Savitribai Phule Pune University

Faculty of Science and Technology

Syllabus for

S.E Electronics Engineering
(VLSI Design & Technology)

(Course 2019)

Savitribai Phule Pune University, Pune
S.E Electronics Engineering
(VLSI Design & Technology)
2019 Course
(With effect from Academic Year 2024-25)

Semester-III

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
207005	Engineering Mathematics III	04	-	01	30	70	25	-	-	125	04	-	01	05
204181	Electronic Circuits	03	-	-	30	70	-	-	-	100	03	-	-	03
204182	Digital Circuits	03	-	-	30	70	-	-	-	100	03	-	-	03
204206	FPGA based system design using Verilog	03	-	-	30	70	-	-	-	100	03	-	-	03
204184	Data structures	03	-	-	30	70	-	-	-	100	03	-	-	03
204185	Electronic Circuit Lab	-	02	-	-	-	-	50	-	50	-	01	-	01
204186	Digital circuits Lab		02					50		50		01		01
204207	FPGA based system design using Verilog Lab	-	02	-	-	-	25	-	-	25	-	01	-	01
204188	Data Structures Lab	-	02	-	-	-	-	-	25	25	-	01	-	01
204189	Electronic Skill Development	-	02	-	-	-	25	-	-	25	-	01	-	01
204190	Mandatory Audit Course 3	-	-	-					-	-	-	-	-	-
Total		**16**	**10**	**01**	**150**	**350**	**75**	**100**	**25**	**700**	**16**	**05**	**01**	**22**

Savitribai Phule Pune University, Pune
S.E Electronics Engineering
(VLSI Design & Technology)
2019 Course
(With effect from Academic Year 2024-25)

Semester-IV

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
204191	Signals & Systems	03	-	01	30	70	25	-	-	125	03	-	01	04
204192	Control Systems	03	-	-	30	70	-	-	-	100	03	-	-	03
204193	Principles of Communication Systems	03	-	-	30	70	-	-	-	100	03	-	-	03
204194	Object Oriented Programming	03	-	-	30	70	-	-	-	100	03	-	-	03
204195	Signals & Control System Lab		02				50			50		01		01
204196	Principle of Communication Systems Lab	-	02	-	-	-	-	50	-	50	-	01	-	01
204197	Object Oriented Programming Lab	-	02	-	-	-	-	-	50	50	-	01	-	01
204208	VLSI Design Lab		02				-		25	25		01		01
204199	Employability Skill Development	02	02	-	-	-	50	-	-	50	02	01	-	03
204200	Project Based Learning	-	04				50		-	50		02		02
204201	Mandatory Audit Course 4	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		**14**	**14**	**01**	**120**	**280**	**175**	**50**	**75**	**700**	**14**	**07**	**01**	**22**

Abbreviations:

In-Sem: In semester End-sem: End semester TH : Theory TW : Term Work

PR : Practical OR : Oral TUT : Tutorial

General Instructions

- PR/Tutorial/PBL must be conducted in three batches per division.
- Minimum number of required Experiments/Assignments in PR/ Tutorial shall be carried out as mentioned in the syllabi of respective subjects.
- Assessment of tutorial work has to be carried out as term-work examination. Term-work Examination at second year of engineering course **shall be internal continuous assessment only.**
- **η:** Project based learning (PBL) requires continuous mentoring by faculty throughout the semester for successful completion of the tasks selected by the students per batch. While assigning the teaching workload of 2 Hrs. / week / batch needs to be considered for the faculty involved. The Batch needs to be divided into sub-groups of 5 to 6 students. Assignments / activities / models/ projects etc. under project-based learning is carried throughout semester and Credit for PBL has to be awarded on the basis of internal continuous assessment and evaluation at the end of semester.
- **&:** Audit course is mandatory but non-credit course. Assessment has to be conducted at the end of Sem III & IV respectively for award of grade at college level. Grade awarded for audit course shall not be calculated for grade point & CGPA.
- **Examination Scheme:** The theory examination shall be conducted in two phases for all the subjects.
  - Phase I as **In-Semester Examination** of 30 marks written theory examination based on Unit-1 and Unit-2 of course syllabus scheduled by university.
  - Phase II as **End-Semester Examination** of 70 marks written theory examination based on unit number 3, 4, 5, 6 of course syllabus scheduled by university.

- **Structure of Question Paper:**
  - Two units **(Unit1 and Unit 2) will** be covered for 30 Marks for **In-Semester Examination** Equal weightage will be given to both the units.

  - Four units **(Unit 3, Unit 4, Unit 5 and Unit 6)** shall have weightage of 70 Marks for **End-Semester Examination**. Marks weightage for the various units shall be as shown in Table below:

Sr. No.	Unit No.	In - Sem	End - Sem
1.	I	15	--
2.	II	15	--
3.	III	--	18
4.	IV	--	17
5.	V	--	18
6.	VI	--	17

  - Papers will have only one section and there will be two questions for In-sem and four questions for End-sem. For each question there will be alternate Question based on same unit and of the same marks.

  - Framing of questions should be according to Anderson / Bloom's Taxonomy and disseminated through the question papers with a mention of course outcomes as well.

- **Assessment**:

A. Theory:

In-sem assessment will be done at the centralized assessment programme (CAP) Centre of the College by the Expert who is appointed as an examiner for the courses as per 48(3) panel of Maharashtra Public University act 2016

- End-sem assessment will be done at the CAP Centre designated by the University by the Expert who is appointed as an examiner for the subject as per 48(3) panel.

B. Term Work: Term Work is continuous assessment based on work done, submission of work in the form of report / journal, timely completion, attendance, and understanding. It should be assessed by subject teacher of the institute. At the end of the semester, the final grade for a Term Work shall be assigned based on the performance of the student and is to be submitted to the Savitribai Phule Pune University (SPPU). A student who fails in the Term Work on account of unsatisfactory performance shall be given F grade and on the account of inadequate attendance shall be given FX grade. Failing in a particular course Term Work shall not be the criteria for detention in the semester.

C. Practical / Oral: Practical / Oral is to be conducted and assessed jointly by internal and external examiners. The performance in the Practical / Oral examination shall be assessed by at least one pair of examiners appointed as examiners by the Savitribai Phule Pune University. The examiners will prepare the mark / grade sheet in the format as specified by the Savitribai Phule Pune University and authenticate it.

Guidelines for Instructor's Manual

- The instructor's manual is to be developed as a hands-on resource and reference.
- Copy of Curriculum, Conduction & Assessment guidelines, List of Experiments to be attached.

Guidelines for Laboratory Conduction

- Students are not allowed to touch any equipment or other materials in the laboratory until they are instructed by Teacher or Technician.
- All the experiments mentioned in the syllabus are compulsory.
- Use of open source software and recent version is to be encouraged.
- In addition to these, faculty member has to get it done a mini-project based on the concepts learned.

Guidelines for Student's Lab Journal

- The laboratory assignments/experiments are to be submitted by student in the form of journal.
- Journal consists of Certificate, table of contents, and handwritten write-up for each experiment.
- Each experiment should consist of:
  - ✓ Title.
  - ✓ Objectives.
  - ✓ Problem Statement, Outcomes
  - ✓ Hardware / Software (If any) requirements.
  - ✓ Concept.
  - ✓ Experimental procedure / Setup.
  - ✓ Observation table.
  - ✓ Conclusion.

Guidelines for Lab Assessment

- Continuous assessment of laboratory work is done based on overall performance.
- Each lab assignment/ experiment assessment will assign grade / marks based on parameters with appropriate weightage.
- Suggested parameters for overall assessment as well as each lab assignment / experiment assessment include:
  - ✓ Timely completion.
  - ✓ Performance.
  - ✓ Punctuality and neatness.
- The parameters for assessment are to be known to the students at the beginning of the course.

Savitribai Phule Pune University

Second Year of Electronics Engineering

VLSI Design & Technology (2019 Course)

207005: Engineering Mathematics - III

Teaching Scheme:	Credit	Examination Scheme:
Theory: 04 hrs. / week **Tutorial: 01 hr. / week**	**04 + 01 = 05**	**In-Sem (Theory): 30 Marks** **End Sem (Theory): 70 Marks** **Term Work: 25 Marks**

Prerequisite Courses, if any: - Differential and Integral calculus, Taylor series, Differential equations of first order and first degree, Fourier series, Vector algebra and Algebra of complex numbers.

Companion Course, if any: --

Course Objectives:

- To make the students familiarize with concepts and techniques in Ordinary differential equations, Fourier Transform, Z-Transform, Numerical methods, Vector calculus and functions of a Complex variable.
- The aim is to equip them with the techniques to understand advanced level mathematics and its applications that would enhance analytical thinking power, useful in their disciplines.

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

CO1: Solve higher order linear differential equation using appropriate techniques for modelling, analyzing of electrical circuits and control systems.

CO2: Apply concept of Fourier transform & Z-transform and its applications to continuous & discrete systems, signal & image processing and communication systems.

CO3: Obtain Interpolating polynomials, numerically differentiate and integrate functions, numerical solutions of differential equations using single step and multi-step iterative methods used in modern scientific computing.

CO4: Perform vector differentiation & integration, analyze the vector fields and apply to electro-magnetic fields & wave theory.

CO5: Analyze Complex functions, Conformal mappings, Contour integration applicable to electrostatics, digital filters, signal and image processing.

Course Contents

Unit I	Linear Differential Equations (LDE) and Applications	(09 Hrs)

LDE of n^{th} order with constant coefficients, Complementary Function, Particular Integral, General method, Short methods, Method of variation of parameters, Cauchy's and Legendre's DE, Simultaneous and Symmetric simultaneous DE. Modeling of Electrical circuits.

Mapping of Course Outcomes for Unit I	**CO1: Solve higher order linear differential equation using appropriate techniques for modelling, analyzing of electrical circuits and control systems.**	
Unit II	**Transforms**	**(09 Hrs)**
Fourier Transform (FT): Complex exponential form of Fourier series, Fourier integral theorem, Fourier Sine & Cosine integrals, Fourier transform, Fourier Sine and Cosine transforms and their inverses. **Z - Transform (ZT):** Introduction, Definition, Standard properties, ZT of standard sequences and their inverses. Solution of difference equations.		
Mapping of Course Outcomes for Unit II	**CO2: Apply concept of Fourier transform & Z-transform and its applications to continuous & discrete systems, signal & image processing and communication systems.**	
Unit III	**Numerical Methods**	**(09 Hrs)**
Interpolation: Finite Differences, Newton's and Lagrange's Interpolation formulae, Numerical Differentiation. **Numerical Integration:** Trapezoidal and Simpson's rules, Bound of truncation error, **Solution of Ordinary differential equations:** Euler's, Modified Euler's, Runge-Kutta 4^{th} order methods and Predictor-Corrector methods.		
Mapping of Course Outcomes for Unit III	**CO3: Obtain Interpolating polynomials, numerically differentiate and integrate functions, numerical solutions of differential equations using single step and multi-step iterative methods used in modern scientific computing.**	
Unit IV	**Vector Differential Calculus**	**(09 Hrs)**
Physical interpretation of Vector differentiation, Vector differential operator, Gradient, Divergence and Curl, Directional derivative, Solenoidal, Irrotational and Conservative fields, Scalar potential, Vector identities.		
Mapping of Course Outcomes for Unit IV	**CO4: Perform vector differentiation & integration, analyze the vector fields and apply to electro- magnetic fields & wave theory.**	
Unit V	**Vector Integral Calculus & Applications**	**(10 Hrs)**
Line, Surface and Volume integrals, Work-done, Green's Lemma, Gauss's Divergence theorem, Stoke's theorem. Applications to problems in Electro-magnetic fields.		
Mapping of Course Outcomes for Unit V	**CO4: Perform vector differentiation & integration, analyze the vector fields and apply to electro- magnetic fields & wave theory.**	
Unit VI	**Complex Variables**	**(06 Hrs)**
Functions of a Complex variable, Analytic functions, Cauchy-Riemann equations, Conformal mapping, Bilinear transformation, Cauchy's integral theorem, Cauchy's integral formula and Residue theorem.		

