication and Networking", Pearson Education, 1st Edition.
3. Greg Tomsho, Ed Tittel, David Johnson. "Guide to Networking Essentials", Thomson India Learning, 5th Edition, 2007.
4. William Stallings, "Data and Computer Communication", Pearson Education, 8th Edition, 2000
5. James F. Kurouse & W. Rouse, "Computer Networking: A Top down Approach", Pearson Education, 6th Edition.

MOOC / NPTEL Courses:

1. Computer Networks - Course (swayam2.ac.in)
2. Introduction to Computer Networks & Internet Protocols - Course (swayam2.ac.in)
3. Computer Networks and Internet Protocol - Course (nptel.ac.in)
4. NPTEL Course **"Computer Networks"**

Link of the Course: https://nptel.ac.in/courses/106/105/106105183/

Savitribai Phule Pune University Third Year of E & Tc Engineering (2019 Course) 304186: Digital Communication Lab		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 hrs. / week	**01**	**Practical: 50 Marks**

Prerequisite Courses, if any:

1. Principles of Communication Systems
2. Signals & Systems
3. Control Systems
4. Digital Circuits
5. Electronic Circuits.

Companion Course, if any: Digital Communication Theory

Guidelines for Instructor's Manual

Design minimum 10 Assignments on the topics listed under Group A & B Below & prepare your own Instructor's Manual. Minimum 2 experiments should be designed from group A & B each and Minimum 3 can be from group C &D each. **Use of highend equipment like USRP is encouraged for Group A & B experiments.**

Guidelines for Student's Lab Journal

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

Guidelines for Lab /TW Assessment

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

List of Laboratory Experiments

Group A (Any Two)

1.	Study of BPSK transmitter & receiver using suitable hardware setup/kit.
2.	Study of QPSK transmitter & receiver using suitable hardware setup/kit.
3.	Study of BFSK transmitter & receiver using suitable hardware setup/kit.

4.	Study of Baseband receiver performance in presence of Noise using suitable hardware setup/kit.
Group B (Any Two)	
1.	Study of Error Control Coding using suitable hardware setup/kit.
2.	Study of DSSS transmitter and receiver using suitable hardware setup/kit.
3.	Study of FHSS transmitter and receiver using suitable hardware setup/kit.
Group C (Any Three)	
1	Simulation study of Performance of M-ary PSK .
2	Simulation study of Performance of M-ary QAM.
3	Simulation study of OFDM transmitter & receiver.
4	Simulation study of random processes. Find various statistical parameters of the random process.
5	Simulation Study of performance of BPSK receiver in presence of noise.
6	Simulation Study of CDMA technique.
Group D (Any Three)	
1	Simulation study of Source Coding technique.
2	Simulation study of various Entropies and mutual information in a communication system.
3	Simulation Study of Linear Block codes.
4	Simulation Study of cyclic codes.
5	Simulation Study of Convolutional codes
6	Simulation Study of Performance of Digital communication system with error control coding.

Virtual LAB Links:

1. **Link: https://www.etti.unibw.de/labalive/index/digitalmodulation/**

2. **Link: https://vlab.amrita.edu/index.php?sub=59&brch=163&sim=262&cnt=970**

Note: Additional 2 experiments to be performed using the virtual labs.

Savitribai Phule Pune University Third Year of E & Tc Engineering (2019 Course) 304187: Database Management Lab		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 hrs. / week	**01**	**Oral: 25 Marks**
Prerequisite Courses, if any:		
Companion Course, if any: Database Management System		

List of Laboratory Experiments

Group A- Database Programming Languages – SQL	
1.	Study of Open Source Relational Databases: MySQL
2.	Design and develop at SQL DDL statements which demonstrate the use of SQL objects such as Table, View, Index, Sequence and Synonym.
3.	Design and develop at least 5SQL queries for suitable database application using SQL DML statements: Insert and Select with operators and functions.
4.	Design and develop at least 5 SQL queries for suitable database application using SQL DML statements: Update and Delete with operators and functions.
5.	Design and develop at least 5 SQL queries for suitable database application using SQL DML statements: all types of Join and Sub-Query.
Group B- Database Programming Languages – PL / SQL	
6.	Write a PL/SQL block of code for the following requirements:- **Schema:** 1. Borrower (Roll no., Name, Date of Issue, Name of Book, Status) 2. Fine (Roll no, Date, Amt.) • Accept roll no. & name of book from user. • Check the number of days (from date of issue), if days are between 15 to 30 then fine amount will be Rs 5per day. • If no. of days>30, per day fine will be Rs 50 per day & for days less than 30, Rs. 5 per day. • After submitting the book, status will change from I to R. • If condition of fine is true, then details will be stored into fine table. **Frame the problem statement for writing PL/SQL block in line with above statement.**
7.	Cursors: (All types: Implicit, Explicit, Cursor FOR Loop, Parameterized Cursor) Write a PL/SQL block of code using parameterized Cursor that will merge the data available in the newly created table N_RollCall with the data available in the table O_RollCall. If the data in the first table already exist in the second table then that data should be skipped. **Frame the separate problem statement for writing PL/SQL block to implement all types of Cursors in line with above statement. The problem statement should clearly state the**

	requirements.
8.	**PL/SQL Stored Procedure and Stored Function.** Write a Stored Procedure namely proc_Grade for the categorization of student. If marks scored by students in examination is <=1500 and marks>=990 then student will be placed in distinction category if marks scored are between 989 and900 category is first class, if marks 899 and 825 category is Higher Second Class Write a PL/SQL block for using procedure created with above requirement. Stud_Marks(name, total_marks) Result(Roll,Name, Class). **Frame the separate problem statement for writing PL/SQL Stored Procedure and function, in line with above statement. The problem statement should clearly state the requirements.**
9.	**Database Trigger** (All Types: Row level and Statement level triggers, Before and After Triggers). Write a database trigger on Library table. The System should keep track of the records that are being updated or deleted. The old value of updated or deleted records should be added in Library_Audit table. **Frame the problem statement for writing Database Triggers of all types, in-line with above statement. The problem statement should clearly state the requirements.**
Group C- Mini Project: Database Project Life Cycle	
11.	Implement MYSQL/Oracle database connectivity with PHP/python/Java Implement Database navigation operations (add, delete, edit,) using ODBC/JDBC.
12.	Using the database concepts covered in Group A & Group B & connectivity concepts covered in Group C, students in group are expected to design and develop database application with following details: **Requirement Gathering and Scope finalization** **Database Analysis and Design:** • Design Entity Relationship Model, Relational Model, Database Normalization • Implementation : • Front End : Java/Perl/PHP/Python/Ruby/.net • Backend : MYSQL/Oracle • Database Connectivity : ODBC/JDBC **Testing: Data Validation** Group of students should submit the Project Report which will be consist of documentation related to different phases of Software Development Life Cycle: Title of the Project, Abstract, Introduction, scope, Requirements, Data Modeling features, Data Dictionary, Relational Database Design, Database Normalization, Graphical User Interface, Source Code, Testing document, Conclusion. Instructor should maintain progress report of mini project throughout the semester from project group and assign marks as a part of the term work.
Virtual LAB Links: **Link of the Virtual Lab: http://vlabs.iitb.ac.in/vlabs-dev/labs/dblab/index.php**	

Note: Additional 2 experiments to be performed using the virtual labs.

Savitribai Phule Pune University Third Year of E & Tc Engineering (2019 Course) 304188: Microcontroller Lab		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 hrs. / week	**01**	**Practical: 50 Marks**
Prerequisite Courses, if any: -		
Companion Course, if any: Microcontroller		

List of Laboratory Experiments

Group A (Any Three)	
1.	Simple programs on Memory transfer.
2.	Parallel port interacting of LEDS—Different programs (flashing, Counter, BCD, HEX, Display of Characteristic)
3.	Interfacing of Multiplexed 7-segment display (counting application)
4.	Waveform Generation using DAC
5.	Interfacing of Stepper motor to 8051- software delay using Timer
Group B (Any Three)	
6.	Write a program for interfacing button, LED, relay & buzzer as follows
7.	Interfacing of LCD to PIC 18FXXXX
8.	Interfacing of 4X4 keypad and displaying key pressed on LCD.
9.	Generate square wave using timer with interrupt
Group C (Any Two)	
11.	Interfacing serial port with PC both side communication.
12.	Interface analog voltage 0-5V to internal ADC and display value on LCD
13.	Generation of PWM signal for DC Motor control.
14.	Interfacing OF RTC using I2C protocol

Virtual LAB Links:

http://vlabs.iitb.ac.in/vlabs-dev/labs/8051-Microcontroller-Lab/labs/index.php

Note: Additional 2 experiments to be performed using the virtual labs.

Savitribai Phule Pune University

Third Year of E & Tc Engineering (2019 Course)

304189(A): Digital Signal Processing Lab (Elective – I)

Teaching Scheme:	Credit	Examination Scheme:
Practical: 02 hrs. / week	01	Practical: 25 Marks

Prerequisite Courses, if any: -
1. Signals & System Lab

Companion Course, if any: - Digital Signal Processing

List of Laboratory Experiments

Group A (All compulsory)

1.	Verify the sampling theorem and aliasing effects with various sampling frequencies. Also implement the sampling theorem using VLAB.
2.	Find the z-transform of a given difference equation, compute its pole zero plot and comment on its stability.
3.	Compute DFT and IDFT { e.g. x(n) = {1,2,3,4} using N=4 and N= 8}
4.	Find N-point circular convolution using formula and verify its results. Implement linear filtering using circular convolution
5	Implement IIR structures using Direct form I/ II/ Cascade form. Implement FIR structures using Direct Form/Cascade/Linear phase structures.
6.	Study the windowing effect (time and frequency) for rectangular, hamming, hanning, blackmann and Kaiser windows.

Group B (Any Two)

7.	Design a Butterworth filter using Bilinear Transformation, for the following conditions: 0.8≤|〖H(e〗^jw)| ≤1 0≤ ≤0.2π |〖H(e〗^jw)≤|≤0.2 0.6≤ ≤π **OR** Design a Second order band pass Digital Butterworth filter with passband of 200 Hz to 300 Hz and sampling frequency of 2000Hz using Bilinear Transformation. **OR** Evaluate the order and the poles of a Butterworth filter which has a 3dB bandwidth of 1000Hz and a attenuation of 20dB at 2000 Hz. Determine the system function H(z) by Bilinear Transformation using T=1/10000

8.	Design the symmetric FIR low pass filter for which desired frequency response is expressed as Hd (w)={(e^(-jwτ for|w|≤ wc) and 0 elsewhere The length of the filter should be M = 7 and Wc=1 radians/sample. Make use of the Rectangular/ Hamming/ Hanning/Blackman/ Kaiser window.
9.	Verify the Sampling Theorem in frequency domain using FFT for undersampled, Nyquist and oversampled signals.
10.	Compute the DFT by writing a function for the N>32 sequence. Calculate the computational complexity. Compare the time required by DFT & FFT functions.
Group C (Any two)	
11.	Implement the Block Convolution algorithms: a) Overlap-add b) Overlap-save
12.	Find the pitch frequency of given speech signal using the autocorrelation method
13.	Implement the following ECG Signal Processing operations: a) Suppression of motion artifacts in ECG using N point moving average filters. b) Peak detection of ECG signal by using Band-limiting digital filters
14.	Image feature extraction using 2D convolution

Virtual LAB Links:

Link of the Virtual Lab: **http://vlabs.iitkgp.ernet.in/dsp/#**

Note: Additional 2 experiments to be performed using the virtual labs.