Mapping of Course Outcomes for Unit VI	CO5: Analyze Complex functions, Conformal mappings, Contour integration applicable to electrostatics, digital filters, signal and image processing.

Learning Resources

Text Books:

1. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill.
2. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publication, New Delhi.

Reference Books:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India,10th Edition.
2. M.D. Greenberg, "Advanced Engineering Mathematics", Pearson Education, 2nd Edition.
3. Peter. V and O'Neil, "Advanced Engineering Mathematics", Cengage Learning,7th Edition.
4. S.L. Ross, "Differential Equations", Wiley India, 3rd Edition.
5. S. C. Chapra and R. P. Canale, "Numerical Methods for Engineers", McGraw-Hill, 7th Edition.
6. J. W. Brown and R. V. Churchill, "Complex Variables and Applications", McGraw-Hill Inc, 8th Edition.

MOOC / NPTEL Courses:

1. NPTEL Course **"Transform Calculus And its applications in differential equations"**
   https://nptel.ac.in/courses/111/105/111105123/
2. NPTEL Course on **"Numerical Methods"**
   https://nptel.ac.in/courses/111/107/111107105/
3. NPTEL Course on **"Integral & Vector Calculus"**
   https://nptel.ac.in/courses/111/105/111105122/
4. NPTEL Course on **"Complex Analysis"**
   https://nptel.ac.in/courses/111/103/111103070/

Virtual LAB Link:

1. **Numerical Methods:**
   http://vlabs.iitb.ac.in/vlabs-dev/labs/numerical_lab/index.php

Guidelines for Tutorial and Term Work

i) Tutorial shall be engaged in three batches per division.
ii) Term work shall be based on continuous assessment of six assignments (one per each unit) and performance in internal tests.
iii) Additional tutorials (Min. 2) are to be conducted using Virtual Lab.

Savitribai Phule Pune University

Second Year of Electronics Engineering

VLSI Design & Technology (2019 Course)

204181: Electronic 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: 104010 - Basic Electronics Engineering

Companion Course, if any: 204185 - Electronic Circuits Laboratory

Course Objectives: To make the students understand

- Semiconductor device MOSFET, its characteristics, parameters & applications.
- Concepts of feedbacks in amplifiers & oscillators.
- Operational amplifier, concept, parameters & applications.
- ADC, DAC as an interface between analog & digital domains.
- Voltage to current and current to voltage converters.
- Concepts, characteristics & applications of PLL.

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

CO1: Assimilate the physics, characteristics and parameters of MOSFET towards its application as amplifier.

CO2: Design MOSFET amplifiers, with and without feedback, & MOSFET oscillators, for given specifications.

CO3: Analyze and assess the performance of linear and switching regulators, with their variants, towards applications in regulated power supplies.

CO4: Explain internal schematic of Op-Amp and define its performance parameters.

CO5: Design, Build and test Op-amp based analog signal processing and conditioning circuits towards various real time applications.

CO6: Understand and compare the principles of various data conversion techniques and PLL with their applications.

Course Contents

Unit I	MOSFET & its Analysis	(08 Hrs)

Enhancement MOSFET: Construction, Characteristics, DC Load line, AC equivalent ckt, Parameters, Parasitics.

Non ideal characteristics: Finite output resistance, Body effect, Sub-threshold conduction, breakdown effects, temperature effect, effect of W/L ratio, Common source amplifier & analysis, Source follower: circuit diagram, comparison with common source, Frequency response for amplifier

Mapping of Course Outcomes for Unit I	CO1: Assimilate the physics, characteristics and parameters of MOSFET towards its application as amplifier.

Unit II	MOSFET Circuits	(06 Hrs)
MOSFET as switch, CMOS inverter, resistor & diode. Current sink & source, Current mirror. Four types of feedback amplifiers, Effects of feedback, Voltage series & current series feedback amplifiers and analysis, Barkhausen criterion, Wein bridge & phase shift oscillator.		
Mapping of Course Outcomes for Unit II	**CO2: Design MOSFET amplifiers, with and without feedback, & MOSFET oscillators, for given specifications.**	
Unit III	**Voltage Regulators**	**(06 Hrs)**
Three terminal voltage regulators (317 & 337): Block diagram of linear voltage regulator, IC 317 and IC337, Features and specifications, typical circuits, current boosting, Low Dropout Regulator (LDO). **SMPS:** Block diagram, Types, features and specifications, typical circuits buck and boost converter.		
Mapping of Course Outcomes for Unit III	**CO3: Analyze and assess the performance of linear and switching regulators, with their variants, towards applications in regulated power supplies.**	
Unit IV	**Operational Amplifier**	**(08 Hrs)**
Block diagram, Differential amplifier analysis for Dual input Balanced output mode - AC analysis (using r parameters) & DC analysis, Level shifter, Op amp parameters, Current mirror, Op-amp characteristics (AC & DC). Voltage series & voltage shunt feedback amplifiers, Effect on R_i, R_o, gain & bandwidth.		
Mapping of Course Outcomes for Unit IV	**CO4: Explain internal schematic of Op-Amp and define its performance parameters.**	
Unit V	**Op-Amp Applications**	**(08 Hrs)**
Inverting amplifier, non-inverting amplifier, Voltage follower, Summing amplifier, Differential amplifier, Practical integrator, Practical differentiator, Instrumentation amplifier, Comparator, Schmitt trigger, Square & triangular wave generator.		
Mapping of Course Outcomes for Unit V	**CO5: Design, Build and test Op-amp based analog signal processing and conditioning circuits towards various real time applications.**	
Unit VI	**Converters & PLL**	**(06 Hrs)**
Voltage to Current, Current to Voltage converters. **DAC & ADC:** Resistor weighted and R-2R DAC, SAR, Flash and dual slope ADC Types / Techniques, Characteristics, block diagrams, Circuits, Specifications, Merits, Demerits, Comparisons. **PLL:** Block Diagram, Characteristics, phase detectors, Details of PLL IC 565 Applications, Typical circuits.		
Mapping of Course Outcomes for Unit VI	**CO6: Understand and compare the principles of various data conversion techniques and PLL with their applications.**	

Learning Resources

Text Books:

1. Donald Neaman, "Electronic Circuits - Analysis and Design", Mc Graw Hill, 3rd Edition.

2. Ramakant Gaikwad, "Op Amps & Linear Integrated Circuits", Pearson Education.

Reference Books:

1. Millman Halkias, "Integrated Electronics".

2. Phillip E. Allen and Douglas R. Holberg, "CMOS Analog Circuit Design", Oxford, 2nd Edition.

3. Salivahan and Kanchana Bhaskaran, "Linear Integrated Circuits", Tata McGraw Hill.

MOOC / NPTEL Courses:

1. NPTEL Course **"Analog Electronic Circuits"**
https://nptel.ac.in/courses/108/105/108105158/

2. NPTEL Course on **"Analog Circuits"**
https://nptel.ac.in/courses/108/101/108101094/

Savitribai Phule Pune University

Second Year of Electronics Engineering

VLSI Design & Technology (2019 Course)

204182: Digital 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: --

Companion Course, if any: 204186 - Digital Circuits Laboratory

Course Objectives: To make the students understand

- The fundamental principles of two-valued logic and various devices used to implement logical operations on variables.
- Boolean algebra, Karnaugh maps and its application to the design and characterization of digital circuits.
- To analyze logic processes and implement logical operations using combinational logic circuits.
- The principles of logic design and use of simple memory devices, flip-flops, and sequential circuits.
- Concepts of sequential circuits and to analyze sequential systems in terms of state machines.
- System design approach using programmable logic devices.

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

CO1: Identify and prevent various hazards and timing problems in a digital design.

CO2: Use the basic logic gates and various reduction techniques of digital logic circuit.

CO3: Analyze, design and implement combinational logic circuits.

CO4: Analyze, design and implement sequential circuits.

CO5: Differentiate between Mealy and Moore machines.

CO6: Analyze digital system design using PLD.

Course Contents

Unit I	Digital Logic Families	(05 Hrs)

Classification and Characteristics of digital Logic Families: Speed, power dissipation, figure of merit, fan in, fan out, current, voltage, noise immunity, operating temperatures and power supply requirements. TTL logic. Operation of TTL NAND gate, active pull up, wired AND, open collector output, unconnected inputs. Tri-State logic. CMOS logic: CMOS inverter, NAND, NOR gates, unconnected inputs, wired logic, open drain output. Interfacing CMOS and TTL, Data sheet specifications.

Mapping of Course Outcomes for Unit I	CO1: Identify and prevent various hazards and timing problems in a digital design.

Unit II	Combinational Logic Design	(08 Hrs)

Definition of combinational logic, canonical forms, Standard representations for logic functions, k-map representation of logic functions (SOP and POS forms), minimization of logical functions for min-terms and max-terms (upto 4 variables), don't care conditions, Design Examples: Arithmetic Circuits, BCD to7 segment decoder, Code converters. Introduction to Quine- McCluskey method, Quine McCluskey using don't care terms, Reduced prime implicants Tables.

Mapping of Course Outcomes for Unit II	CO2: Use the basic logic gates and various reduction techniques of digital logic circuit.

Unit III	Combinational Circuits	(06 Hrs)

Adders and their use as subtractor, look ahead carry, ALU, Digital Comparator, Parity generators/checkers, Multiplexers and their use in combinational logic designs, multiplexer trees, De-multiplexers and their use in combinational logic designs, Decoders, Demultiplexer trees.

Mapping of Course Outcomes for Unit III	CO3: Analyze, design and implement combinational logic circuits.

Unit IV	Sequential Logic Design	(08 Hrs)

1 Bit Memory Cell, Clocked SR, JK, MS J-K flip flop, D and T flip-flops. Use of preset and clear terminals, hold and setup time and metastability.

Excitation Table for flip flop, Conversion of flip flops, Typical data sheet specifications of Flip flop application of Flip flops.

Registers, Shift registers, Counters (ring counters, twisted ring counters), ripple counters, Mod-n counters, up/down counters, synchronous counters, lock out, Clock Skew, Clock jitter. Effect on synchronous designs, Sequence Generators.

Mapping of Course Outcomes for Unit IV	**CO4: Analyze, design and implement sequential circuits.**

Unit V	**State Machines**	**(07 Hrs)**

Basic design steps- State diagram, State table, State reduction, State assignment, Mealy and Moore machines representation, Implementation, finite state machine implementation, Sequence detector. Introduction to Algorithmic state machines- construction of ASM chart and realization for sequential circuits

Mapping of Course Outcomes for Unit V	**CO5: Differentiate between Mealy and Moore machines.**

Unit VI	**Programmable Logic Devices**	**(08 Hrs)**

Programmable logic devices: Detail architecture, Study of PROM, PAL, PLA, General Architecture, features and typical specifications of FPGA and CPLD. Semiconductor memories: memory organization and operation, expanding memory size, Classification and characteristics of memories, RAM ROM, EPROM, EEPROM, NVRAM, SRAM, and DRAM. Designing combinational circuits using PLDs.

Mapping of Course Outcomes for Unit VI	**CO6: Analyze digital system design using PLD.**

Learning Resources

Text Books:

1. R.P. Jain, "Modern Digital Electronics", Tata McGraw Hill Publication, 3rd Edition.
2. Thomas Floyd, "Digital Electronics", 11th Edition.
3. M. Morris Mano, "Digital Logic and Computer Design", Prentice Hall of India, 4th Edition.
4. Taub and Schilling, "Digital Principles and Applications," TMH.

Reference Books:

1. Anand Kumar, "Fundamentals of Digital Circuits", Prentice Hall of India, 1st Edition.
2. J. F. Wakerly, "Digital Design- Principles and Practices,", Pearson, 3rd Edition.
3. M. M. Mano, "Digital Design," Prentice Hall India.

MOOC / NPTEL Courses:

1. NPTEL Course **"Digital Circuits"**
   https://nptel.ac.in/courses/108/105/_108105113/

2. NPTEL Course **"Digital Circuits & Systems"**
   https://nptel.ac.in/courses/117/106/117106086/

3. NPTEL Course **"Digital Electronic Circuits"**
   https://nptel.ac.in/courses/108/105/108105132/

Savitribai Phule Pune University

Second Year of Electronics Engineering

VLSI Design & Technology (2019 Course)

204206: FPGA Based System Design using Verilog

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

Prerequisite Courses, if any: - Basic Electronics Engineering

Companion Course, if any: - Digital Circuits

Course Objectives:

- Know FPGA Architecture and Interconnect
- Understand Digital System Design using FPGA
- Know different FPGA's and implementation methodologies.
- Configuring and implementing digital embedded system, microcontrollers, microprocessors

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

CO1: Understand the FPGA Architecture

CO2: Understand FPGA Design flow

CO3: Design and model digital circuits with Verilog HDL at behavioral, structural, and RTL Levels

CO4: Model Combinational and sequential digital circuits by Verilog HDL

CO5: Design and optimize complex sequential digital circuits

CO6: Design specific examples using FPGAs

Course Contents		
Unit I	Overview of FPGA Architectures and Technologies	**(05 Hrs)**
Introduction to FPGA Architecture, FPGA Architectural options, coarse vs fine grained, vendor specific issues, Antifuse, SRAM and EPROM based FPGAs, FPGA logic cells, interconnection network and I/O Pad.		
Mapping of Course Outcomes for Unit I	**CO1: Understand FPGA Architecture**	
Unit II	FPGA Design Flow	**(08 Hrs)**
Architecture design. Project design using Verilog Hardware Description Language (HDL). Defining testing methodology and test bench, design. RTL simulation, synthesizing, implementation, gate level simulation of design. Reusing of internal hard modules during design and implementation.		
Mapping of Course Outcomes for Unit II	**CO2: Understand FPGA Design flow**	
Unit III	Verilog HDL	**(06 Hrs)**
Introduction to HDL, Verilog HDL Coding Style: Lexical Conventions - Ports and Modules – Operators - Gate Level Modeling - System Tasks & Compiler Directives - Test Bench - Data Flow Modeling - Behavioral Level Modeling -Tasks & Functions		
Mapping of Course Outcomes for Unit III	**CO3: Design and model digital circuits with Verilog HDL at behavioral, structural, and RTL Levels**	
Unit IV	Verilog Modelling	**(08 Hrs)**
Verilog Modelling of Combinational and Sequential Circuits: Behavioral, Data Flow and Structural Realization of Adders , Multiplexers, Comparators , Flip Flops , Shift Register , Realization of a Counter: Synchronous and Asynchronous , Pseudo Random LFSR (Linear Feedback Shift Register) , Cyclic Redundancy Check.		
Mapping of Course Outcomes for Unit IV	**CO4: Model Combinational and sequential digital circuits by Verilog HDL**	
Unit V	Synchronous Sequential Circuits	**(08 Hrs)**
Synchronous Sequential Circuit: State diagram-state table –state assignment-choice of flip-flops – Timing diagram –One hot encoding Mealy and Moore state machines – Design of serial adder using Mealy and Moore state machines - State minimization – Sequence detection- Design examples: Sequence detector, Serial adder, Vending machine using One Hot Controller		
Mapping of Course Outcomes for Unit V	**CO5: Design and optimize complex sequential digital circuits**	

Unit VI	System Design Applications	**(06 Hrs)**
Embedded system design using FPGAs, DSP using FPGAs, Dynamic architecture using FPGAs, reconfigurable systems, System Design Examples using Xilinx FPGAs – Traffic light Controller, Real Time Clock - Interfacing using FPGA: VGA, Keyboard, LCD		
Mapping of Course Outcomes for Unit IV	**CO6: Design specific examples using FPGAs**	

Learning Resources

Text Books:

1. M.J.S. Smith, "Application Specific Integrated Circuits", Pearson, 2000

2. Peter Ashenden, "Digital Design using Verilog", Elsevier, 2007. 4. W. Wolf, "FPGA based system design", Pearson, 2004

3. Stephen Brown &ZvonkoVranesic, "Digital Logic Design with Verilog HDL" TATA McGraw Hill Ltd. 2nd Edition 2007

Reference Books:

4. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis" Prentice Hall, Second Edition, 2003
5. Clive Maxfield, "The Design Warriors's Guide to FPGAs", Elsevier, 2004
6. S. Ramachandran, "Digital VLSI System Design: A Design Manual for implementation of Projects on FPGAs and ASICs Using Verilog" Springer Publication, 2007
7. Wayne Wolf, "FPGA Based System Design", Prentices Hall Modern Semiconductor Design Series

MOOC / NPTEL Courses

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Savitribai Phule Pune University
Second Year of Electronics Engineering
VLSI Design and Technology (2019 Course)
204184: Data Structures

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

Prerequisite Courses, if any: 110005 - Programming and Problem Solving

Companion Course, if any: 204188 - Data Structures Laboratory

Course Objectives:

To learn basic concepts of C Programming language.

- To learn different sorting and searching algorithms and their analysis.
- To learn linear data structures: Stack and Queue, Linked List and their applications.
- To learn nonlinear data structures: Tree, Graph and their applications.
- To study the systematic ways of solving problem, various methods of organizing large amount of data.

Course Contents

Unit I	**Introduction to C Programming**	**(08 Hrs)**

C Fundamentals: Constants, Variables and Keywords in C, Operators, Bitwise Operations, Decision Control and Looping Statements.

Arrays & Pointers: Arrays, Functions, Recursive Functions, Pointers, String Manipulations, Structures, Union, Enumeration, MACROS.

File Handling: File Operations- Open, Close, Read, Write and Append.

Mapping of Course Outcomes for Unit I	**CO1: Solve mathematical problems using C programming language.**

Unit II	**Searching and Sorting Algorithms**	**(06 Hrs)**

Algorithms: Analysis of Iterative and Recursive algorithms, Space & Time complexity, Asymptotic notation- Big-O, Theta and Omega notations.

Searching methods: Linear, Binary and Fibonacci Search.

Sorting methods: Bubble, Insertion, Selection, Merge, and Quick Sort.

Mapping of Course Outcomes for Unit II	**CO2: Implement sorting and searching algorithms and calculate their complexity.**

Unit III	**Stack and Queue**	**(06 Hrs)**

Stack: Concept, Basic Stack operations, Array representation of stack, Stack as ADT, Stack Applications: Reversing data, Arithmetic expressions conversion and evaluation.

Queue: Concept, Queue operations, Array representation of queue, Queue as ADT, Circular queue, Priority Queue, Applications of queue: Categorizing data, Simulation of queue.

Mapping of Course Outcomes for Unit III	**CO3: Develop applications of stack and queue using array.**

Unit IV	**Linked List**	**(06 Hrs)**

Concept of linked organization, Singly Linked List, Stack using linked list, Queue using linked list, Doubly Linked List, Circular Linked List, Linked list as ADT. Representation and manipulations of polynomials using linked list, comparison of sequential and linked organization.

Mapping of Course Outcomes for Unit IV	**CO4: Demonstrate applicability of Linked List.**

Unit V	**Trees**	**(06 Hrs)**

Introduction to trees: Basic Tree Concepts.
Binary Trees: Concept & Terminologies, Representation of Binary Tree in memory, Traversing a binary tree.
Binary Search Trees (BST): Basic Concepts, BST operations, Concept of Threaded Binary Search Tree
AVL Tree: Basic concepts and rotations of a Tree.

Mapping of Course Outcomes for Unit V	**CO5: Demonstrate applicability of nonlinear data structures - Binary Tree with respect to its time complexity.**

Unit VI	**Graphs**	**(06 Hrs)**

Graph: Basic Concepts & terminology.

Representation of graphs: Adjacency matrix, Adjacency list.

Operations on graph: Traversing a graph.

Spanning trees: Minimum Spanning tree- Kruskal's Algorithm, Prim's Algorithm and Dijkstra's Shortest Path Algorithm.

Mapping of Course Outcomes for Unit VI	**CO6: Apply the knowledge of graph for solving the problems of spanning tree and shortest path algorithm.**

Learning Resources

Text Books:

1. Ellis Horowitz and Sartaj Sahni, "Fundamentals of Data Structures", Galgotia Books Source,2nd Edition

2. Richard. F. Gilberg and Behrouz A. Forouzan, "Data Structures: A Pseudocode Approach with C," Cengage Learning, 2nd Edition.

Reference Books:

1. E Balgurusamy, "Programming in ANSI C", Tata McGraw-Hill, 3rd Edition.

2. Yedidyah Langsam, Moshe J Augenstein and Aaron M Tenenbaum "Data structures using C and C++" PHI Publications, 2nd Edition.