Savitribai Phule Pune University

Third Year of E & Tc Engineering (2019 Course)

304189 (B): Electronic Measurements Lab (Elective-I)

Teaching Scheme:	Credit	Examination Scheme:
Practical: 02 hrs. / week	01	Practical: 25 Marks

Prerequisite Courses, if any:
1. Basic Electronics Engineering
2. Electronic Skill Development Lab

Companion Course, if any: Electronic Measurements

List of Laboratory Experiments

Group A (Any Four)

1.	Statistical analysis of measurements, probable error, calibration of meters
2.	Measurement of RMS of common and true RMS of complex waveforms.
3.	Measurement of L, C, R, Q and Distortion Factor using Q –Meter.
4.	Measurement of Total Harmonic Distortion contained by output of amplifier, inverter.
5.	Measurements of Time period, Time Interval, Frequency and frequency ratio using universal counter/ Timer.

Group B (Any Two)

6.	Measurements using Digital Storage Oscilloscope, different modes of DSO, capturing transients and analysis of waveforms. https://iitg.vlabs.ac.in/Understanding_The_%20Basic_Functions_Of_An%20Oscilloscope.html
7.	Measurement using spectrum analyzer by observing spectrum of AM and FM waveforms for different modulation indices.
8.	Case study of measurement system using software package like LABVIEW and other software. https://www.iitk.ac.in/mimt_lab/vlab/index.php?pg=smith

Group C (Any Two)

9.	Microwave network analysis. Measurement of SWR, reflection coefficient and s parameters using network analyzer. https://www.iitk.ac.in/mimt_lab/vlab/index.php?pg=reflection_coefficients
10.	Measurement and timing analysis of digital signals using Logic Analyzer.
11	Measurement and timing analysis using OTDR.

Virtual LAB Links:

Link of the Virtual Lab: https://eil-iitg.vlabs.ac.in

Note: Additional 2 experiments to be performed using the virtual labs.

Savitribai Phule Pune University Third Year of E & Tc Engineering (2019 Course) 304189 (C): Fundamentals of JAVA Programming Lab (Elective - I)		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 hrs. / week	**01**	**Practical : 25 Marks**
Prerequisite Courses, if any: - Knowledge of Object Oriented Programming		
Companion Course, if any: Fundamentals of JAVA Programming		

List of Laboratory Experiments

Group A (All are Compulsory)

1.	Write some simple programs in Java such as: i) To find factorial of number. ii) To display first 50 prime numbers. iii) To find sum and average of N numbers
2.	Write a program in Java to implement a Calculator with simple arithmetic operations such as add, subtract, multiply, divide, factorial etc. using switch case and other simple java statements. The objective of this assignment is to learn Constants, Variables, and Data Types, Operators and Expressions, Decision making statements in Java.
3.	Write a program in Java with class Rectangle with the data fields width, length, area and colour. The length, width and area are of double type and colour is of string type. The methods are get_length(), get_width(), get_colour() and find_area(). Create two objects of Rectangle and compare their area and colour. If the area and colour both are the same for the objects then display " Matching Rectangles", otherwise display " Non-matching Rectangle"
4.	Write a program in JAVA to demonstrate the method and constructor overloading

Group B (Any Four)

5	Write Programs in Java to sort i) List of integers ii) List of names. The objective of this assignment is to learn Arrays and Strings in Java
6.	Write a Program in Java to add two matrices. The objective of this assignment is to learn Arrays in Java
7.	Write a program in Java to create a player class. Inherit the classes Cricket_player, Football_player and Hockey_player from player class. The objective of this assignment is to learn the concepts of inheritance in Java.
8.	Write a Java program which imports user defined package and uses members of the classes contained in the package.
9.	Write a Java program which implements interface.

10	Write a program to create multiple threads and demonstrate how two threads communicate with each other.
Group C (Any Three)	
11.	Write a java program which use try and catch for exception handling.
12.	Write a Java program to draw oval, rectangle, line , text using graphics class
13.	Write a java program in which data is read from one file and should be written in another file line by line.
14.	A Mini project in Java: A group of 4 students can develop a small application in Java

Virtual LAB Links:

Link of the Virtual Lab: https://java-iitd.vlabs.ac.in/

Note: Additional 2 experiments to be performed using the virtual labs.

Savitribai Phule Pune University Third Year of E & Tc Engineering (2019 Course) 304189 (D): Computer Networks Lab (Elective – I)		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 hrs. / week	**01**	**Oral : 25 Marks**
Prerequisite Courses, if any: -		
Companion Course, if any: Computer Networks		

List of Laboratory Experiments

NOTE: All experiments should be implemented using Open-Source Tools: Wireshark, Packet Tracer and C / C++

Group A (Any Four)

1.	Implementation of LAN using suitable multiuser Windows operating System and demonstrating client-server and peer to peer mode of configuration.
2.	Simulating various Networks (LAN, WAN) using relevant network devices on Simulator a) Ping b) ipconfig / ifconfig c) Host name d) Whois e) Netstat f) Route g) Tracert/Traceroute/ Tracepath h) NSlookup i) ARP j) Finger k) Port Scan / nmap
3.	Observe and note the details of the live type of traffic (ARP, Frame analysis, ethernet) from interface using packet capture and analysis tool
4.	Using a Network Simulator (e.g., packet tracer) Configure router using RIP
5.	Capture and note the packet of HTTP /FTP /Telnet / DHCP Protocol using TCP-stream learn sequence of packets being sent and received.

Group B (Any Four)

1.	Socket Programming in C/C++ on TCP Client, TCP Server.
2.	Write a program to simulate leaky bucket/token bucket.
3.	Observe and note the working of protocols using PING / TRACEROUTE / PATHPING and capture packets in LAN using packet capture and analysis tool.
4.	Configure servers like HTTP / FTP and understand packet sequence and data flowing between client-server using packet analysis tools.
5.	Executing Proxy, web Server using simulator.
6.	Executing Telnet, DHCP Server using simulator.

Savitribai Phule Pune University Third Year of E & Tc Engineering (2019 Course) 304190: Skill Development		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 hrs. / week	**01**	**Term work: 25 Marks**

Prerequisite Courses, if any:

1. Basics of Electronics Components
2. Working of Operational amplifier
3. Basics of Electronics measurement instruments and Tools

Companion Course, if any: --

Course Objectives:

- To build and upgrade practical knowledge ofan individual.
- To make students Employable with required skill set.
- To promote youth work to assist "Make in India" initiative.
- To grow and build confidence among students on specific skill sets.
- To cultivate Entrepreneur mindset after getting required experience.
- To improve professional skills such as moral/ethics/team work/communication skill/lifelong learning etc.

Course Outcome: After Successfully completing the course,

CO1: Student should recognize the need to engage in independent and life-long learning in required skill sets

CO2: Student needs to experience the impact of industries on society by visiting different industries and understand the importance of industrial products for analog and digital circuits and systems.

CO3: Student has to make use of the modern electronic and IT Engineering Tools and Technologies for solving electronic engineering problems.

CO4: Student would be able to communicate effectively at different technical and administrative levels.

CO5: Student will exhibit leadership skills both as an individual and as a member in a team in multidisciplinary environment.

List of Laboratory Experiments

Group A (Any Three)

Testing /Measurement/Calibration/Troubleshooting/Maintenance/Installation

1.	**Case studies on Study, Testing and maintenance of Batteries.** A. Apply skill sets mentioned in ***#Group A Skills 1***and may be covered as per availability of lab or equipment's. **OR**

	B. Apply Skill sets mentioned in ***#Group A Skills 1***may be covered by visiting any Automobile service centers/Battery maintenance service centers or related industry. **Note: Batteries of e-Vehicle & Technology Involved (Lithium Batteries etc.)**
2.	**Case study on Automotive Electronics. (Sensors, Clusters, Controls, Semiconductor's devices etc.)** A. Apply Skill set mentioned in ***#Group A Skills 1and Group A Skills 2*** which is related to automotive electronics may be covered as per availability of lab or equipment's. **OR** B. Apply Skill sets mentioned in ***#Group A Skills 1***may be coveredby visiting any Automobile service centers or related industry.
3.	**Case study on Biomedical Instrumentation** A. Apply Skill set mentioned in ***#Group A Skills 3*** which is related to automotive electronics may be covered as per availability of lab or equipment's. **OR** B. Visit biomedical instrument maintenance service centers **OR** C. Visit Hospitals or related industry. **Note: Students are expected to know about sensors technology / Interface / maintenance / calibration of electronic instrumentation of some of these equipment's.**
4.	Troubleshooting and maintenance of PCB Boards &Controllers
5.	Troubleshooting and maintenance of Power supply
Group B (Any Two) **Software / Hardware Design**	
1.	**Design and Simulate dc-dc boost converter for battery-based applications** Design a conventional dc-dc boost converter to step-up the battery voltage of 5 V to 10 V. Draw the circuit diagram and find required value of duty ratio. Implement the circuit in open-source TINA software. Plot the graphs of output voltage and PWM signal with respect to time.

2.	**Design a web page(s)** A. Using different text formatting tags B. With links to different pages and allow navigation between pages C. With Images, tables and frames D. Using style sheets to maintain uniform style for all web pages E. Using a form that uses all types of controls. F. Validate all the controls placed on the form using Java Script.

	Note: Use maximum above points while designing Web page.
3.	**SMPS Design** A. Design and Simulate of SMPS of 24 V @ 1A. **OR** B. Design, simulate and Implement buck converter using ICs like LM3842 / LM 3524 and measure performance parameters like 1. Load regulation 2. Line regulation 3. Ripple rejection 4. Output impedance and 5. Dropout voltage. 6. Note: Hardware based assignments: **Note : EDA tool (NI Multisim/ORCAD/PSPICE / Altium Designer suite etc.)**
4.	**Design and Simulate dc-dc boost converter for battery-based applications** Design a conventional dc-dc boost converter to step-up the battery voltage of 5 V to 10 V. Draw the circuit diagram and find required value of duty ratio. Implement the circuit in open-source TINA software. Plot the graphs of output voltage and PWM signal with respect to time.
5.	**Design and Simulate PID Controller based on OP-AMP** Design an analog PID controller to track a reference voltage of 5 V in a circuit. Draw the circuit diagram of the controller and implement the circuit in open-source TINA software. Change the reference voltage to 10 V and show that the circuit can still track this changed reference voltage. Show the effect of 3 controller gains viz. proportional gain, integral gain and derivative gain on the output response.
Group C (Compulsory) **Industrial Visit (Practical Visit)**	
1.	Industrial visit to Maintenance /Calibration/ service department of Electronics industry/Hospitals/Service centers etc. Student Should visit to related field and submit report in a predefined format.
2.	Industrial visit to software industry to understand the different processes and skills required as a software professional engineer

Group D (Compulsory) Documentation/Specification /Manual	
1.	Study of documentation/specification /Manual/SOP **Note: Based on group B assignment, student need to prepare user manual / SOP and make and effective presentation.**

Learning Resources

Reference Books:

1. Ron Lenk, "Practical design of Power Supplies", John Wiley & Sons, 2005.
2. Abraham I. Pressman," Switching Power Supply Design", McGraw-Hill, 3rd Edition, 2009.
3. Khandpur R.S., "Biomedical Instrumentation", TMH, 3rd Edition.
4. W Bosshart, "Printed Circuit Boards - Design & Technology", Tata McGraw Hill, 1st Edition.
5. D.Patranabis, "Principles of Industrial Instrumentation", TMH Publishing Co., 2nd Edition, 2008
6. R.K. Jain, "Mechanical and Industrial Measurement", Khanna Publishers, New Delhi,11th Edition,1999,
7. L.D. Goettsche, "Maintenance of Instruments and systems – Practical guides for measurement and control", International Society for Automation, 2nd Edition, 1995.
8. Henry W.Ott, "Noise Reduction Techniques in Electronic Systems", John Wiley & Sons, USA,2nd Edition.
9. Kim R Fowler, "Electronic Instrument Design", Oxford University Press, 1997, 1st Edition.
10. Jiuchun Jiang, And Caiping Zhang, "Fundamentals and Applications of Lithium-Ion Batteries In Electric Drive Vehicles", Wiley Publication, 1st Edition.
11. Web Technologies: Black Book, 2018, Dreamtech Press (1 January 2018), ISBN-10: 9386052490, ISBN-13: 978-9386052490
12. Jennifer Robbins, "Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics", Shroff/O'Reilly, 5th Edition.
13. Thomas Powell, "Web Design: The complete Reference", Tata McGraw Hill; 2nd Edition.