3. Reema Thareja, "Data Structures using C", Oxford University Press, 2nd Edition.

MOOC / NPTEL Courses:

1. NPTEL Course **"Programming & Data Structure"**

https://nptel.ac.in/courses/106/105/106105085/

2. NPTEL Course "**Data Structures & Algorithms**"

https://nptel.ac.in/courses/106/102/106102064/

Savitribai Phule Pune University
Second Year of Electronics Engineering

VLSI Design & Technology (2019 Course)

204185: Electronic Circuits Lab

Teaching Scheme:	Credit	Examination Scheme:
Practical: 02 hrs. / week	01	Practical: 50 Marks

Prerequisite Courses, if any: -

Companion Course, if any: 204181 - Electronic Circuits

List of Laboratory Experiments

Group A: [Any 4 to be performed]

1.	To design, build single stage CS amplifier & verify dc operating point.
2.	To build & test single stage CS amplifier, plot frequency response. Calculate A_v, R_i, R_o & bandwidth.
3.	To implement current series feedback amplifier & measure R_{if}, R_{of}, A_{vf} & bandwidth.
4.	To implement MOSFET amplifier-based Wein bridge oscillator.
5.	To design & implement an adjustable voltage regulator using three terminal voltage regulator IC.

Group B: Compulsory

6.	To measure following Op- amp parameters & compare with specifications given in data sheet. **[Any two Practical Op-Amp can be used for comparison. e.g. LM741, OP07, LF351, LF356, TI071, TI072]** a) Input bias current b) Input offset current c) Input offset voltage d) Slew rate e) CMRR
7.	To design, build & test integrator using Op-amp for given frequency f_a.
8.	To design, build & test 2 or 3-bit R-2R ladder DAC.
9.	To design, build & test Square and triangular waveform generator using Op-Amp (LF351/6)

Group C: [Any 2 to be performed]

11.	To design, build & test Schmitt trigger using Op-Amp (LF356, TI071)
12.	To design, build & test three Op amp Instrumentation amplifier for typical application.
13.	To design, build & test 2-bit flash ADC.
14	To build and test PLL ckt

Note:
One practical from each Group should be performed as simulation practical(using any available tool).

Additional (min.2) practicals are to be performed using Virtual Lab

Virtual LAB Links:

1. **Integrated Circuits:**
   http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/electronerds/index.html

2. **Basic Electronics Virtual Lab:**
   http://vlabs.iitkgp.ernet.in/be/

Savitribai Phule Pune University
Second Year of Electronics Engineering

VLSI Design & Technology (2019 Course)

204186: Digital Circuits Lab

Teaching Scheme:	Credit	Examination Scheme:
Practical: 02 hrs. / week	01	Practical: 50 Marks

Prerequisite Courses, if any: --

Companion Course, if any: - Digital Circuits

List of Laboratory Experiments

1.	**Study of IC-74LS153 as a Multiplexer:** (Refer Data-Sheet). a. Design and Implement 8:1 MUX using IC-74LS153 & Verify its Truth Table. b. Design & Implement the given 4 variable function using IC74LS153. Verify its Truth-Table.
2.	**Study of IC-74LS138 as a Demultiplexer / Decoder:** (Refer Data-Sheet) a. Design and Implement full adder and subtractor function using IC-74LS138. b. Design & Implement 3-bit code converter using IC-74LS138. (Gray to Binary/Binary to Gray).
3.	**Study of IC-74LS83 as a BCD adder:** (Refer Data-Sheet). a. Design and Implement 1-digit BCD adder usingIC-74LS83. b. Design and Implement 4-bit Binary sub tractor using IC-74LS83.
4.	**Study of IC-74LS85 as a magnitude comparator:** (Refer Data-Sheet)
	a. Design and Implement 4-bit Comparator. **b. Design and Implement 8-bit Comparator.**
5.	**Study of Counters:**

	a. Design and Implement 4-bit counter using JK- Flip flop.
6.	**Study of Counter ICs (74LS90/74LS93): (Refer Data-Sheet)** **a. Design and Implement MOD-N and MOD-NN using IC-74LS90 and draw Timing diagram.** **b. Design and Implement MOD-N and MOD-NN using IC-74LS93 and draw Timing diagram.**
7.	**Study of synchronous counter:** **a. Design & Implement 4-bit Up/down Counter and MOD-N Up/down Counter using IC74HC191 / IC74HC193. Draw Timing Diagram.**
8.	**Verify four voltage and current parameters for TTL and CMOS (IC 74LSXX, 74HCXX), (Refer Data-Sheet).**
9.	**Study of Shift Register:** **Design and Implement 4-bit right shift and left shift register using D-flip flop.**
10.	**Study of Shift Register (74HC194 / 74LS95):** **a. Design and Implement Pulse train generator using IC-74HC194 / IC74LS95 (Use right shift/ left shift).** **b. Design and Implement 4-bit Ring Counter/ Twisted ring Counter using shift registers IC 74HC194 / IC74LS95.**
11.	**Study of Counter ICs (74LS90 / 74LS93): (Refer Data-Sheet)** **a. Design and Implement MOD-N and MOD-NN using IC-74LS90 and draw Timing diagram.** **b. Design and Implement MOD-N and MOD-NN using IC-74LS93 and draw Timing diagram.**

Virtual LAB Links:

1. Digital Logic Design:
http://vlabs.iitb.ac.in/vlabs-dev/labs/dldesignlab/index.html

2. Digital Electronics:
http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/cool_developers/index.html

3. Digital Logic Design using Gates:
http://vlabs.iitb.ac.in/vlabs-dev/labs/dldgates/index.html

4. Digital Applications:
http://vlabs.iitb.ac.in/vlabs-dev/labs/digital_application/index.html

5. Digital Electronics Circuits Lab:

http://vlabs.iitkgp.ernet.in/dec/

6. Digital Logic Design Lab:
http://cse15-iiith.vlabs.ac.in/

7. Hybrid Electronics:
http://he-coep.vlabs.ac.in/

Note: Additional (min.2) practicals are to be performed using Virtual Lab

Savitribai Phule Pune University Second Year of Electronics Engineering VLSI Design & Technology (2019 Course) 204207: FPGA Based System Design using Verilog LAB		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 hrs. / week	**01**	**TW: 25 Marks**
Prerequisite Courses, if any: -		
Companion Course, if any:		

List of Laboratory Experiments	
Group A: [Any 4 to be performed]	
1.	Study of FPGA Architecture
2.	To Learn the basics of Verilog and Gate level Modelling in Verilog
3.	Write the code for all logic gates with simulation in Verilog
4.	Design and simulation of Full adder
5.	Design and simulation of 4bit binary counter
Group B: Compulsory	
6.	To implement Structural Modelling using Module and verify the module using test bench
7.	To implement a gate level circuit on FPGA board
8.	To implement Behavioral modelling using Module and verify the module using test bench
9.	Modelling of Edge triggered and level triggered FF : D,SR, JK
Group C: [Any 2 to be performed]	
11.	Design of Sequence Detector using FSM (Mealy and Moore Machine)
12.	Design a traffic light controller system
13.	Design of Vending machine

Virtual Lab Links:

Savitribai Phule Pune University Second Year of Electronics Engineering Electronics / E & Tc Engineering (2019 Course) 204188: Data Structures Lab		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 hrs. / week	**01**	**Oral: 25 Marks**
Prerequisite Courses, if any: 110005 - Programming and Problem Solving		
Companion Course, if any: 204184 - Data Structures		

List of Laboratory Experiments	
Group A: Compulsory **Write a C program to:**	
1.	Perform following String operations with and without pointers to arrays (without using the library functions): a. substring b. palindrome c. compare d. copy e. reverse
2.	Implement Database Management using array of structures with operations Create, Display, Modify, Append, Search and Sort. (For any database like Employee or Bank database with and without pointers to structures)
3.	Implement Stack and Queue using arrays.
4.	Create a singly linked list with options: a. Insert (at front, at end, in the middle) b. Delete (at front, at end, in the middle) c. Display d. Display Reverse e. Revert the SLL
5.	Implement Binary search tree with operations Create, search, and recursive traversal.
6.	Implement Graph using adjacency Matrix with BFS & DFS traversal.
Group B: [Any 3 to be performed] **Write a C program to:**	
7.	Implement stack and queue using linked list.
8.	Implement assignment 2 using files.

9.	Add two polynomials using linked list.
10.	Reverse a doubly linked list.
11.	Evaluate postfix expression (input will be postfix expression).
12.	Reverse and Sort stack using recursion.
13.	Implement inorder tree traversal without recursion.
14.	To find inorder predecessor and successor of a given key in BST.
15.	Implement Quicksort.

Group C: [Any 1 to be performed]

Write a C program to:

16.	Implement merge sort for doubly linked list.
17.	Construct a tree from given in order and preorder traversal.
18.	Implement Dijkstra's Algorithm.
19.	Implement Circular Linked List with various operations.
20.	Represent graph using adjacency list or matrix and generate minimum spanning tree using Prim's algorithm.

Group Assignment

- Make Group of **4 students** in a batch (Batch of 20)
- Group will select any one topic as group assignment
- After completing the assignment, the respective group will present it during the practical slot.
  - Distribution of work in a group during presentation may contain:
    - Algorithm / Flowchart
    - Program Explanation
    - Applications

Virtual LAB Links:

1. **Data Structures - I:**
   https://ds1-iiith.vlabs.ac.in/data-structures-1/

2. **Data Structures - II:**
   https://ds2-iiith.vlabs.ac.in/data-structures-2/

3. **Data Structures Lab:**
   http://cse01-iiith.vlabs.ac.in/

4. **Computer Programming Lab:**
   http://cse02-iiith.vlabs.ac.in/

Savitribai Phule Pune University Second Year of Electronics Engineering VLSI Design & Technology (2019 Course): 20189:Electronic Skill Development Lab		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 hrs. / week	**01**	**Term Work: 25 Marks**
Prerequisite Courses, if any: Basic Electronics Engineering, Fundamentals of Programming, Open-source electronics platform based on easy-to-use hardware and software (preferably Arduino)		
Companion Course, if any: Any one of the following: 1. Jeremy Blum PCB tutorials. 2. OrCAD basic Tutorials.		

List of Assignments [Min. 10 has to be completed]	
Group A: Application of Electronics Principles in Practice	
1.	Electronic Components and Connections (Bread boarding).
2.	Introduction and applications using Arduino and micro python.
3.	Using Sensors & Actuators and their interfacing with Arduino (Motor Driver with relays , Reversible motor, SSR).
4.	Wireless Connectivity to Arduino .
Group B: Hardware Design, Fault Finding, Testing, Repair and Measuring	
5.	Drawing layout of PCB using PCB design software.
6.	Single layer PCB design for a simple electronic circuit.
7.	Using test equipment for testing, fault finding & repair etc.
8.	Use of measuring equipment for measurement of signals.
9.	Using Simulation software for design & testing of electronic circuits.
Group C: Assembly, SMD Overview, Power Budgeting, Batteries (Lead Acid , LiPo), Solar	
10.	Assemble and utilize mechanical parts such as DC Motor, AC Motor, Stepper motor Solenoid, sensors etc., connect and assemble mechanical parts to form a working unit , Wire and form cables. industry standards
11.	Assemble and use various types of parts and surface mounted devise parts, Assemble parts to standard determined by IPC-A-610, Work to correct sequences and tolerances, Accurately solder components using lead free solder to comply with
12.	Calculation of Power budget for an electronic circuit.

13.	Study & Use of various types of Batteries.
14.	Study of various solar power generation systems.

Learning Resources

Reference Books:

1. R S Khandpur, "Printed Circuit Boards: Design - Fabrication and Assembly", Tata McGraw Hill

2. Simon Monk "Hacking Electronics", McGraw Hill

Web resources:

1. https://github.com/arduino/Arduino

2. https://spoken-tutorial.org/tutorialsearch/?search_foss=Arduino&search_language=English

3. https://worldskillsindia.co.in/worldskill/file/2019/Electronics.pdf

4. https://worldskills.org/what/projects/wsss/

Savitribai Phule Pune University
Second Year of Electronics Engineering

VLSI Design & Technology (2019 Course)

204190: Mandatory Audit Course - 3

Teaching Scheme:	Credit	Examination Scheme:
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List of Courses to be opted (Any one) under Mandatory Audit Course 3

- Technical English For Engineers
- Ecology and Environment
- Ecology and Society
- German I
- Science, Technology and Society
- Introduction to Japanese Language 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 whichmake 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 mark sheet

Savitribai Phule Pune University
Second Year of Electronics Engineering

VLSI Design & Technology (2019 Course)

204191: Signals & Systems

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: --

Companion Course, if any: 204195 - Signal & Control Systems Lab

Course Objectives:

- To understand the mathematical representation of continuous and discrete time signals and systems.
- To classify signals and systems into different categories.
- To analyze Linear Time Invariant (LTI) systems in time and transform domains.
- To build basics for understanding of courses such as signal processing, control system and communication.
- To develop basis of probability and random variables.

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

CO1: Identify, classify basic signals and perform operations on signals.

CO2: Identify, Classify the systems based on their properties in terms of input output relation and in terms of impulse response and will be able to determine the convolution between to signals.

CO3: Analyze and resolve the signals in frequency domain using Fourier series and Fourier Transform.

CO4: Resolve the signals in complex frequency domain using Laplace Transform, and will be able to apply and analyze the LTI systems using Laplace Transforms.

CO5: Define and Describe the probability, random variables and random signals. Compute the probability of a given event, model, compute the CDF and PDF.

CO6: Compute the mean, mean square, variance and standard deviation for given random variables using PDF.

Course Contents		
Unit I	**Introduction to Signals & Systems**	**(07 Hrs)**

Signals: Introduction, Graphical, Functional, Tabular and Sequence representation of Continuous and Discrete time signals. Basics of Elementary signals: Unit step, Unit ramp, Unit parabolic, Impulse, Sinusoidal, Real exponential, Complex exponential, Rectangular pulse, Triangular, Signum, Sinc and Gaussian function.

Operations on signals: time shifting, time reversal, time scaling, amplitude scaling, signal addition, subtraction, signal multiplication. Communication, control system and Signal processing examples.

Classification of signals: Deterministic, Random, periodic , Non periodic, Energy , Power, Causal , Non-Causal, Even and odd signal.

Systems: Introduction, Classification of Systems: Lumped Parameter and Distributed Parameter System, static and dynamic systems, causal and non-causal systems, Linear and Non- linear systems, time variant and time invariant systems, stable and unstable systems, invertible and non- invertible systems.

Mapping of Course Outcomes for Unit I	**CO1: Identify, classify basic signals and perform operations on signals.**

Unit II	**Time domain representation of LTI System**	**(07 Hrs)**

Input-output relation, definition of impulse response, convolution sum, convolution integral, computation of convolution integral using graphical method for unit step to unit step, unit step to exponential, exponential to exponential, unit step to rectangular and rectangular to rectangular only. Computation of convolution sum. Properties of convolution. System interconnection, system properties in terms of impulse response, step response in terms of impulse response.

Mapping of Course Outcomes for Unit II	**CO2: Identify, Classify the systems based on their properties in terms of input output relation and in terms of impulse response and will be able to determine the convolution between to signals.**

Unit III	**Fourier Series**	**(07 Hrs)**

Fourier series (FS) representation of periodic Continuous Time (CT) signals, Dirichlet condition forexistence of Fourier series, orthogonality, basis functions, Amplitude and phase response, FS representationof CT signals using trigonometric and exponential Fourier series. Applications of Fourier series, properties of Fourier series and their physical significance, Gibbs phenomenon.

Mapping of Course Outcomes for Unit III	**CO3: Analyze and resolve the signals in frequency domain using Fourier series and Fourier Transform.**

Unit IV	**Fourier Transform**	**(07 Hrs)**

Fourier Transform (FT) representation of aperiodic CT signals, Dirichlet condition for existence of Fourier transform, evaluation of magnitude and phase response, FT of standard CT signals, Properties and their significance, Interplay between time and frequency domain using sinc and rectangular signals, Fourier Transform for periodic signals.

Mapping of Course Outcomes for Unit IV	**CO3: Analyze and resolve the signals in frequency domain using Fourier series and Fourier Transform.**	
Unit V	**Laplace Transform**	**(07 Hrs)**
Definition of Laplace Transform (LT), Limitations of Fourier transform and need of Laplace transform, ROC, Properties of ROC, Laplace transform of standard periodic and aperiodic functions, properties of Laplace transform and their significance, Laplace transform evaluation using properties, Inverse Laplace transform based on partial fraction expansion, stability considerations in S domain, Application of Laplace transforms to the LTI system analysis.		
Mapping of Course Outcomes for Unit V	**CO4: Resolve the signals in complex frequency domain using Laplace Transform, and will be able to apply and analyze the LTI systems using Laplace Transforms.**	
Unit VI	**Probability and Random Variables**	**(07 Hrs)**
Probability: Experiment, sample space, event, probability, conditional probability and statistical independence, Bayes theorem, Uniform and Gaussian probability models. **Random variables:** Continuous and Discrete random variables, cumulative distributive function, Probability density function, properties of CDF and PDF. Statistical averages, mean, moments and expectations, standard deviation and variance.		
Mapping of Course Outcomes for Unit VI	**CO5: Define and Describe the probability, random variables and random signals. Compute the probability of a given event, model, compute the CDF and PDF.** **CO6: Compute the mean, mean square, variance and standard deviation for given random variables using PDF.**	

Learning Resources

Text Books:

1. Simon Haykins and Barry Van Veen, "Signals and Systems", Wiley India, 2nd Edition.
2. M.J. Roberts "Signal and Systems", Tata McGraw Hill 2007.

Reference Books:

1. Charles Phillips, "Signals, Systems and Transforms", Pearson Education, 3rd Edition.
2. Peyton Peebles, "Probability, Random Variable, Random Processes", Tata Mc Graw Hill, 4th Edition.
3. A. Nagoor Kanni "Signals and Systems", Mc Graw Hill, 2nd Edition.

MOOC / NPTEL Courses:

1. NPTEL Course **"Principles of Signals & System"**
   https://nptel.ac.in/courses/108/104/108104100/

2. Lecture Series on, **"Signals & Systems"**
   http://www.nptelvideos.in/2012/12/signals-and-system.html

Signals & Systems Tutorial

Guidelines for Tutorial / TW Assessment

Tutorial is generally a teaching session carried out into a batches of students. The main objective is to focus on one-on-one, tutoring the specific contents listed out below from the course Signals & Systems. Helping the students to solve and understand the underlying concept which is otherwise difficult to address it in a classroom.

List of Tutorials

1. A) Sketch and write mathematical expression for the following signals in Continuous Time (CT) and Discrete Time (DT)

a) Sine b) Rectangular c) Triangular d) Exponential e) Unit Impulse
f) Unit Step g) Ramp h) Signum i) Sinc h)Gaussian

B) Classify and find the respective value for the above signals if applicable
a) Periodic / Non Periodic
b) Energy / Power /Neither
c) Even and Odd signal

2. Take any two CT and DT signals and perform the following operations:
Amplitude scaling, Addition, multiplication, differentiation, integration (accumulator for DT)
Time scaling , Time folding, Time shifting.

3. Express any two system mathematical expressions in input output relation form and determine whether each one of them is, Memory less, Causal, Linear, Stable, Time invariant, Invertible.

4. Express any two system mathematical expressions in impulse response form and determine whether each one of them is, Memory less, Causal, Linear, Stable, Time invariant, Invertible.

5. Perform Convolution Integral of two Continuous time signals and Convolution Sum of any two Discrete Time signal. (Various Combinations can be taken for this.)

6. To find Fourier series for the signals and plot its magnitude and phase response. (Signals like: Half/Full wave rectified signal, Saw tooth wave, square wave etc.) Minimum three signals may be taken.

7. State and prove the various properties of CT Fourier Transform. Take rectangular and sinc signal as examples and demonstrate the applications of CTFT properties. Demonstrate the interplay between the time and frequency domain.

8. State and prove the properties of CT Laplace Transform. Take any example of a system in time domain and demonstrate the application of LT in system analysis.

9.A) List and Explain the properties of CDF & PDF.

B) Suppose a certain random variable has the CDF

$$F_X(x) = \begin{cases} 0 & x \le 0 \\ kx^2 & 0 < x \le 10 \\ 100k & x > 10 \end{cases}$$

Evaluate k, write the corresponding PDF and find the values of $P(X \le 5)$ and $P(5 < X \le 7)$

(This is only an example. Various problems on Probability functions may be considered)

C) Find the mean, mean square, standard deviation, variance of X, when

$$f_X(x) = ae^{-ax}u(x) \text{ with } a > 0$$

(This is only an example. Various Probability functions may be considered)

Savitribai Phule Pune University
Second Year of Electronics Engineering

VLSI Design & Technology (2019 Course)

204192: Control Systems

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: 204195 - Signal & Control Systems Lab

Course Objectives:

- To Introduce elements of control system and their modeling using various Techniques.
- To get acquainted with the methods for analyzing the time response and Stability of System
- To Introduce and analyze the frequency response and Stability of System
- To Introduce concept of root locus, Bode plots, Nyquist plots.
- To Introduce State Variable Analysis method.
- To get acquainted with Concepts of PID controllers and IoT based Industrial Automation.

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

CO1: Determine and use models of physical systems in forms suitable for use in the analysis and design of control systems.

CO2: Determine the (absolute) stability of a closed-loop control system.

CO3: Perform time domain analysis of control systems required for stability analysis.

CO4: Perform frequency domain analysis of control systems required for stability analysis.

CO5: Apply root-locus, Frequency Plots technique to analyze control systems.

CO6: Express and solve system equations in state variable form.

CO7: Differentiate between various digital controllers and understand the role of the controllers in Industrial automation.

Course Contents

Unit I	Introduction to Control Systems & its modelling	(06 Hrs)

Basic Elements of Control System, Open loop and Closed loop systems, Differential equations and Transfer function, Modeling of Electric systems, Translational and rotational mechanical systems, Block diagram reduction Techniques, Signal flow graph.