Savitribai Phule Pune University Third Year of E & Tc Engineering (2019 Course) 304191 (A): Mandatory Audit Course - 5		
Teaching Scheme:	**Credit**	**Examination Scheme:**
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List of Courses to be opted (Any one) under Mandatory Audit Course 5

- Developing Soft skills and Personality
- Entrepreneurship and IP Strategy
- Urbanization and Environment
- Environmental & Resource Economics
- Environment and Development
- Globalization and Culture

GUIDELINES FOR CONDUCTION OF AUDIT COURSE

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

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

Selecting an Audit Course:

Using NPTEL Platform:

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

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

Assessment of an Audit Course:

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

SEMESTER - VI

Savitribai Phule Pune University

Third Year of E & Tc Engineering (2019 Course)

304192: Cellular Networks

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

Prerequisite Courses, if any:
1. Basic knowledge of - Probability, Random variables and Modulation.

Companion Course, if any: Cellular Networks Lab

Course Objectives: To make the students understand

- Various propagation Model and Estimation techniques of wireless communication system.
- OFDM and MIMO technologies to explain modern wireless systems.
- Various aspects of mobile communication system.
- Various aspects of wireless-system planning.
- Different Generation of Mobile Networks.
- Diversified issues that can enhance Network Performance.

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

CO1: Understand fundamentals of wireless communications.

CO2: Discuss and study OFDM and MIMO concepts.

CO3: Elaborate fundamentals mobile communication.

CO4: Describes aspects of wireless system planning.

CO5: Understand of modern and futuristic wireless networks architecture.

CO6: Summarize different issues in performance analysis.

Course Contents

Unit I	Introduction of Wireless Channel	(06 Hrs.)

Introduction, Free Space Propagation Model, Ground-Reflection Scenario, Hata Model and Receiver-Noise Computation. Channel Estimation techniques and Diversity in wireless communications.

Mapping of Course Outcomes for Unit I	CO1: Understand fundamentals of wireless communications.

Unit II	Orthogonal Frequency Division Multiplexing	(06 Hrs.)

Introduction, Motivation and Multicarrier basics, OFDM example, bit error rate for OFDM.

Multiple-Input Multiple-Output Wireless Communications: Introduction to MIMO Wireless Communications, MIMO System Model and MIMO-OFDM.

Mapping of Course Outcomes for Unit II	CO2: Discuss and study OFDM and MIMO concepts.

Unit III	Introduction to Mobile Communication	(08 Hrs.)
Introduction to Cellular Service Progression, Cell Geometry, Overview of Cellular mobile and Network architecture, Cellular radio system design-- Frequency assignments, frequency reuse channels, Concept of cell splitting and Cell sectoring. Significance of Handover in cellular systems with Handoff algorithms and roaming.		
Mapping of Course Outcomes for Unit III	**CO3: Elaborate fundamentals mobile communication.**	
Unit IV	**Wireless System Planning**	**(06 Hrs.)**
Link-Budget Analysis, Tele-traffic Theory, Tele-traffic System Model and Steady State Analysis.		
Mapping of Course Outcomes for Unit IV	**CO4: Describes aspects of wireless system planning.**	
Unit V	**Wireless and Mobile Technologies and Protocols and their performance evaluation**	**(06 Hrs.)**
Introduction, Wireless and mobile technologies, LTE- advanced, 5G – Architecture, wireless local area network and Simulations of wireless networks.		
Mapping of Course Outcomes for Unit V	**CO5: Understand of modern and futuristic wireless networks architecture**	
Unit VI	**Performance Analysis Issues**	**(08 Hrs.)**
Introduction to Network coding, basic hamming code and significance of Information Theory. Interference suppression and Power control. MAC layer scheduling and connection admission in mobile communication.		
Mapping of Course Outcomes for Unit VI	**CO6: Summarize different issues in performance analysis**	

Learning Resources

Text Books:

1. Rappaport, T. S., "Wireless Communications--Principles and Practice", Pearson, 2nd Edition.

2. Jagannatham, A. K., "Principles of Modern Wireless Communication Systems", McGraw-Hill Education.

Reference Books:

1. Cristopher Cox, "An Introduction to LTE: LTE, LTE-Advanced, SAE, VoLTE and 4G Mobile Communications", Wiley, 2nd Edition.
2. E. Dahlman, J. Skold, and S. Parkvall, "4G, LTE-Advanced Pro and The Road to 5G", Academic Press, 3rd Edition.
3. B. P. Lathi, "Modern Digital and Analog Communications Systems". Oxford university press, 2015, 4th Edition.
4. Obaidat, P. Nicopolitids, "Modeling and simulation of computer networks and systems: Methodologies and applications" Elsevier, 1st Edition.

MOOC / NPTEL Courses:

1. NPTEL Course **"Introduction to Wireless & Cellular Communications"**
   Link of the Course: https://nptel.ac.in/courses/106/106/106106167/

1. NPTEL Course **"Advanced 3G and 4G Wireless Mobile Communications"**
   Link of the Course: https://nptel.ac.in/courses/117/104/117104099/

Savitribai Phule Pune University

Third Year of E & Tc Engineering (2019 Course)

304193: Project Management

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

Prerequisite Courses, if any: NIL

Companion Course, if any: NIL

Course Objectives: To make the students understand

- The basics of project management and its life cycle
- The process of project identification, selection criteria of the project and how the project planning is undertaken.
- The organizational structure within a project and issues related to project management
- The techniques for effective project scheduling and resource considerations in project.
- The basics of effective handling the risks as well as managing finances within the project
- The complete product development process and requirements for entrepreneurship along with related legal issues.

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

CO1: Apply the fundamental knowledge of project management for effectively handling the projects.

CO2: Identify and select the appropriate project based on feasibility study and undertake its effective planning.

CO3: Assimilate effectively within the organizational structure of project and handle project management related issues in an efficient manner.

CO4: Apply the project scheduling techniques to create a Project Schedule Plan and accordingly utilize the resources to meet the project deadline.

CO5: Identify and assess the project risks and manage finances in line with Project Financial Management Process.

CO6: Develop new products assessing their commercial viability and develop skillsets for becoming successful entrepreneurs while being fully aware of the legal issues related to Product development and Entrepreneurship.

Course Contents		
Unit I	**Fundamentals of Project Management**	**(06 Hrs.)**
Basics of Project Management: Definition of Project, The Project Life Cycle, Definition of project management, Need of Project management, Project Management process and its importance, The Project Manager (PM), Phases of Project Management Life Cycle, Project Management Processes, Impact of Delays in Project Completions, Essentials of Project Management Philosophy, Project Management Principles.		
Mapping of Course Outcomes for Unit I	**CO1: Apply the fundamental knowledge of project management for effectively handling the projects.**	
Unit II	**Project Identification, Selection & Planning**	**(06 Hrs.)**
Project Identification and Selection: Introduction, Project Identification Process, Project Initiation, Pre-Feasibility Study, Feasibility Studies, Project Break-even point. **Project Planning:** Introduction and need for Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS)		
Mapping of Course Outcomes for Unit II	**CO2: Identify and select the appropriate project based on feasibility study and undertake its effective planning.**	
Unit III	**Project Organizational structure & Issues**	**(07 Hrs.)**
Organizational Structure and Organizational Issues: Introduction, Concept of Organizational Structure, Roles and Responsibilities of Project Leader, Relationship between Project Manager and Line Manager, Leadership Styles for Project Managers, Conflict Resolution, Team Management and Diversity Management, Change management		
Mapping of Course Outcomes for Unit III	**CO3: Assimilate effectively within the organizational structure of project and handle project management related issues in an efficient manner.**	
Unit IV	**Project Scheduling**	**(07 Hrs.)**
PERT and CPM: Introduction, Development of Project Network, Time Estimation, Determination of the Critical Path, PERT Model, Measures of variability, CPM Model, Network Cost System **Resources Considerations in Projects:** Introduction, Resource Allocation, Scheduling, Project Cost Estimate and Budgets, Cost Forecasts		
Mapping of Course Outcomes for Unit IV	**CO4: Apply the project scheduling techniques to create a Project Schedule plan and accordingly utilize the resources to meet the project deadline.**	

Unit V	Project Risk & Financial Management	(08 Hrs.)
Project Risk Management: Introduction, Risk, Risk Management, Role of Risk Management in Overall Project Management, Steps in Risk Management, Risk Identification, Risk Analysis, Reducing Risks **Introduction to Project Management Tools** such as: Trello, JIRA and Asana. **Financial Management in Projects:** Project Finance structure, Process of Project Financial Management: Conducting Feasibility Studies, Planning the Project Finance, Arranging the Financial Package, Controlling the Financial Package, Controlling Financial Risk, Options Models.		
Mapping of Course Outcomes for Unit V	**CO5: Identify and assess the project risks and manage finances in line with Project Financial Management Process.**	
Unit VI	**Product Development & Entrepreneurship**	**(08 Hrs.)**
Product Development: Introduction, Development Process and organizations, product planning, identifying customer needs, Product Significations, concept generation, selection, testing, Design for Manufacturing, Prototyping, Robust Design **Entrepreneurship:** Concept, knowledge, and skills requirement; characteristic of successful entrepreneurs; entrepreneurship process; factors impacting emergence of entrepreneurship **Legal issues related to Product development and Entrepreneurship:** Intellectual property rights- patents, trademarks, copyrights, trade secrets, licensing, franchising.		
Mapping of Course Outcomes for Unit VI	**CO6: Develop new products assessing their commercial viability and develop skillsets for becoming successful entrepreneurs while being fully aware of the legal issues related to Product development and Entrepreneurship.**	

Learning Resources

Text Books:

1. H.Kerzer, "Project Management: A Systems Approach to Planning, Scheduling, and Controlling", John Wiley & Sons, Inc., 10th Edition, 2009.
2. Chandra, P., "Projects", Tata McGraw-Hill Education, 8th Edition, 2009.

Reference Books:

1. Morris, P. W. G. and Pinto, J. K., "The Wiley Guide to Managing Projects", JohnWiley & Sons, 2004.
2. Karl Ulrich, Steven Eppinger, "Product Design and Development", McGraw Hill / Irvin, 3rd Edition 2009.
3. R. Majumdar, "Product Management in India", PHI, 2nd Edition, 2010.
4. G.S. Batra, "Development of Entrepreneurship", Deep and Deep publications, New Delhi.
5. Christine Petersen, "The Practical Guide to Project Management", PMP,1st Edition, 2013.
6. Russell W. Darnall, John M. Preston, "Project Management from Simple to Complex", The Saylor Foundation.
7. Levy, F. K. and Wiest, J. D., "A Management Guide to PERT/CPM", Prentice Hall, 2nd Edition, 1969.
8. Lewis, R., "Project Management: Strategic Design and Implementation", McGraw-Hill, 5th Edition. 2006.
9. Venkataraman. R., J.K. Pinto, "Cost and Value Management in Projects", John Wiley & sons.

MOOC / NPTEL Courses:

1. NPTEL Course **"Project Management for Managers"**

   Link of the Course: https://nptel.ac.in/courses/110/107/110107081/

2. NPTEL Course on **"Intellectual Property Rights and Competition Law"**
   Link of the Course: https://nptel.ac.in/courses/110/105/110105139/

List of Tutorials to be carried out

1.	Understanding Impact of Delays in Project Completions with a company's case study.
2.	Designing a Work Breakdown Structure (WBS) for any sample project.
3.	Case study on Conflict Resolution and understanding its challenges.
4.	Solve examples on Project scheduling using CPM and PERT Model.
5.	Assignment on Risk Identification and Risk Analysis with a company's example and/ or exploration of various project management tools.
6.	Prepare a Business plan for an sample Product/ Service to be launched.