Mapping of Course Outcomes for Unit I	CO1: Determine and use models of physical systems in forms suitable for use in the analysis and design of control systems.

Unit II	Time domain analysis	(06 Hrs)
Time domain analysis: transient response and steady state response, standard test inputs for time domain analysis, order and type of a system, transient analysis of first and second order systems, time domain specifications of second order under damped system from its step response, Steady state error and static error constants.		
Mapping of Course Outcomes for Unit II	**CO2: Determine the (absolute) stability of a closed-loop control system.**	
Unit III	**Stability analysis**	**(08 Hrs)**
Characteristic equation of a system, concept of pole and zero, response of various pole locations in s-plane, concept of stability absolute stability, relative stability, stability of system from pole locations, Routh Hurwit stability criterion, Root locus: definition, magnitude and angle conditions, construction of root locus, concept of dominant poles, effect of addition of pole and zero on root locus. Application of root locus for stability analysis.		
Mapping of Course Outcomes for Unit III	**CO3: Perform time domain analysis of control systems required for stability analysis.**	
Unit IV	**Frequency domain analysis**	**(08 Hrs)**
Frequency response and frequency domain specifications, correlation between time domain and frequency domain specifications, polar plot, Nyquist stability criterion and construction of Nyquist plot, Bode plot, determination of frequency domain specifications and stability analysis using Nyquist plot and Bode plot.		
Mapping of Course Outcomes for Unit IV	**CO4: Perform frequency domain analysis of control systems required for stability analysis.** **CO5: Apply root-locus, Frequency Plots technique to analyze control systems.**	
Unit V	**State space representation**	**(06 Hrs)**
State space advantages and representation, Transfer function from State space, physical variable form, phase variable forms: controllable canonical form, observable canonical form, Solution of homogeneous state equations, state transition matrix and its properties, computation of state transition matrix by Laplace transform method only.		
Mapping of Course Outcomes for Unit V	**CO6: Express and solve system equations in state variable form.**	
Unit VI	**Controllers and Digital Control Systems**	**(06 Hrs)**
Concept of Controller, Basic ON-OFF Controller, Concept of Dead Zone, Introduction to P, I, D, PI, PD and PID controller, OFFSET of Controller, Integral Reset, PID Characteristics. Concept of Zeigler-Nicholas method. Concept of Industrial Automation, Need of IoT based Industrial Automation.		

Mapping of Course Outcomes for Unit VI	CO7: Differentiate between various digital controllers and understand the role of the controllers in industrial automation.

Learning Resources

Text Books:

1. N. J. Nagrath and M. Gopal, "Control System Engineering", New Age International Publishers, 5th Edition.
2. K. Ogata, "Modern Control Engineering", Prentice Hall India Learning Private Limited; 5th Edition.

Reference Books:

1. Benjamin C. Kuo, "Automatic control systems", Prentice Hall of India, 7th Edition.
2. M. Gopal, "Control System – Principles and Design", Tata McGraw Hill, 4th Edition.
3. Schaum's Outline Series, "Feedback and Control Systems" Tata McGraw-Hill.
4. John J. D'Azzo and Constantine H. Houpis, "Linear Control System Analysis and Design", Tata McGraw-Hill, Inc.
5. Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", Addison – Wesley.

MOOC / NPTEL Courses:

1. NPTEL Course **"Control System"**

   https://nptel.ac.in/courses/107/106/107106081/

2. NPTEL Course **"Control System Design"**

   https://nptel.ac.in/courses/115/108/115108104/

Savitribai Phule Pune University
Second Year of Electronics Engineering

VLSI Design & Technology (2019 Course)

204193: Principles of Communication Systems

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: 204191 - Signals & Systems
204196 - Principles of Communication Systems Lab

Course Objectives:

- To equip/ familiarize students with basic mathematical tools for time and frequency domain analysis of communication signal and systems.
- To acquaint the students with the fundamental principles of modulation process and different amplitude and angle modulation systems.
- To introduce the students with the concept of Sampling theorem and pulse modulation techniques PAM, PWM, PPM.
- To impart pre-requisites of digital communication systems and explore digital representation techniques like PCM, DPCM, DM and ADM.
- To highlight the issues in baseband digital transmission such as data representation, synchronization, multiplexing and ISI.

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

CO1: To compute & compare the bandwidth and transmission power requirements by analyzing time and frequency domain spectra of signal required for modulation schemes under study.

CO2: Describe and analyze the techniques of generation, transmission and reception of Amplitude Modulation Systems.

CO3: Explain generation and detection of FM systems and compare with AM systems.

CO4: Exhibit the importance of Sampling Theorem and correlate with Pulse Modulation technique (PAM, PWM, and PPM).

CO5: Characterize the quantization process and elaborate digital representation techniques (PCM, DPCM, DM and ADM).

CO6: Illustrate waveform coding, multiplexing and synchronization techniques and articulate their importance in baseband digital transmission.

Course Contents		
Unit I	**Signals & spectra**	**(08 Hrs)**
Introduction to Communication System, Analog and Digital messages, regenerative repeaters, Signal Bandwidth & Power. Size & classification of signal, exponential Fourier series, concept of negative frequencies. Fourier transform and properties, Frequency shifting, Concept of baseband and bandpass signals, Signal transmission through LTI system. Signal energy & Energy Spectral density. Signal power & Power Spectral Density, Input and output PSD, PSD of modulated signal.		
Mapping of Course Outcomes for Unit I	**CO1: To compute & compare the bandwidth and transmission power requirements by analyzing time and frequency domain spectra of signal required for modulation schemes under study.**	

Unit II	AM transmission & reception for signal tone	(08 Hrs)
Need for frequency translation, Amplitude modulation (DSB-C), Double sideband Suppressed carrier (DSB-SC) modulation, Single sideband modulation (SSB), Vestigial Sideband modulation (VSB),Spectrum and Bandwidth of AM, DSB-SC, SSB & VSB, Calculation of modulation index for AM wave, Modulation index for more than one modulating signals, Power and power efficiency, AM reception		
Mapping of Course Outcomes for Unit II	**CO2: Describe and analyze the techniques of generation, transmission and reception of Amplitude Modulation Systems.**	
Unit III	**FM transmission & reception for signal tone**	**(08 Hrs)**
Phase Modulation (PM) and Frequency Modulation (FM), Relationship between Phase and Frequency Modulation, Modulation Index, Spectrum of FM (single tone): Feature of Bessel Coefficient, Power of FM signal, Bandwidth of tone modulated FM signal, modulation index : AM vs. FM, Spectrum of constant Bandwidth' FM, Narrowband and Wideband FM. **FM Modulators and Demodulators:** FM generation by Armstrong's Indirect method, frequency multiplication and application to FM, FM demodulator.		
Mapping of Course Outcomes for Unit III	**CO3: Explain generation and detection of FM systems and compare with AM systems.**	
Unit IV	**Pulse Modulation**	**(06 Hrs)**
Need of analog to digital conversion, sampling theorem for low pass signal in time domain, and Nyquist criteria, Types of sampling- natural and flat top. Pulse amplitude modulation & concept of TDM: Channel bandwidth for PAM, equalization, Signal Recovery through holding. Pulse Width Modulation (PWM) and Pulse Position Modulation (PPM): Generation & Detection.		
Mapping of Course Outcomes for Unit IV	**CO4: Exhibit the importance of Sampling Theorem and correlate with Pulse Modulation techniques (PAM, PWM, and PPM)**	

Unit V	Digital Representation of Analog Signals	(06 Hrs)
Quantization of Signals: Quantization error, Uniform & Non-Uniform types of Quantization, Mid-rise & Mid-tread Quantizer. **Companding:** A-law & μ-law. **Pulse Code Modulation system**: Generation & Reconstruction, Differential Pulse code modulation, Delta Modulation, Adaptive Delta Modulation.		
Mapping of Course Outcomes for Unit V	**CO5: Characterize the quantization process and elaborate digital representation techniques (PCM, DPCM, DM and ADM).**	
Unit VI	**Baseband Digital Transmission**	**(06 Hrs)**

Line codes: Properties and spectrum.

Digital Multiplexing and hierarchies: T1, AT&T, E1, CCITT, Scrambling & Unscrambling.

Synchronization: Carrier Synchronization, Bit Synchronization and Frame Synchronization. Intersymbol Interference, Equalization.

Mapping of Course Outcomes for Unit VI	**CO6: Illustrate waveform coding, multiplexing and synchronization techniques and articulate their importance in baseband digital transmission.**

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 and 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 and J C Rutledge, "Communication Systems", Tata McGraw Hill Publication, 5th Edition.
4. Simon Haykin, "Communication Systems",John Wiley & Sons, 4th Edition.

MOOC / NPTEL Course:

1. NPTEL Course **"Principles of Communication Systems-I"**

https://nptel.ac.in/courses/108/104/108104091/

Savitribai Phule Pune University
Second Year of Electronics Engineering

VLSI Design & Technology (2019 Course)

204194: Object Oriented Programming

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: 204197 - Object Oriented Programming Lab

Course Objectives:

- Make the students familiar with basic concepts and techniques of object oriented programming in C++ To acquaint the students with the fundamental principles of modulation process and different amplitude and angle modulation systems.
- Develop an ability to write programs in C++ for problem solving.

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

CO1: Describe the principles of object oriented programming.

CO2: Apply the concepts of data encapsulation, inheritance in C++.

CO3: Understand Operator overloading and friend functions in C++.

CO4: Apply the concepts of classes, methods inheritance and polymorphism to write programs C++.

CO5: Apply Templates, Namespaces and Exception Handling concepts to write programs in C++.

CO6: Describe and use of File handling in C++.

Course Contents

Unit I	Foundation of Object Oriented Programming	(08 Hrs)

Introduction to procedural, modular, object-oriented and generic programming techniques, Limitations of procedural programming, Need of object-oriented programming, fundamentals of object-oriented programming: objects, classes, data members, methods, messages, data encapsulation, data abstraction and information hiding, inheritance, polymorphism. Inline functions, Function overloading, call by value and call by reference, return by reference, functions with default arguments, this pointer, illustrative SimpleC++ Programs. Dynamic initialization of variables, memory management operators, Member dereferencing operators, operator precedence, typecast operators, Scope resolution operators, arrays.

Mapping of Course Outcomes for Unit I	CO1: Describe the principles of object oriented programming.	
Unit II	**Classes & Objects**	**(06 Hrs)**

Defining class, Defining member functions, static data members, static member functions, private data members, public member functions, arrays of objects, objects as function arguments.

Constructors and Destructors: types of constructors, handling of multiple constructors, destructors. (**Complex Class & String Class**)

Mapping of Course Outcomes for Unit II	CO2: Apply the concepts of data encapsulation, inheritance in C++.	
Unit III	**Operator Overloading**	**(06 Hrs)**

Fundamentals of Operator Overloading, Restrictions on Operators Overloading, Operator Functions as Class Members vs. as Friend Functions, Overloading Unary Operators, Overloading Binary Operators, Overloading of operators using friend functions.		
Mapping of Course Outcomes for Unit III	**CO3: Understand Operator overloading and friend functions in C++.**	
Unit IV	**Inheritance & Polymorphism**	**(06 Hrs)**
Introduction to inheritance, base and derived classes, friend classes, types of inheritance, hybrid inheritance, member access control, static class, multiple inheritance, ambiguity, virtual base class, Introduction to polymorphism, pointers to objects, virtual functions, pure virtual functions, abstract base class, Polymorphic class, virtual destructors, early and late binding, container classes, Contained classes, Singleton class.		
Mapping of Course Outcomes for Unit IV	**CO4: Apply the concepts of classes, methods inheritance and polymorphism to write programs C++.**	
Unit V	**Templates, Namespaces and Exception handling**	**(06 Hrs)**
Templates: Introduction, Function template and class template, function overloading vs. function templates **Namespaces:** Introduction, Rules of namespaces **Exception handling:** Introduction, basics of exception handling, exception handling mechanism, throwing and catching mechanism, specifying exceptions, Multiple Exceptions, Exceptions with arguments C++ streams, stream classes, unformatted I/O, formatted I/O and I/O manipulators.		
Mapping of Course Outcomes for Unit V	**CO5: Apply Templates, Namespaces and Exception Handling concepts to write programs in C++.**	

Unit VI	**Working with files**	**(06 Hrs)**
Introduction, classes for file Stream Operations, opening and closing files, detecting End_Of_File (EOF), modes f File Opening, file pointers and manipulators, updating file, error handling during file operations.		
Mapping of Course Outcomes for Unit VI	**CO6: Describe and use of File handling in C++.**	
Learning Resources		
Text Books: **1.** E Balagurusamy, "Programming with C++", Tata McGraw Hill, 3rd Edition. **2.** Herbert Schildt, "The Complete Reference C++", 4th Edition.		
Reference Books: **1.** Robert Lafore, "Object Oriented Programming in C++", Sams Publishing, 4th Edition. **2.** Matt Weisfeld, "The Object-Oriented Thought Process", Pearson Education.		

MOOC / NPTEL Courses:

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

https://nptel.ac.in/courses/106/105/106105191/

2. NPTEL Course **"Programming in C++"**

https://nptel.ac.in/courses/106/105/106105151/

Other Resources:

1. Bjarne Stroustrup, "A Tour of C++".

Savitribai Phule Pune University Second Year of Electronics Engineering VLSI Design & Technology (2019 Course) 204195: Signals & Control System Lab		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 hrs. / week	**01**	**Term Work: 50 Marks**
Prerequisite Courses, if any: --		
Companion Course, if any: 204192 - Signals & Systems 204193 - Control systems		

SIGNALS & SYSTEMS

Note:- Attempt any six exercises from group A, eight exercises from group B and perform additional (min.3) tutorials using Virtual Lab.

Group A	
1.	Generate and plot the following signals in time domain and also sketch its amplitude and phase spectrum. Verify the result: • Impulse • Unit Step • Exponential • Unit ramp • Sinc • Rectangular

2 (a)	Write the codes to plot the following signals also simulate the signals: (a) $\sin(200\pi t)$ (b) $\sin(200\pi t + \frac{\pi}{6})$ (c) $\sin(200\pi t - \frac{\pi}{6})$ (d) $\cos(200\pi t)$ (e) $\cos(200\pi t + \frac{\pi}{4})$ (f) $\cos(200\pi t - \frac{\pi}{6})$
2 (b)	Develop codes to simulate, and plot the results for an exponential signal: $x(t) = k\, e^{-at}u(t)$ for the cases: (a) $k = 1$, and $a = 0.35$ (b) $k = 1.2$ and $a = -0.45$
3.	**Sampling & Aliasing** Consider various human voice / speech (probably your voice both male and female) or music signals. Try different sampling rates and observe the effect of aliasing.
4.	**Real time speech signal and Spectral analysis** The speech signal has frequency components in the audio frequency range 300 Hz to 3400 Hz of the electromagnetic spectrum. Record the male and female voice speech Signal. Writea program to record the speech signals and sketch it in time domain, its amplitude spectrum and phase spectrum.
5.	The music signal has frequency components in the audio frequency range 20 Hz to 20000 Hz of the electromagnetic spectrum. Record or use the recorded music samples of different instruments (at least four) and Write a program to record the music signal and sketch it in time domain, its amplitude spectrum and phase spectrum. Also comment on the result.
6.	Find the convolution integral of Unit step and exponential signals and write a program to sketch the out response of the system. Also verify the commutative property of convolution integral.
7.	Take any one periodic signal and find its Fourier series coefficients using exponential or trigonometric FS method. Write a program to find its Fourier series coefficients. Also using FS coefficients, reconstruct the signal. Observe the effect of Gibb's phenomenon.

CONTROL SYSTEMS

Group B	
1.	Numerical on Black diagram reduction technique, Signal Flow Graphs (at least 4 numericals)
2.	Computation of transfer function of Electric Circuits, Mechanical Circuits for concept understanding with their analogy Force-Voltage and Force Current.
3.	Standard input signals and time response analysis of First Order and Second order Systems for step input. Underdamped, Critically damped and Overdamped case.
4.	Stability analysis for any given system with Characteristic Equation given (Software Simulation).

5.	Computation and Software / Simulation of root locus for given G(s)H(s). Comment on time domain specifications and stability of the system.
6.	Computation and analysis of frequency response analysis u Bode Plot for given G(s) H(s). Comment on Gain Margin, Phase Margin and Stability of the system.
7.	Software implementation/Simulation frequency response analysis using Nyquist Plot for given G(s) H(s). Comment on Gain Margin, Phase Margin and Stability of the system
8.	Compute correlation time domain and frequency domain with examples (at least 4 numericals).
9.	Computation of State Model from Transfer function and Compute Transfer Function from state model solve at least 4/5 numericals.
10.	Derivation of Properties and solve numerical on state transition matrix.
11.	Observe the effect of P, PI, PD and PID controller on the step response of a feedback control system. Comment on effect of Controller mode Time domain specifications/ analysis.

Virtual LAB Link:

1. **Signals and Systems Laboratory:**
   http://ssl-iitg.vlabs.ac.in/

Savitribai Phule Pune University
Second Year of Electronics Engineering

VLSI Design & Technology (2019 Course)

204196: Principles of Communication Systems Lab

Teaching Scheme:	Credit	Examination Scheme:
Practical: 02 hrs. / week	01	Practical: 50 Marks

Prerequisite Courses, if any: --

Companion Course, if any: 204193 - Principles of Communication Systems

List of Laboratory Experiments

Group A: Hardware Practicals

1.	AM Generation (DSB-FC): Calculation of modulation index by graphical method, Power of AM Wave for different modulating signal and Observe Spectrum.
2.	Frequency modulator & demodulator using Varicap/Varactor Diode and NE 566 VCO, IC 565 (PLL based detection), calculation of modulation index & BW of FM.
3.	Verification of Sampling Theorem, PAM Techniques, (Flat top & Natural sampling), reconstruction of original signal, Observe Aliasing Effect in frequency domain.
4.	Generation and Detection of PWM using IC 555
5.	Study of PCM

6.	Study of Companded PCM
7.	**Study of DM:** Generation and detection
8.	**Study of ADM:** Generation and detection
9.	Study of line codes (NRZ, RZ, POLAR RZ, BIPOLAR (AMI), MANCHESTER) & their
	spectral analysis.
Group B: Simulation Practicals [Any 3 to be performed]	
10.	Simulation of T1/E1 system using suitable software.
11.	Simulation program to study effect of ISI and noise in baseband communication system.
12.	Simulation program to calculate Signal to noise ratio for PCM system & DM system.
13.	Verify Sampling Theorem using simulation.
14.	Demonstrate Scrambling and descrambling operation either using hardware or any simulation tool.

Savitribai Phule Pune University
Second Year of Electronics Engineering

VLSI Design & Technology (2019 Course)

204197: Object Oriented Programming Lab

Teaching Scheme:	Credit	Examination Scheme:
Practical: 02 hrs. / week	01	Oral: 50 Marks

Prerequisite Courses, if any: --

Companion Course, if any: 204194 - Object Oriented Programming

List of Laboratory Experiments

Group A: [Any Four to be performed]	
1.	Write a program in C++ to sort the numbers in an array using separate functions for read, display, sort and swap. The objective of this assignment is to learn the concepts of input, output, functions, call by reference in C++.
2.	Write a C++ program that illustrates the concept of Function over loading.
3.	Write a program in C++ to perform following operations on complex numbers Add, Subtract, Multiply, Divide, Complex conjugate. Design the class for complex number representation and the operations to be performed. The objective of this assignment is to learn the concepts classes and objects.
4.	Write a program in C++ to implement Stack. Design the class for stack and the operations to be performed on stack. Use Constructors and destructors. The objective of this assignment is to learn the concepts classes and objects, constructors and destructors.
5.	Write a program in C++ to overload unary operators for complex class.

Group B : [Any Seven to be performed]	
6.	Write a program in C++ to perform following operations on complex numbers Add, Subtract, Multiply, Divide. Use operator overloading for these operations. The objective of this assignment is to learn the concepts operator overloading.
7.	Write a program in C++ to implement string class. Write constructors, destructor, Accepts function and Display function.
8.	Write a program in C++ to implement string class. Write constructors, destructor, Accepts function and Display function. To overload = operator so as call copy constructor.
9.	Write a program in C++ to implement containment concept using Employee, B Date, & String Classes.
10.	Write a program in C++ to Read and Display the information of Employee Using Multiple Inheritance. Use Basic Info and Department Info as a base classes of Employee class.
11.	Write a C++ program that illustrates run time polymorphism by using virtual functions.
12.	Write a C++ program which use try and catch for exception handling.
13.	Write a C++ program which to implement class and function template.
14.	Write a C++ program which to demonstrate use of namespace in the program.
15.	Write a C++ program which copies the contents of one file to another.

Virtual LAB Links:

1. **Object Oriented Programming with C++:**
   http://vlabs.iitb.ac.in/vlabs-dev/labs/oops/index.php

2. **Problem Solving Lab:**
   http://ps-iiith.vlabs.ac.in/

Note: Additional (min.2) practicals are to be performed using Virtual Lab.

Savitribai Phule Pune University Second Year of Electronics Engineering VLSI Design & Technology (2019 Course) 204208 : VLSI Design Lab		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 hrs. / week	**01**	**OR: 25 Marks**
Prerequisite Courses, if any:		
Companion Course, if any: --		

Guidelines for Student's Lab Journal

The student's Lab Journal can be assignments submitted in the form a soft copy/hard copy. In case of soft copy submission, the print out of only first page can be kept in the Journal. It should include following as applicable:

Assignment No, Title of Assignment, Date of Performance, Date of Submission, Aims & Objectives, Theory, Description of data used, Results, Conclusion.