Savitribai Phule Pune University

Third Year of E & Tc Engineering (2019 Course)

304194: Power Devices & Circuits

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

Prerequisite Courses, if any:

1. Basic Electrical Engineering
2. Basic Electronics Engineering
3. Electronic Circuits
4. Electrical Circuits

Companion Course, if any: Power Devices & Circuits Lab

Course Objectives:

- To introduce different power devices viz. SCR, GTO, MOSFET and IGBT with construction, characteristics, repetitive and non repetitive ratings and typical triggering/driver circuits.
- To understand working, design and performance analysis and applications of various power converter circuits such as ac to dc converters, inverter and chopper
- To know various protection circuit requirements of power electronic devices.

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

CO1: To differentiate based on the characteristic parameters among SCR, GTO, MOSFET & IGBT and identify suitability of the power device for certain applications and understand the significance of device ratings.

CO2: To design triggering / driver circuits for various power devices.

CO3: To evaluate and analyze various performance parameters of the different converters and its topologies.

CO4: To understand significance and design of various protections circuits for power devices.

CO5: To evaluate the performance of uninterruptible power supplies, switch mode power supplies and battery.

CO6: To understand case studies of power electronics in applications like electric vehicles, solar systems etc.

Course Contents		
Unit I	**Study of Power Devices**	**(06 Hrs.)**
Construction, VI characteristics (input, output and transfer if any), switching characteristics of SCR, GTO, Power MOSFET and IGBT, Performance overview of Silicon, Silicon Carbide & GaN based MOSFET and IGBT, various repetitive and non-repetitive ratings of SCR, GTO , Power MOSFET & IGBT and their significance, requirement of a typical triggering / driver (such as opto isolator) circuits for various power devices, importance of series and parallel operations of various power devices **(no derivation and numerical).**		
Mapping of Course Outcomes for Unit I	**CO1: To differentiate based on the characteristic parameters among SCR, GTO, MOSFET & IGBT and identify suitability of the power device for certain applications and understand the significance of device ratings.** **CO2: To design triggering / driver circuits for various power devices**	
Unit II	**AC to DC Power Converters**	**(06 Hrs.)**
Concept of line & forced commutation, Single phase Semi & Full converters using SCR for R and R-L loads and its performance analysis and numerical, Effect of source inductance, Significance of power factor and its improvement using PWM based techniques, Three phase Full converters using SCR for R load and its performance analysis, Single Phase PWM Rectifier using IGBT, Three Phase Controlled Rectifier Using IGBT, Difference between SCR based conventional rectifiers and IGBT based rectifiers.		
Mapping of Course Outcomes for Unit II	**CO3: To evaluate and analyze various performance parameters of the different converters and its topologies.**	
Unit III	**DC to AC Converters**	**(06 Hrs.)**
Single phase half and full bridge square wave inverter for R and R-L load using MOSFET / IGBT and its performance analysis and numerical, Cross conduction in inverter, need of voltage control and strategies in inverters, classifications of voltage control techniques, control of voltage using various PWM techniques and their advantages, concept and need of harmonic elimination / reduction in inverters, Three Phase voltage source inverter for balanced star R load with 120 and 180 degree mode of operation, device utilization factor, Advanced Converters like matrix inverter, multi-level inverters and their topologies and its driver circuits (no derivation and numerical).		
Mapping of Course Outcomes for Unit III	**CO3: To evaluate and analyze various performance parameters of the different converters and its topologies.**	
Unit IV	**DC to DC Converters**	**(06 Hrs.)**
Classification of choppers, Step down chopper for R and RL load and its performance analysis, Step up chopper, various control strategies for choppers, types of choppers (isolated and non isolated) such as type A, B, C, D & E, switch mode power supply (SMPS) viz buck, boost and buck-boost, Fly back, Half and full Bridge isolated and non-isolated interleaved bidirectional topologies, and concept of integrated converter and design of LM3524 based choppers, concept of maximum power point tracking (MPPT).		
Mapping of Course Outcomes for Unit IV	**CO3: To evaluate and analyze various performance parameters of the different converters and its topologies.**	

Unit V	Power Devices Protection and Circuits	(06 Hrs.)
Over voltage, over current, di/dt and dv/dt protection circuits and their design, Various cooling techniques and heat sink design, Resonant converters such as Zero current switching (ZCS) and Zero voltage switching (ZVS), Electromagnetic interference such as radiated and conducted EMI, Difference between EMI and EMC, EMI sources and soft switching and minimizing / shielding techniques for EMI, Various EMI and EMC standards, Importance of isolation transformer.		
Mapping of Course Outcomes for Unit V	**CO4: To understand significance and design of various protections circuits for power devices.**	
Unit VI	**Power Electronics Applications**	**(06 Hrs.)**
AC Voltage Controller using IGBT & SCR, Fan Regulator, Electronic Ballast, LED Lamp driver, DC motor drive for single phase separately excited dc motor, BLDC motor drive, Variable voltage & variable frequency three phase induction motor drive, On-line and Off- line UPS, study of various selection criteria and performance parameters of batteries in battery operated power systems, battery charging models and modes for EVs, Architecture of EVs battery charger, PFC stage circuit topologies with details of Full-bridge boost rectifier and Full-bridge interleaved for EV battery charger, case study of power electronics in electric vehicle and photovoltaic solar system		
Mapping of Course Outcomes for Unit VI	**CO5: To evaluate the performance of uninterruptible power supplies, switch mode power supplies and battery.** **CO6: To understand case studies of power electronics in applications like electric vehicles, solar systems etc.**	

Learning Resources

Text Books:

1. M. H. Rashid, "Power Electronics Circuits Devices and Applications", PHI, 4th Edition 2017 New Delhi.
2. M. D. Singh and K. B. Khanchandani, "Power Electronics", TMH, 2nd Edition 2006.

Reference Books:

1. Bogdan M. Wilamowski, J. David Irwin, "The Power Electronics and Motor Drives Handbook", CRC Press, 1st Edition, 2011. ; **eBook: ISBN 9780429165627, 2019.**
2. Muhammad H. Rashid , "Power Electronics Handbook", Academic Press, 2nd Edition, 2001
3. Ned Mohan, T. Undeland & W. Robbins, "Power Electronics Converters Applications and Design, John Willey & sons, Singapore, 2nd Edition Oxford University Press, New Delhi, 2005
4. Ali Emadi Alireza Khaligh Zhong Nie Young Joo Lee, "Integrated Power Electronic Converters and Digital Control", CRC Press, 1st Edition.
5. Vinod Kumar Khanna "Insulated Gate Bipolar Transistor IGBT Theory and Design", John Wiley & Sons, Illustrated Edition.
   Print ISBN:9780471238454; Online ISBN:9780471722915, DOI:10.1002/047172291.
6. L. Ashok Kumar, S. Albert Alexander and Madhuvanthani Rajendran, "Power Electronic Converters for Solar Photovoltaic Systems", Elsevier, 1st Edition, 2020.

MOOC / NPTEL Courses:

1. NPTEL Course on **"Power Electronics "**

Link of the Course: https://nptel.ac.in/courses/108/105/108105066/

https://nptel.ac.in/courses/108/102/108102145/

https://nptel.ac.in/courses/108/107/108107128/

https://nptel.ac.in/courses/108/108/108108077/

https://batteryuniversity.com/

Savitribai Phule Pune University

Third Year of E & Tc Engineering (2019 Course)

304195 (A): Digital Image Processing (Elective - II)

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: Digital Image Processing Lab

Course Objectives:

- To become familiar with digital image fundamentals.
- To get exposed to simple image enhancement techniques in Spatial and Frequency domain.
- To study the image segmentation and representation techniques.
- To become familiar with image compression methods.
- To learn concepts of degradation function and restoration techniques.
- To understand the Object Recognition.

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

CO1: Apply knowledge of mathematics for image understanding and analysis.

CO2: Implement spatial domain image operations.

CO3: Design and realize various algorithms for image segmentation.

CO4: Design and realize various algorithms for image Compression.

CO5: Apply restoration to remove noise in the image.

CO6: Describe the object recognition system.

Course Contents

Unit I	DIP Fundamentals	(08 Hrs.)

Fundamental steps of Image Processing, components of IP, Image formation, image sampling and quantization, image types, Image histogram Color Fundamentals, Color Models, pixel connectivity, Pseudo color image processing.

Mapping of Course Outcomes for Unit I	CO1: Apply knowledge of mathematics for image understanding and analysis.

Unit II	Image Enhancement in Spatial Domain	(07 Hrs.)

Image enhancement in spatial domain, Basic gray level transformation, histogram processing, enhancement using arithmetic and logic operations, basic spatial filtering, smoothing and sharpening spatial filters, Intensity transformation, contrast stretching, histogram equalization.

Mapping of Course Outcomes for Unit II	CO2: Implement spatial domain image operations.

Unit III	Image Segmentation	(06 Hrs.)
Point, line and edge detection, Thresholding, Regions Based segmentation, Edge linking and boundary detection, Hough transform.		
Mapping of Course Outcomes for Unit III	**CO3: Design and realize various algorithms for image segmentation.**	
Unit IV	**Image Compression**	**(07 Hrs.)**
Fundamentals of redundancies, Basic Compression Methods: Huffman coding, Concept of Discrete Cosine Transform , JPEG Compression standard, Y CB CR transformation, Introduction to MPEG standard ,Motion estimation, compensation, Introduction to video compression.		
Mapping of Course Outcomes for Unit IV	**CO4: Design and realize various algorithms for image compression.**	
Unit V	**Image Restoration**	**(07 Hrs.)**
A model of the image degradation/restoration process, noise models, restoration in the presence of noise–only spatial filtering, Weiner filtering, constrained least squares filtering, geometric transforms; Introduction to the Fourier transform and the frequency domain, estimating the degradation function.		
Mapping of Course Outcomes for Unit V	**CO5: Apply restoration to remove noise in the image.**	
Unit VI	**Object Recognition**	**(07 Hrs.)**
Object Recognition- patterns and pattern classes, recognition based on decision theoretic methods, structural methods. **Case studies:** Character recognition, Content based image retrieval, image classification, Introduction to Deep learning using CNN.		
Mapping of Course Outcomes for Unit VI	**CO6: Describe the object recognition system.**	

Learning Resources

Text Books:

1. Gonzalez & Woods, “Digital Image Processing”, Pearson Education, 3rd Edition, 2008

2. S Sridhar, “Digital Image Processing”, Oxford University Press, 2nd Edition.

Reference Books:

1. Jain Anil K., "Fundamentals Digital Image Processing", Prentice Hall India, 4th Edition.
2. Milan Sonka, Vaclav Hlavav, Roger Boyle, "Image Processing, Analysis and Machine Vision", Thomson Learning, 2nd Edition., 2001
3. Pratt W.K, "Digital Image Processing", John Wiley & Sons, 3rd Edition, 2007
4. Jayaraman. S, Veerakumar. T, "Digital Image Processing", McGraw Hill Education, 2nd Edition.

MOOC / NPTEL Courses:

1. NPTEL Course **"Digital Image Processing"**

   Link of the Course: https://nptel.ac.in/courses/117/105/117105079/

1. NPTEL Course **"Digital Image Processing"**

   Link of the Course: https://nptel.ac.in/courses/106/105/106105032/

Savitribai Phule Pune University

Third Year of E & Tc Engineering (2019 Course)

304195 (B): Sensors in Automation (Elective -II)

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

Prerequisite Courses, if any:
1. Basic Electrical Engineering
2. Basic Electronics Engineering

Companion Course, if any: Sensors in Automation Lab

Course Objectives: To make the students understand about:

- Concept of Sensors/Transducers and their Static and Dynamic Characteristics.
- Sensors used in Industry for Temperature and Humidity Measurement.
- Sensors used for Sensors used for Force, Pressure, Stress and Flow measurements.
- Sensors used for Displacement and Level Measurement.
- Applications of Image and Biosensors.
- Role of Sensors/Transducers in IoT applications.

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

CO1: Understand the Concepts of Sensors/Transducers, classify and evaluate static and Dynamic Characteristics of Measurement Systems.

CO2: Choose the proper sensor comparing different standards and guidelines for measurements of Temperature and Humidity.

CO3: Choose the proper sensor comparing different standards and guidelines for measurements of Force, Pressure, Stress and Flow

CO4: Choose the proper sensor comparing different standards and guidelines for measurements of Displacement, Vibration, Acceleration and Level

CO5: Explore sensors to profound areas like environmental, Agricultural and bio-medical equipment and sustainability.

CO6: Explore IoT based applications of Sensors and Transducers.

Course Contents

Unit I	Introduction to Sensors &Transducers	(06 Hrs.)

Concept of Sensor, Concept of Transducer, Comparison between Sensors and Transducers , Role of Sensors in Automation, Broad Classification of Sensors and Transducers, Role of Transducer in measurement Systems, Block Diagram Measurement system, Study of Static and Dynamic Characteristics of Measurement Systems: Accuracy, Precision, Reproducibility, Linearity, repeatability, resolution, Sensitivity, Range, Span, Dead Zone, Hysteresis, Backlash, Dynamic Characteristics: Fidelity, Time response and frequency response, Classification of errors – Error analysis. Concept and Basic Principle of working of Resistive, Capacitive and Inductive sensors.

Mapping of Course Outcomes for Unit I	CO1: Understand the concepts of Sensors / Transducers, classify and evaluate static and Dynamic Characteristics of Measurement Systems.

Unit II	Sensors for Temperature and Humidity Measurement	(06 Hrs.)

Temperature Measurement: Units of Temperature Measurement / Temp Measurement Scales; Celsius Scale, Fahrenheit Scale, Kelvin Scale, Rankine Scale-Unit Conversions Broad Classification of Temperature Transducers, RTD (e.g.PT-100), Thermocouple, Thermistors, Optical Fiber Sensors.

(Basic Principle of Working, Selection Criteria, Installation and Calibration, Signal Conditioning (e.g Instrumentation Amplifier (with AD-620).

DC bridge: Wheatstone bridges, **AC Bridge:** Wein Bridge, Schering Bridge, Signal Conditioning: 2 Wire, 3-Wire and 4-Wire Compensation.

IR Temperature Sensor: MLX90614 ESF Non-Contact Human Body Infrared Temperature Measurement Module.

Smart temperature and solid state sensors: LM35, AD590 **(Only for real time application/implementation in project based learning)**

Humidity: Hygrometer, Soil Humidity Sensor, Soil Hygrometer (DHT11, TI HDC1050)

Mapping of Course Outcomes for Unit II	CO2: Choose the proper sensor comparing different standards and guidelines for measurements of Temperature and Humidity.

Unit III	Sensors for Force, Pressure, Stress and Flow	(06 Hrs.)

(Basic Principle of Working, Selection Criteria, Installation and Calibration, Signal Conditioning)

- **Pressure scales:** Newton, Bar, Pascal, PSI -Unit Conversions
- Absolute, Gauge and Vacuum Pressure

Classification of Pressure sensors: Strain gauge (Load Cell using Strain gauge), Piezoelectric Transducer, Solid State Pressure Sensors (**IC's like GY-63 MS5611-01BA03 to be discussed**)

Differential Pressure Transducer flow measurement **(only Mention of basic Principle of working, Bernoulli's theorem)**, Orifice, Venturi, Nozzle flow meter **(only Descriptive)**, Pneumatic sensors (bellows, diaphragm), Ultrasonic and Hall effect Sensors for flow Measurement

Solid State Flow Sensors: YF-S201, E8FC-25D, Fiber-Optic Sensors.

Mapping of Course Outcomes for Unit III	**CO3: Choose the proper sensor comparing different standards and guidelines for measurements of Force, Pressure, Stress and Flow.**	
Unit IV	**Sensors for Displacement, Vibration, Acceleration and Level**	**(06 Hrs.)**
(Basic Principle of Working, Selection Criteria, Installation and Calibration, Signal Conditioning) **Classification of Displacement Sensors:** Potentiometer, Strain-gauged element, Capacitive element, Differential transformers, Eddy current proximity sensors, Inductive and Capacitive Proximity switch, Optical encoders. Pneumatic sensors (**Bellows, Diaphragm**), Hall effect sensors, Accelerometer, Gyroscope and Magnetometer (**ADXL335/345**), Electro-Optical Sensors, Position Encoders.		
Mapping of Course Outcomes for Unit IV	**CO4: Choose the proper sensor comparing different standards and guidelines for measurements of Displacement, Vibration, Acceleration and Level.**	
Unit V	**Sensors in Environmental Studies, Bio Sensors**	**(06 Hrs.)**
Charge-Coupled and CMOS Image Sensors, Biosensors Resonant mirror, electrochemical, surface Plasmon resonance, Light addressable Potentio-Metric., Ph Measurement, CMOS MQ-2 Smoke LPG Butane Hydrogen Gas Sensor Detector Module **(MQ-3 Alcohol Detector Gas Sensor Module MQ 135 Air Quality / Gas Detector Sensor Module for Arduino Data Sheet MLX90614 non-contact temperature sensor)**, Camera Sensor Ultrasonic proximity, Colour Sensors, Light Sensors Like Light Dependent Resistance(LDR), Photo Diode, Photo Transistors, RFID sensors, e.g. EM18 module, Applications RFID Sensors, MEMS and NEMS sensors.		
Mapping of Course Outcomes for Unit V	**CO5: Explore sensors to profound areas like environmental, Agricultural and bio-medical equipment and sustainability.**	
Unit VI	**Latest trends in Sensors Applications**	**(07 Hrs.)**
Basic Concept of Data Acquisition Systems (Block Diagram Understanding), Basic Concept of IoT, Sensor Interface in IoT systems. **Case Study 1**: IoT based Agriculture/Greenhouse systems.(Block Diagram) (**Mention of Optical Sensors, Electro-Chemical Sensors, Mechanical Sensors Dielectric Soil Moisture Sensors, Air Flow Sensors may be considered**) **Case Study 2**: IoT based Healthcare Systems.(Block Diagram) (**Mention of ECG Module, Temperature, ,Humidity, Accelerometer, Oxygen Level, Heart Rate sensors**) **Case Study 3**: IoT based Automobile Sector (Engine Management System) (**Mention of Fuel Level, Ignition, Exhaust Sensors**)		
Mapping of Course Outcomes for Unit VI	**CO6: Explore IoT based applications of Sensors and Transducers.**	

Learning Resources

Text Books:

1. Sawhney A. K., "Electrical and Electronics Measurements and Instrumentation", Dhanpat Rai & Sons, 4th Edition, 1994.
2. D. Patranabis, "Sensors and Transducers", Prentice Hall India Learning Private Limited, 2nd Edition.

Reference Books:

1. Liptak, "Instrument Engineers Handbook Process Control", Elsevier exclusive; 3rd Edition.
2. John G. Webster, "Instrumentation and Sensors Handbook", CRC Press, 1st Edition, 1999.
3. A. Bahga, V. Madisetti, "Internet of Things A Hands-on Approach" Hands-on Approach Text book, 1st Edition
4. B.C. Nakra, K.K. Chaudhary, "Instrumentation, Measurement and Analysis", McGraw Hill Education India Private Limited, 4th Edition.
5. C.S. Rangan, G.R. Sarma, V.S.V. Mani, "Instrumentation: Devices and System", TMH, 2nd Edition, 1983.

MOOC / NPTEL Courses:

1. NPTEL Course **"Sensors and Actuators"**

Link of the course: **https://nptel.ac.in/courses/108/108/108108147/**

Savitribai Phule Pune University

Third Year of E & TC Engineering (2019 Course)

304195 (C): Advanced JAVA Programming (Elective - II)

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

Prerequisite Courses, if any:

1. Fundamentals of Java Programming

Companion Course, if any: Advanced JAVA Programming Lab

Course Objectives: Make the learner to:

- Design and develop GUI applications using Abstract Windowing Toolkit (AWT), Swing and Event Handling.
- Design and develop Web applications
- Designing Enterprise based applications by encapsulating an application's business logic.
- Designing applications using pre-built frameworks.

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

CO1: Design and develop GUI applications using Applets.

CO2: Apply relevant AWT/ swing components to handle the given event.

CO3: Design and develop GUI applications using Abstract Windowing Toolkit (AWT), Swing and Event Handling.

CO4: Learn to access database through Java programs, using Java Database Connectivity (JDBC)

CO5: Invoke the remote methods in an application using Remote Method Invocation (RMI)

CO6: Develop program for client /server communication using Java Networking classes.

Course Contents

Unit I	Applet	(06 Hrs.)

Applet Basics – Introduction, limitations of AWT, Applet architecture – HTML APPLET tag – Passing parameter to Appletget, DocumentBase() and getCodeBase() , Japplet: Icons and Labels Text Fields Buttons, Combo Boxes , Checkboxes, Tabbed Panes, Scroll Panes, Trees: Tables

Mapping of Course Outcomes for Unit I	CO1: Design and develop GUI applications using Applets.

Unit II	Event Handling using AWT/Swing components	(08 Hrs.)

Event Handling: Events, Event sources, Event classes, Event Listeners, Delegation event model, handling mouse and keyboard events, Adapter classes, inner classes. The AWT class hierarchy, user interface

components- labels, button, canvas, scrollbars, text components, checkbox, checkbox groups, choices, lists panels – scroll pane, dialogs, menu bar, graphics, layout manager – layout manager types – boarder, grid, flow, card and grib bag.		
Mapping of Course Outcomes for Unit II	**CO2: Apply relevant AWT/ swing components to handle the given event.**	
Unit III	**GUI Programming**	**(06 Hrs.)**
Designing Graphical User Interfaces in Java, Components and Containers, Basics of Components, Using Containers, Layout Managers, AWT Components, Adding a Menu to Window, Extending GUI Features Using Swing Components, Java Utilities (java.util Package) The Collection Framework: Collections of Objects, Collection Types, Sets, Sequence, Map, Understanding Hashing, and Use of Array List & Vector.		
Mapping of Course Outcomes for Unit III	**CO3: Design and develop GUI applications using Abstract Windowing Toolkit (AWT), Swing and Event Handling.**	
Unit IV	**Database Programming using JDBC**	**(06 Hrs.)**
The Concept of JDBC, JDBC Driver Types & Architecture, JDBC Packages, A Brief Overview of the JDBC process, Database Connection, Connecting to non-conventional Databases Java Data Based Client/server, Basic JDBC program Concept, Statement, Result Set, Prepared Statement, Callable Statement, Executing SQL commands, Executing queries		
Mapping of Course Outcomes for Unit IV	**CO4: Learn to access database through Java programs, using Java Database Connectivity (JDBC).**	
Unit V	**Remote Method Invocation (RMI)**	**(06 Hrs.)**
Remote Method Invocation: Architecture, RMI registry, the RMI Programming Model; Interfaces and Implementations; Writing distributed application with RMI, Naming services, Naming and Directory Services, Setting up Remote Method Invocation – RMI with Applets, Remote Object Activation; The Roles of Client and Server, Simple Client/Server Application using RMI.		
Mapping of Course Outcomes for Unit V	**CO5: Invoke the remote methods in an application using Remote Method Invocation (RMI)**	

Unit VI	**Networking**	**(08 Hrs.)**
The java.net package, Connection oriented transmission – Stream Socket Class, creating a Socket to a remote host on a port (creating TCP client and server), Simple Socket Program Example. InetAddress, Factory Methods, Instance Methods, Inet4Address and Inet6Address, TCP/IP Client Sockets. URL, URLConnection, HttpURLConnection, The URI Class, Cookies, TCP/IP Server Sockets, Datagrams, DatagramSocket, DatagramPacket, A Datagram Example.		

Connecting to a Server, Implementing Servers, Sending EMail, Servlet overview – the Java web server – The Life Cycle of a Servlet, your first servlet.	
Mapping of Course Outcomes for Unit VI	**CO6: Develop program for client /server communication using Java Networking classes.**

Learning Resources

Text Books:

1. Herbert Schildt, "Java: The complete reference", Tata McGraw Hill, 7th Edition
2. Jim Keogh, "Complete Reference J2EE" , Enterpr
3. E. Balaguruswamy, "Programming with JAVA: A Primer" McGraw Hill Education, India, 5th Edition.

Reference Books:

1. "Java 6 Programming", Black Book, Dreamtech
2. "Java Server Programming, Java EE6 (J2EE 1.6)", Black Book, Dreamtech
3. M.T. Savaliya,"Advanced Java Technology", Dreamtech

MOOC / NPTEL Courses:

1. NPTEL Course **"Programming in Java"**

Link of the Course: **https://nptel.ac.in/courses/106/105/106105191/**

2. Udemy course **"Advanced Java Programming"**

Link of the Course: **https://www.udemy.com/course/advanced-java-programming**

Savitribai Phule Pune University

Third Year of E & TC Engineering (2019 Course)

304195 (D): Embedded Processors (Elective - II)

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 Systems
2. Microcontrollers

Companion Course, if any: Embedded Processors Lab

Course Objectives:

- To make the students aware of the need of Embedded C and programming in Embedded C.
- To get the students acquainted with the need and applications of ARM Microprocessors in Embedded systems.
- To get insight of architecture and features of ARM 7 and ARM CORTEX M4 microcontroller.
- To enhance the capabilities of students to interface of various I/O devices, sensors and communication devices.

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

CO1: Understand basics of Embedded C Programming and usage of Embedded C and study different software tools for programming microcontrollers.

CO2: Get acquainted with various Embedded Processor architectures related to industrial application.

CO3: Know about the programming of ARM 7 based microcontroller with on chip peripherals and external peripherals.

CO4: Understand the architectures of ARM Cortex M4 Microcontrollers and its advantages over ARM 7 Microcontrollers.

CO5: Implement the real world programming of ARM 7 based microcontroller with on chip peripherals and external peripherals.

CO6: Recognize the interfacing of real world sensors and standard buses. Will also able to design different case studies.

Course Contents

Unit I	Embedded Processor Fundamentals	(06 Hrs.)

Programming in Embedded C: Using C for Embedded C, data types, storage class, operators, Branching: if, else-if, Looping: for, while, do-while.

Embedded System Development Environment: IDE (Introduction) types of file generated on cross-compilation, assembler, disassembler, Simulators and Debuggers.

Embedded System definition, Embedded Processor definition and classification, The RISC and CISC, von Neumann and Harvard Architecture, ARM processors and its versions, features of ARM Processor Families: ARM7, ARM9 & ARM11, ARM Design Philosophy.

Mapping of Course Outcomes for Unit I	**CO1: To understand basics of Embedded C Programming and usage of Embedded C and study different software tools for programming microcontrollers.**

Unit II	ARM7 Based Microcontroller	(08 Hrs.)

ARM core data flow model, Programmers model, Registers, CPSR and SPSR, Processor modes, ARM Nomenclature.

LPC2148: Features, Block Diagram and Description, System Control Block, Memory Map, System Control Block (PLL and VPB divider), Pin Connect Block, GPIO, Timer Block for Delay Generation, LPC 2148 Interfacing with LED, Switches, Relay, Interfacing LCD and keypad.

Mapping of Course Outcomes for Unit II	**CO2: To get acquainted with various Embedded Processor architectures related to industrial application.**

Unit III	Real World Interfacing with ARM7 Based Microcontroller	(06 Hrs)

UART Programming for transmission and reception of characters, Interfacing the peripherals to LPC2148: GSM and GPS using UART, on-chip ADC using interrupt (VIC), EEPROM using I2C, on-chip DAC for waveform generation, Interfacing with ARM 7 with DHT 11 sensor and servomotor.

Mapping of Course Outcomes for Unit III	**CO3: To Know about the programming of ARM 7 based microcontroller with on chip peripherals and external peripherals.**

Unit IV	Introduction to ARM CORTEX M4 Based Microcontroller	(08 Hrs)

Introduction to ARM CORTEX series: CORTEX A, R, M processors**,** Firmware development using CMSIS Standard. Introduction to ARM CORTEX M4 microprocessor core, programmer model, Processor Modes, Memory Map, Introduction Arm Cortex-M cores, STM32F4xx Architecture, ARM STM Bus Architecture, STM32F4xx Clock and SYSCLK, Peripheral Clock, PLL clock, Interrupts and Exceptions in STM32F4xx.

Mapping of Course Outcomes for Unit IV	**CO4: To understand the architectures of ARM Cortex M4 Microcontrollers and its advantages over ARM 7 Microcontrollers.**

Unit V	Real World Interfacing with Cortex M4 Based Microcontroller	(06 Hrs.)
GPIO Programming, Interfacing seven segment LED, LDR and MQ3 sensor with STM32F4xx, STM32F4xx: Counters and Timers: Timer and Delay Generation, UART Programming, on chip ADC and On-chip DAC for waveform generation.		
Mapping of Course Outcomes for Unit V	**CO5: Implement the real world programming of ARM 7 based microcontroller with on chip peripherals and external peripherals.**	
Unit VI	**Case Studies with Cortex M Based Microcontroller**	**(06 Hrs.)**
STM32F4xx Interfacing with accelerometer MPU 6050, Ultrasonic Sensor HC-SR04, PWM: Controlling speed and direction of DC Motor CAN Bus: Features, CAN Frame, sequence of transmitting and receiving data on CAN Bus.		
Mapping of Course Outcomes for Unit VI	**CO6: To become aware of the interfacing of real world sensors and standard buses. Will also able to develop embedded application using different case studies.**	

Learning Resources

Text Books:

1. K.V. Shibu, "Introduction to Embedded Systems", McGraw Hill Education India Private Limited, 2nd Edition
2. Andrew Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide – Designing and Optimizing System Software", Elsevier, 1st Edition.
3. Shujen Chen, Muhammad Ali Mazidi, Eshragh Ghaemi, "STM32 Arm Programming for Embedded Systems: Using C Language with STM32", Nucleo, Micro DigitalEd., Illustrated Edition,2018.

Reference Books:

1. UM10139 LPC214x User manual, NXP Semiconductor
2. RM0390 Reference manual, STM32F446xx advanced Arm®-based 32-bit MCUs
3. Joseph Yiu, "The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors", Newnes, 3rd Edition.

MOOC / NPTEL Courses:

1. NPTEL Course **"ARM Based Development"**, video course

   Link of the Course: https://nptel.ac.in/courses/117/106/117106111/

2. NPTEL Course on **" Embedded System Design with ARM", video course**

   Link of the Course: https://nptel.ac.in/courses/106/105/106105193/

Savitribai Phule Pune University

Third Year of E & Tc Engineering (2019 Course)

304195 (E): Network Security (Elective-II)

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: To introduce various network models, security threats and attacks and fundamentals of network security.

- To imbibe good foundation of network security in students for implementation of new network security algorithms.
- To understand different network models and the protocols used in each layer.
- To acquire detailed approach of encryption decryption for the data to transmit.
- To understand the role of network security as a tool for protection of different network entities.
- To be able to accurately apply security algorithms to real world security issues.
- To ensure windows and web browser security through implementation of various encryption standards.

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

CO1: Analyze attacks on computers and computer security.

CO2: Demonstrate knowledge of cryptography techniques.

CO3: Illustrate various Symmetric and Asymmetric keys for Ciphers

CO4: Evaluate different Message Authentication Algorithms and Hash Functions

CO5: Get acquainted with various aspects of E-Mail Security

CO6: Assimilate various aspects of Web Security

Course Contents

Unit I	Attacks on Computers and Computer Security	(06 Hrs.)

Introduction, The need for security, Security approaches, Principles of security, Types of Security attacks, Security services, Security Mechanisms, A model for Network Security

Mapping of Course Outcomes for Unit I	CO1: Analyze attacks on computers and computer security.

Unit II	Cryptography-Concepts and Techniques	(06 Hrs.)

Introduction, plain text and cipher text, substitution techniques, transposition techniques, encryption and decryption, symmetric and asymmetric key cryptography, stenography, key range and key size, possible types of attacks.

Mapping of Course Outcomes for Unit II	**CO2: Demonstrate knowledge of cryptography techniques.**	
Unit III	**Symmetric and Asymmetric key for Ciphers**	**(08 Hrs.)**
Block Cipher principles & Algorithms (DES, AES, Blowfish), Differential and Linear Crypt analysis, Block cipher modes of operation, Stream ciphers, RC4, Location and placement of encryption function, Key distribution, Asymmetric key Ciphers, Principles of public key crypto systems, Algorithms (RSA, Diffie-Hellman, ECC), Key Distribution.		
Mapping of Course Outcomes for Unit III	**CO3: Illustrate various Symmetric and Asymmetric keys for Ciphers.**	
Unit IV	**Message Authentication Algorithms and Hash Functions**	**(07 Hrs.)**
Authentication requirements, Functions, Message authentication codes, Hash Functions, Secure hash algorithm, HMAC, CMAC, Digital signatures, knapsack algorithm, Authentication Applications such as Kerberos, X.509 Authentication Service, Public – Key Infrastructure, Biometric Authentication.		
Mapping of Course Outcomes for Unit IV	**CO4: Evaluate different Message Authentication Algorithms and Hash Functions.**	
Unit V	**E-Mail Security**	**(06 Hrs.)**
Pretty Good Privacy, S/MIME, IP security overview, IP Security architecture, Authentication Header, Encapsulating , Security payload, Combining security associations, Key management		
Mapping of Course Outcomes for Unit V	**CO5: Get acquainted with various aspects of E-Mail Security**	
Unit VI	**Web Security**	**(07 Hrs.)**
Web security considerations, Secure Socket Layer and Transport Layer Security, Secure electronic transaction, Intruders, Intrusion detection, password management, virus and related threats, Countermeasures, Firewall design principles, types of firewalls, Secure Inter-branch Payment Transactions, Cross site Scripting Vulnerability, Virtual E lections.		
Mapping of Course Outcomes for Unit VI	**CO6**: Assimilate various aspects of Web Security	

Learning Resources

Text Books:

1. William Stallings , “Cryptography and Network Security” ,Pearson Education, 4th Edition
2. Atul Kahate, “Cryptography and Network Security”, McGraw Hill, 3rd Edition.
3. C K Shymala, N Harini, Dr. T R Padmanabhan, “Cryptography and Network Security”, Wiley India,1st Edition.

Reference Books:

1. Forouzan Mukhopadhyay, "Cryptography and Network Security", Mc Graw Hill, 2nd Edition.
2. Mark Stamp, "Information Security, Principles and Practice", Wiley India, 2nd Edition.
3. W.M. Arthur Conklin, Greg White, "Principles of Computer Security", TMH, 4th Edition.
4. Neal Krawetz, "Introduction to Network Security", CENGAGE Learning Distributor, 1st Edition.
5. Bernard Menezes, "Network Security and Cryptography", CENGAGE Learning Distributor, 1st Edition.

MOOC / NPTEL Courses:

1. NPTEL Course **"Introduction to Cyber Security "**
   Link of the Course: https://onlinecourses.swayam2.ac.in/nou19_cs08/preview

2. NPTEL Course "**Information Security – 5 – Secure Systems Engineering**"
   Link of the Course: https://nptel.ac.in/courses/106/106/106106199/

Savitribai Phule Pune University Third Year of E & Tc Engineering (2019 Course) 304196: Cellular Networks Lab		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 hrs. / week	**01**	**Oral: 50 Marks**
Prerequisite Courses, if any: -		
Companion Course, if any: Cellular Networks		

List of Laboratory Experiments	
Group A (Expt. 1 is compulsory and any two from Expt. 2 to 4)	
1.	Compute and compare the median loss by employing Hata model for various distance for carrier frequencies of 2.1 GHz and 6 GHz. Assume transmit and receive antenna heights of 40 m and 2 m in a large city. Plot the graph of path loss vs distance.
2.	Simulate BER performance over a Rayleigh fading wireless channel with BPSK transmission for SNR: 0 to 50 dB.
3.	Simulate BER performance over a wireline AWGN channel with BPSK transmission for SNR: 0 to 50 dB.
4.	Estimate fading channel coefficient in AWGN for given transmitted pilot symbols and received outputs across the standard Rayleigh fading wireless channel (Single Rx/Tx antenna).
5.	Compute the RMS delay spread for a given Power profile and plot the graph of Power vs Delay.
Group B (Expt. 6 is compulsory and any two from Expt. 7 to 10)	
6.	Perform a Link-Budget analysis for a wireless communication system.
7.	Simulate BER performance of multi-antenna Rayleigh channel for SNR varying from 0 to 60 dB.
8.	Simulate and Compute minimum spacing required between the antenna for independent fading channels against operating carrier frequency bands for every generation of mobile standards.
9.	Estimate channel coefficient vector Multi-Antenna Systems.
10.	Compute doppler shift of the received signal for different carrier frequency of mobile generations by considering vehicle is moving at 60 miles per hour at an angle of 30 degree with the line joining the base station.
Group C (Expt. 11 is compulsory and any two from Expt. 12 to 15)	
11.	Simulate mobile environment to evaluate performance parameters using any open source Network Simulator tool.
12.	Bread-board implementation to demonstrate and evaluate performance metrics of loss system
13.	Program to implement OFDM and evaluate frame error rate against SNR
14.	Program to understand Scheduling Mechanism for resource sharing
15.	Simulate a cellular system with 48 channels per cell and blocking probability of 2%. Assume traffic per user is 0.04 E. What is the number pf users that can be supported in a city of 603 km^2 area if cell radios are changed in the steps of 500 m, 700m, 900 m, 1000 m 1200 m and 1500 m
Virtual LAB Links:	

1. **Link of the Virtual Lab:**

Fading Channels: **http://www.vlab.co.in/ as**

2. **Link of the Virtual Lab:**

Mobile Communications: **http://fcmcvlab.iitkgp.ac.in**

Note: Additional 2 experiments to be performed using the virtual labs.

Savitribai Phule Pune University Third Year of E & Tc Engineering (2019 Course) 304197: Power Devices & Circuits Lab		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 hrs. / week	**01**	**Practical: 50 Marks**
Prerequisite Courses, if any: 1. Electrical Circuit Laboratory 2. Electronic Circuit Laboratory		
Companion Course, if any: Power Devices & Circuits		

List of Laboratory Experiments

Group A (All Compulsary)	
1.	VI Characteristics of SCR i) Plot output V-I characteristics to measure I_H, I_L and voltage before and after breakdown , ii) Observe the effect of gate current on forward break down iii) gate characteristics iv) compare with datasheet specifications
2.	V-I Characteristics of Power MOSFET i) Plot output characteristics and calculate output resistance ii) Plot transfer characteristics and measure threshold voltage iii) compare with datasheet specifications
3.	V-I Characteristics of IGBT i) Plot output characteristics and calculate output resistance ii) Plot transfer characteristics and measure threshold voltage iii) compare with datasheet specifications
Group B (Any 2)	
6.	Single phase Full Converter using IGBT / SCR with R & R-L load i) Observe load voltage waveform, ii) Measurement of average o/p voltage across loads, iii) Verification of theoretical values with practically measured values.
8.	Single-Phase PWM Power MOSFET / IGBT based bridge inverter for R and motor load i) Observe output voltage waveforms and measure set of rms output voltage for varying pulse width and variable input dc voltage for R and motor load, ii) compare measured output voltages with the theoretical findings
9.	Step down / Step up chopper using power MOSFET / IGBT i) Measure duty cycle and observer effect on average load voltage for DC chopper
Group C (Any 4)	
11.	SMPS /UPS Performance Evaluation i) find load & line regulation characteristics for no load condition and at 500 mA & 1A load ii) compare the performance with supplier specifications
12.	Single phase AC voltage controller using IGBT/SCR for R and RL load i) Observe output rms voltage waveforms, ii) Measurement output voltage across load, iii) Verification of theoretical values with practically measured values. Or Simulation of the Single phase AC voltage controller using Powersim / any open source circuit simulation software

13.	To study speed control of DC / single phase AC motor
14.	To design and implement a solar cell operated emergency lighting system.
15.	To study battery testing, safety and maintenance of batteries

- **Visit to solar power generation plant is recommended**

Savitribai Phule Pune University Third Year of E & Tc Engineering (2019 Course) 304198 (A): Digital Image Processing Lab (Elective - II)		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 hrs. / week	**01**	**Practical: 25 Marks**

Prerequisite Courses, if any: -

Companion Course, if any: Digital Image Processing

NOTE:

1.Use the MATLAB / SCILAB / Open CV.

2. For Group A recommended not to use inbuilt functions

List of Laboratory Experiments

Group A (All Compulsory)

1.	Introduction to Image Processing Toolbox/ CVIP tools (MATLAB/SCILAB/Open CV)
2.	Perform the following basic operations on image a. Obtain Negative image b. Obtain Flip image
3.	(a) Implement Gray level slicing (intensity level slicing) in to read cameraman image. (b) Read an 8 bit image and to see the effect of each bit on the image. (c) Read an image and to extract 8 different planes i.e. 'bit plane slicing."
4.	Implement various Smoothing spatial filter.
5.	Perform the following basic operations on image: a. Point Detection b. Line Detection c. Edge Detection d. Thresholding
6	Implement and study the effect of Different Mask (Sobel, Prewitt and Roberts)

Group B (Any Two)

7.	Implement region based segmentation.
8.	Implement Image compression using DCT Transform.
9.	Implement various noise models and their Histogram.
10.	Read an image, plot its histogram then do histogram equalization. Comment about the result.

Group C (Any One)	
11.	Implement inverse filter and wiener filter over image and comment on them.
12.	Implement Huffman coding algorithm for image compression.
14.	Implement wiener filter over image and comment on them.

Virtual LAB Links:

Link of the Virtual Lab: https://cse19-iiith.vlabs.ac.in/

Note: Additional 2 experiments to be performed using the virtual labs.

Savitribai Phule Pune University

Third Year of E & Tc Engineering (2019 Course)

304198 (B): Sensors in Automation Lab (Elective - II)

Teaching Scheme:	Credit	Examination Scheme:
Practical: 02 hrs. / week	01	Practical: 25 Marks

Prerequisite Courses, if any: -
1. Basic Electronics Engineering
2. Basic Electrical Engineering

Companion Course, if any: Sensors in Automation

List of Laboratory Experiments

Group A (Any Five)

1.	Temperature Measurement using appropriate sensor (Thermocouple/RTD).
2.	Weight Measurement using Load Cell.
3.	Liquid Level using Capacitive Sensor.

NOTE: Observe and plot Input/ Output characteristics, Hysteresis, and Sensitivity in above experiments.

4.	Position control using Servomechanism using photoelectric pickups.
5.	Moisture Measurement using appropriate Sensor and plot its static characteristics.

Group B (Any Two)

6.	To measure speed of a rotating shaft using appropriate sensor, plot the measurement characteristics.
7.	R - Color Sensing using appropriate sensor.
8.	To measure acceleration and orientation (x,y,z axis) using MEMS gyro/accelerometer sensor such as ADXL335.
9.	Simulate the performance of chemical sensor (PH).

Group C (Any Two)

10.	Acquisition of Minimum 2 Sensor Data using a Data Acquisition Systems
11.	Temperature Measurement using IR Detector
12.	Heart rate measurement using appropriate sensor
13.	Simulate the performance of Biosensor

Virtual LAB Links:

1. https://slcoep.vlabs.ac.in/List%20of%20experiments.html?domain=Electrical%20Engineering

2. http://uorepc-nitk.vlabs.ac.in/index.html

Note: Additional 2 experiments to be performed using the virtual labs.

Savitribai Phule Pune University Third Year of E & TC Engineering (2019 Course) 304198 (C): Advanced JAVA Programming Lab (Elective – II)		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 hrs. / week	**01**	**Practical: 25 Marks**

Prerequisite Courses, if any:
1.Fundamentals of Java Programming

Companion Course, if any: Advanced JAVA Programming

List of Laboratory Experiments

Group A (All are Compulsory)

1.	Write a program to demonstrate status of key on an Applet window such as KeyPressed, KeyReleased, KeyUp, KeyDown.
2.	Write a program to create a frame using AWT. Implement mouseClicked, mouseEntered() and mouseExited() events. Frame should become visible when the mouse enters it.
3.	Develop a GUI which accepts the information regarding the marks for all the subjects of a student in the examination. Display the result for a student in a separate window.
4.	Write a program to insert and retrieve the data from the database using JDBC.
5.	Develop an RMI application which accepts a string or a number and checks that string or number is palindrome or not.
6.	Write a program to demonstrate the use of InetAddress class and its factory methods.

Group B (Any Two)

7.	A. Write Servlet (procedure for client side) to display the username and password accepted from the client. B. Write Servlet (procedure for server side) to display the username and password accepted from the client.
8.	Write program with suitable example to develop your remote interface, implement your RMI server, implement application that create your server, also develop security policy file.
9.	Write a database application that uses any JDBC driver.

Group C (Any Two)

10.	Write a simple JSP page to display a simple message (It may be a simple html page).
11.	Create login form and perform state management using Cookies, HttpSession and URL Rewriting.
12.	Create a simple calculator application using servlet.
13.	Create a registration servlet in Java using JDBC. Accept the details such as Username, Password, Email, and Country from the user using HTML Form and store the registration details in the database.

Savitribai Phule Pune University Third Year of E & Tc Engineering (2019 Course) 304198 (D): Embedded Processors Lab (Elective – II)		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 hrs. / week	**01**	**Practical: 25 Marks**
Prerequisite Courses, if any: -		
Companion Course, if any: Embedded Processors		

List of Laboratory Experiments

Group A (Any Three)	
1.	Interfacing 16 X 2-character LCD display and Keypad with ARM LPC 2148 Microcontroller to display the key pressed.
2.	Write embedded C program to use timer block of LPC 2148 along with Switches to generate suitable delay to toggle LEDs.
3.	To generate different waveforms using on-chip DAC for LPC 2148.
4.	Use on-chip ADC to read the analog value and display digital value on LCD for LPC 2148.
5.	Interfacing GPS with UART using LPC 2148
Group B (Any Three)	
6.	Interfacing Seven Segment LED using STM32F4xx
7.	Write embedded C program to Transmit a character from keyboard using on chip UART for STM32F4xx.
8.	Write embedded C program to on chip ADC implementation with STM32F4xx
9.	To control speed and direction of DC Motor using PWM Block for STM32F4xx.
Group B (Any Two)	
10.	Interfacing DHT11 with LPC2148.
11.	Interfacing accelerometer cum Gyroscope MPU 6050 with STM32F4xx.
12.	Interfacing Ultrasonic Sensor HC-SR04 with STM32F4xx.
13.	Interfacing LDR and MQ3 sensor with STM32F4xx

Virtual LAB Links:

Link of the Virtual Lab: http: // vlabs.iikgp.ernet.in/rtes/

Note: Additional 2 experiments to be performed using the virtual lab

Savitribai Phule Pune University Third Year of E & Tc Engineering (2019 Course) 304198 (E): Network Security Lab (Elective – II)		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 hrs. / week	**01**	**Practical: 25 Marks**

Prerequisite Courses, if any: -

Companion Course, if any: Network Security

	Group A (Any Three)
1.	Design and implement for the insecurity of default passwords, printed passwords and password transmitted in plain text.
2.	Write a program for Encryption and Decryption.
3.	Write a program to perform encryption and decryption using the following algorithms: Ceaser Cipher, Substitution Cipher http://vlabs.iitb.ac.in/bootcamp/labs/dbms/exp13/
4.	Write a program to implement digital Signature http://cse29-iiith.vlabs.ac.in/
	Group B (Any Two)
6.	Isolating WLAN traffic using separate firewall for VPN connection
7.	Study of different wireless network components and features of any one of the Mobile Security Apps
8.	Implementation of Symmetric and Asymmetric cryptography
9.	Implementation of Steganography
	Group C (Any Three)
10.	Implementation of DES http://cse29-iiith.vlabs.ac.in/
11.	Implementation of AES http://cse29-iiith.vlabs.ac.in/
12.	Implementation of Windows security using firewall and other tools
13.	Steps to ensure Security of any one web browser (Mozilla Firefox/Google Chrome)
14.	Implementation of Hash functions http://cse29-iiith.vlabs.ac.in/

Virtual LAB Links:

Links of the Virtual Lab:

http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/Byte_Karma/index.html

Note: Additional 2 experiments to be performed using the virtual lab

Savitribai Phule Pune University Third Year of E & Tc Engineering (2019 Course) 304199: Internship		
Teaching Scheme:	**Credit**	**Examination Scheme:**
**	04	Term Work: 100 Marks

Course Objective:

- Will expose technical students to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
- Provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.
- Exposure to the current technological developments relevant to the subject area of training.
- Experience gained from the **'Internship'** will be used in classroom discussions.
- Create conditions conducive to quest for knowledge and its applicability on the job.
- Learn to apply the Technical knowledge in real industrial situations.
- Gain experience in writing Technical reports/projects.
- Expose students to the engineer's responsibilities and ethics.
- Familiarize with various materials, processes, products and their applications along with relevant aspects of quality control.
- Promote academic, professional and/or personal development.
- Expose the students to future employers.
- Understand the social, economic and administrative considerations that influence the working environment of industrial organizations.
- Understand the psychology of the workers and their habits, attitudes and approach to problem solving.

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

CO1: To develop professional competence through internship.

CO2: To apply academic knowledge in a personal and professional environment.

CO3: To build the professional network and expose students to future employees.

CO4: Apply professional and societal ethics in their day to day life.

CO5: To become a responsible professional having social, economic and administrative considerations.

CO6: To make own career goals and personal aspirations.

Internships are educational and career development opportunities, providing practical experience in a field or discipline. Internships are far more important as the employers are looking for employees who are properly skilled and having awareness about industry environment,

practices and culture. Internship is structured, short-term, supervised training often focused around particular tasks or projects with defined time scales.

Core objective is to expose technical students to the industrial environment, which cannot be simulated/experienced in the classroom and hence creating competent professionals in the industry and to understand the social, economic and administrative considerations that influence the working environment of industrial organizations.

Engineering internships are intended to provide students with an opportunity to apply theoretical knowledge from academics to the realities of the field work/training. The following guidelines are proposed to give academic credit for the internship undergone as a part of the Third Year Engineering curriculum.

A. Duration:

Internship to be completed after semester 5 and before commencement of semester 6 of at least 4 to 6 weeks; and it is to be assessed and evaluated in semester 6.

B. Framework of Internship:

- ✓ Students are required to be involved in Inter/ Intra Institutional Activities viz; Training with higher Institutions.
- ✓ Soft skill training organized by Training and Placement Cell of the respective institutions; contribution at incubation/ innovation /entrepreneurship cell of the institute; participation in conferences/ workshops/ competitions etc.
- ✓ Learning at Departmental Lab/ Tinkering Lab/ Institutional workshop.
- ✓ During the vacation after 5th semester, students are ready for industrial experience. Therefore, they may choose to undergo Internship / Innovation / Entrepreneurship related activities.
- ✓ Students may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/ NGO's/ Government organizations/ Micro/ Small/ Medium enterprises to make themselves ready for the industry.
- ✓ Every student is required to prepare a file containing documentary proofs of the activities done by him. The evaluation of these activities will be done by Programmed Head / Cell In-charge / Project Head / TPO / faculty mentor or Industry Supervisor.

C. Internship Guidelines:

a) Guidelines to the Institute:

Department will arrange internship for students in industries / organization after fifth semester or as per AICTE/ affiliating University guidelines & managing internships. The general procedure for arranging internship is given below:

Step 1: Request Letter/ Email should go to industry to allot various slots of 4-6 weeks as internship periods for the students. Students request letter /profile / interest areas may be submitted to industries for their willingness for providing the training.

Step 2: Industry will confirm the training slots and the number of seats allocated for internships via Confirmation Letter/ Email. In case the students arrange the training themselves the confirmation letter will be submitted by the students.

Step 3: Students on joining Training at the concerned Industry / Organization, submit the Joining Report/ Letters / Email.

Step 4: Students undergo industrial training at the concerned Industry / Organization. In-between Faculty Member(s) evaluate(s) the performance of students once/twice by visiting the Industry/Organization and Evaluation Report of the students is submitted in department.

Step 5: Students will submit training report after completion of internship.

Step 6: Training Certificate to be obtained from industry.

Step 7: List of students who have completed their internship successfully will be issued by Training and Placement Cell.

b) Guidelines to the students:

Any absenteeism by students during their internship should be informed immediately to the mentor/reporting manager and the internal guide. No special considerations will be accepted. Students cannot take leave for college work or fest activities. The leave permission for any college related activities will be solely approved by the HOD. The monthly attendance format should be duly submitted to the internal guide by the intern.

c) Internal reporting Guidelines:

Every intern should send weekly report to their internal guide without fail. It is mandatory for the intern to send weekly reports to their respective guide on regular basis. Interns should have at least fortnightly verbal communication with the internal guide without fail. In cases where in the company wants to secure their confidential information in the project / internship report, the internal guide should duly co-ordinate with the respective mentor/reporting manager on the method of reporting to assure that no information will be leaked outside and is purely for academic purposes.

d) Internship Diary / Internship Workbook:

Students must maintain Internship Diary/ Internship Workbook. The main purpose of maintaining diary/workbook is to cultivate the habit of documenting. The students should record in the daily training diary account of the observations, impressions, information gathered and

suggestions given, if any. The training diary/workbook should be signed after every day by the supervisor/ in charge of the section where the student has been working.

Internship Diary/workbook and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training. Internship Diary / workbook may be evaluated on the basis of the following criteria:

- Proper and timely documented entries.
- Adequacy & quality of information recorded
- Data recorded.
- Thought process and recording techniques used.
- Organization of the information.

e) Internship Work Evaluation:

Every student is required to prepare a maintain documentary proofs of the activities done by him / her as internship diary or as workbook. The evaluation of these activities will be done by Programme Head/ Cell In-charge / Project Head / faculty mentor or Industry Supervisor based on-overall compilation of internship activities, sub-activities, the level of achievement expected, evidence needed to assign the points and the duration for certain activities.

Assessment and Evaluation is to be done in consultation with internship supervisor (Internal and External - a supervisor from place of internship).

f) Evaluation through Seminar presentation / Viva-voce at the institute:

The student will give a seminar based on his training report, before an expert committee constituted by the concerned department as per norms of the institute. The evaluation will be based on the following criteria:

- ✓ Depth of knowledge and skills Communication & Presentation Skills.
- ✓ Team Work
- ✓ Creativity
- ✓ Planning & Organizational skills
- ✓ Adaptability and Analytical Skills
- ✓ Attitude & behavior at work.
- ✓ Societal Understanding
- ✓ Ethics
- ✓ Regularity and punctuality
- ✓ Attendance record
- ✓ Log book
- ✓ Student's Feedback from External Internship Supervisor

g) Internship Report:

The report shall be presented covering following recommended fields but limited to:

- Title/Cover Page
- Internship completion certificate.
- Internship Place Details- Company background-organization and activities/Scope and object of the study / personal observation.
- Index/Table of Contents
- Introduction
- Title/Problem statement/objectives
- Motivation/Scope and rationale of the study
- Methodological details
- Results / Analysis /inferences and conclusion
- Suggestions / Recommendations for improvement to industry, if any
- Attendance Record
- List of reference (Library books, magazines and other sources)

h) Feedback from internship supervisor (External and Internal):

Post internship, faculty coordinator should collect feedback about student with following recommended parameters:

- ✓ Technical knowledge
- ✓ Discipline
- ✓ Punctuality
- ✓ Commitment
- ✓ Willingness to do the work
- ✓ Communication skill
- ✓ Individual work
- ✓ Team work
- ✓ Leadership

Savitribai Phule Pune University Third Year of E & Tc Engineering (2019 Course) 304200: Mini Project		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 04 hrs. / week	**02**	**Term Work: 25 Marks** **Oral: 50 Marks**

Course Objectives:

- To understand the ―Product Development Process‟ including budgeting through Mini Project.
- To plan for various activities of the project and distribute the work amongst team members.
- To inculcate electronic hardware implementation skills by -
- Learning PCB artwork design using an appropriate EDA tool.
- Imbibing good soldering and effective trouble-shooting practices.
- Following correct grounding and shielding practices.
- To develop student‘s abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Mini Project.
- To understand the importance of document design by compiling Technical Report on the Mini Project work carried out.

Course Outcome:

On completion of the course, student will be able to

CO1: Understand, plan and execute a Mini Project with team.

CO2: Implement electronic hardware by learning PCB artwork design, soldering techniques, testing and troubleshooting etc.

CO3: Prepare a technical report based on the Mini project.

CO 4: Deliver technical seminar based on the Mini Project work carried out.

A) Execution of Mini Project

- Project group shall consist of **not more than 3** students per group.
- Mini Project Work should be carried out in the Design / Projects Laboratory.

- Project designs ideas can be necessarily adapted from recent issues of electronic design magazines Application notes from well known device manufacturers may also be referred.

- Use of Hardware devices/components is mandatory.
- Layout versus schematic verification is mandatory.
- Bare board test report shall be generated.
- Assembly of components and enclosure design is mandatory.

B: Selection: Domains for projects may be from the following, but not limited to:

- Instrumentation and Control Systems
- Electronic Communication Systems
- Biomedical Electronics
- Power Electronics
- Audio , Video Systems
- Embedded Systems
- Mechatronic Systems
- Microcontroller based projects should preferably use Microchip PIC controllers / ATmega controller / AVR microcontrollers / Ardino / Rasberry Pi.

C. Monitoring: (for students and teachers both): Suggested Plan for various activities to be monitored by the teacher.

Week 1 & 2: Formation of groups, Finalization of Mini project & Distribution of work.

Week 3 & 4: PCB artwork design using an appropriate EDA tool, Simulation.

Week 5 to 8: PCB manufacturing through vendor/at lab, Hardware assembly, programming (if required) Testing, Enclosure Design, Fabrication etc

Week 9 & 10: Testing of final product, Preparation, Checking & Correcting of the Draft Copy of Report

Week 11 & 12: Demonstration and Group presentations.

Log book for all these activities shall be maintained and shall be produced at the time of examination.

D. Report writing: A project report with following contents shall be prepared:

- Title
- Specifications
- Block Diagram
- Circuit Diagram
- Selection of components, calculations
- Simulation Results
- PCB Art work
- Testing Procedures
- Enclosure Design
- Test Results & Conclusion
- References

Savitribai Phule Pune University Third Year of E & Tc Engineering (2019 Course) 304191 (B): Mandatory Audit Course - 6		
Teaching Scheme:	**Credit**	**Examination Scheme:**
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List of Courses to be opted (Any one) under Mandatory Audit Course 6

- Patent Law for Engineers and Scientists
- English language for competitive exams
- Energy Resources, Economics and Environment
- Principles of Human Resource Management
- Six Sigma
- Non-Conventional Energy Resources

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.