Guidelines for Lab /TW Assessment

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

List of Laboratory Experiments / Assignments

Group A: [CMOS Design] (Any Three)

1.	Design and implement basic logic gates (AND, OR, XOR, NAND, NOR) using CMOS 180nm technology using any integrated EDA software. Simulate with and without capacitive load.
2.	Design and simulate a Half adder circuit using CMOS 180nm technology, and verify its functionality using any integrated EDA software. Simulate with and without capacitive load.
3.	Design and simulate a D flip-flop using CMOS 180nm technology, and verify their functionality any integrated EDA software. Simulate with and without capacitive load.
4.	To prepare CMOS layout for 2:1 multiplexer using logic gates and transmission gates. Simulate with and without capacitive load

Group B: VHDL Simulation (Any Three)

5.	To write VHDL code for 4-bit ALU for add, subtract, AND, NAND, XOR, XNOR, OR, & ALU pass.
6.	To write VHDL code for universal shift register with mode selection input for SISO, SIPO, PISO, & PIPO modes. Simulate with test bench, synthesis, implement on PLD.
7	To write VHDL code for FIFO memory. Simulate with test bench, synthesis, implement on PLD.
8	Design and simulate a finite state machine (FSM) by using VHDL for a simple application such as a traffic light controller or a vending machine.
	Group C: [Compulsory]
9	Study on steps of the ASIC design flow, from specification to synthesis, placement and routing, and verification

10	**Project Work**: Assign a project where students can design a small-scale VLSI circuit or system, such as a simple processor, memory module, or digital signal processing block

Learning Resources

Reference Books:

1.

Web resources:

1.

Savitribai Phule Pune University
Second Year of Electronics Engineering

VLSI Design & Technology (2019 Course)

204199: Employability Skills Development

Teaching Scheme:	Credit	Examination Scheme:
Theory: 02 hrs. / week **Practical: 02 hrs. / week**	**02 + 01 = 03**	**Term work: 50 Marks**

Prerequisite Courses, if any: --

Companion Course, if any: --

Course Objectives:

- Develop good communication skills – both oral as well as written.
- Encourage creative and critical thinking among students.
- Nurture collaborative behavior to work efficiently in groups.

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

CO1: Define personal and career goals using introspective skills and SWOC assessment. Outline and evaluate short-term and long-term goals.

CO2: Develop effective communication skills (listening, reading, writing, and speaking), self- management attributes, problem solving abilities and team working & building capabilities in order to fetch employment opportunities and further succeed in the workplace.

CO3: Be a part of a multi-cultural professional environment and work effectively by enhancing inter-personal relationships, conflict management and leadership skills.

CO4: Comprehend the importance of professional ethics, etiquettes & morals and demonstrate sensitivity towards it throughout certified career.

CO5: Develop practically deployable skill set involving critical thinking, effective presentations and leadership qualities to hone the opportunities of employability and excel in the professional environment.

Course Contents

Unit I	Understanding Self and Soft Skills	(04 Hrs)

Introduction to introspective methods, SWOC Analysis, Understanding the importance of soft skills, soft skill vs hard skill, interdisciplinary relevance, emotional quotient and emotional intelligence, personal and career goal setting, aligning aspirations with individual's skill sets, understanding self-esteem and critically evaluating oneself.

Mapping of Course Outcomes for Unit I	CO1: Define personal and career goals using introspective skills and SWOC assessment. Outline and Evaluate short-term and long-term goals.

Unit II	Communication Skills	(04 Hrs)

Essentiality of good communication skills, Importance of feedback, Different types of communication, Barriers in communication and how to overcome these barriers, Significance of non-verbal messages as augmentation to verbal communication, Group Discussion, Listening Vs Hearing, Reading to comprehend, Learning to skim and scan to extract relevant information, Effective digital communication.

Mapping of Course Outcomes for Unit II	CO2: Develop effective communication skills (listening, reading, writing, and speaking), self - management attributes, problem solving abilities and team working & building capabilities in order to fetch employment opportunities and further succeed in the workplace.

Unit III	Language & Writing Skills	(04 Hrs)

Fundamentals of English Grammar, improve Lexical resource, essential steps to improve spoken and written English, Business vocabulary, Writing - Email, Resume, Formal letter, Official Communication, Essay, Presentation – Planning, Organizing, Preparing and Delivering Professional presentation, Resume writing: Resume content, identification of carrier objective, characteristics of good resume, different formats of resume-chronological, Functional , Hybrid Effective letter and cover letter writing, Application writing, Report writing.		
Mapping of Course Outcomes for Unit III	**CO2: Develop effective communication skills (listening, reading, writing, and speaking), self - management attributes, problem solving abilities and team working & building capabilities in order to fetch employment opportunities and further succeed in the workplace.**	
Unit IV	**Leadership Skills and Group Dynamics**	**(04 Hrs)**
Understanding Corporate Culture and Leadership skills, difference between a leader and a manager, Importance of resilience in a professional surrounding, Developing empathy and emotional intelligence, being assertive and confident, 4-Ds of decision making, Creative and solution-centric thinking, Resolving conflicts, Working cohesively as a team to achieve success, 5 Qualities of an Effective team - Positivity, respect for others, trust, goal-focused, supportiveness.		
Mapping of Course Outcomes for Unit IV	**CO3: Be a part of a multi-cultural professional environment and work effectively by enhancing inter- personal relationships, conflict management and leadership skills.**	
Unit V	Professionalism & Ethics	(04 Hrs)
Understanding ethics and morals, Importance of Professional Ethics, hindrances due to absence of Work ethics, Professional etiquette – Introductions, with colleagues, attire, events, dinning, telephone, travelling, netiquette, social media, writing. Stress as integral part of life, Identifying signs and sources of stress, Steps to cope with stress – open communication, positive thinking, Belief in oneself, ability to handle failure, Retrospective thinking for future learning, Organizing skills to enhance time management, Focusing on goals, smart work vs hard work, Prioritizing activities, Perils of procrastination, Daily evaluation of “to-do” list.		
Mapping of Course Outcomes for Unit V	**CO4: Comprehend the importance of professional ethics, etiquettes & morals and demonstrate sensitivity towards it throughout certified career.** **CO5: Develop practically deployable skill set involving critical thinking, effective presentations and leadership qualities to hone the opportunities of employability and excel in the professional environment.**	
Unit VI	**Quantitative Ability & Logical Reasoning**	**(04 Hrs)**
Numbers, HCF and LCM, Time and distance, Time and work, Clock, Simple interest and compound interest, Boats and steams, Number series, Ratio and proportion, probability, profit and loss, odd man out series, permutations, height and distance, square and cube rootmatching, selection, verbal reasoning, logical games, logical deductions, logical problems, cause and effect.		

Mapping of Course Outcomes for Unit VI	**CO2: Develop effective communication skills (listening, reading, writing, and speaking), self - management attributes, problem solving abilities and team working & building capabilities in order to fetch employment opportunities and further succeed in the workplace.**

Learning Resources

Text Books:

1. R. S. Agarwal "Quantitative Aptitude for Competitive Examinations" S. Chand Publications.
2. R.Gajendra Singh Chauhan and Sangeeta Sharma, "Soft Skills-An integrated approach to maximize personality", Wiley Publication, ISBN: 987-81-265-5639-7

Reference Books:

1. Indrajit Bhattacharya, "An Approach to Communication Skills", Dhanpat Rai.

2. Simon Sweeney, "English for Business Communication", Cambridge University Press.

3. Sanjay Kumar and Pushpa Lata, "Communication Skills", Oxford University Press.

4. Atkinson and Hilgard's, "Introduction to Psychology", 14th Edition.

5. Kenneth G. Mcgee, "Heads Up: How to Anticipate Business Surprises & Seize Opportunities First", Harvard Business School Press, Boston, Massachusetts.

6. Krishnaswami, N. and Sriraman, "Creative English for Communication", Macmillan.

MOOC / NPTEL Courses:

1. NPTEL Course "Developing Soft skills & Personality"

https://nptel.ac.in/courses/109/104/109104107/

2. NPTEL Course "Communication Skills"

https://nptel.ac.in/courses/109/104/109104030/

3. NPTEL Course "Effective Writing"

https://nptel.ac.in/courses/109/107/109107172/

4. NPTEL Course "Interpersonal Skills"

https://nptel.ac.in/courses/109/107/109107155/

THEORY SESSIONS

Sr. No.	Topic to be covered	No. of Hours
1.	Soft Skills Vs Hard Skills	1
2.	Planning Career Goals – Short Term & Long Term	1
3.	Understanding SWOC Analysis	1
4.	Resume Writing	1
5.	Presentation Skills	1
6.	Interview Skills	1
7.	Writing Skills	1
8.	Corporate Business Etiquette	2
9.	Time & Stress Management	1
10.	Attitude	1
11.	Leadership Skills	1
12.	Creative & Lateral Thinking	1
13.	Problem Solving	1
14.	Team Dynamics	1
15.	Mental Arithmetic	2
16.	Number Sequence	2
17.	Speed Calculation	2
18.	Fundamentals of English Grammar	2
19.	Verbal Reasoning / Verbal Ability	1
	TOTAL HOURS	**24**

Guidelines for Conduction of Employability Skills Development Lab

- The teacher may design specific assignments that can highlight the learning outcomes of each unit.
- Each activity conducted in the lab should begin with a brief introduction of the topic, purpose of the activity from a professional point of view and end with the learning outcomes as feedback from students.
- Most of the lab sessions can be designed to be inclusive; allowing students to learn skills experientially; which will benefit them in the professional environment.
- Every student must be given sufficient opportunity to participate in each activity and constructive feedback from the instructor / facilitator at the end of the activity should learn towards encouraging students to work on improving their skills.
- Activities should be designed to respect cultural, emotional and social standing of students. Some of the activities can be designed to cater to enhancement of multiple skills – For eg – Team Building Activity can highlight 'open communication', 'group discussion', 'respecting perspectives', 'leadership skills', 'focus on goals' which can help students improve their inherent interpersonal skills.

Guidelines for Student's Lab Journal and TW Assessment

- Each student should have a Lab Workbook (sample can be provided if required) which outlines each lab activity conducted.
- The student must respond by writing out their learning outcomes and elaborating the activities performed in the lab.
- Continuous assessment of laboratory work is to be done based on overall performance and lab assignments and performance of student.
- Each lab assignment assessment will be assigned grade/marks based on parameters with **appropriate weightage.**
- **Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, punctuality, neatness, enthusiasm, participation and contribution in various activities-SWOC analysis, presentations, team activity, event management, group discussion, group exercises and interpersonal skills and similar other activities/assignments**

List of Laboratory Sessions

1.	**Introduction of Self / SWOC Analysis:** a. Explain how to introduce oneself in a professional manner and presenting oneself positively. Name | Academic Profile | Achievements | Career Aspirations | Personal Information (hobbies, family, social) b. Focus on introspection and become aware of one's Strengths, Weakness, Opportunities and Challenges. Students can write down their SWOC in a matrix and the teacher can discuss the gist personally.
2.	**Career Goals and Planning:** • Make students understand the difference between a job and a career. Elaborate steps on how to plan a career. ➢ Students can choose a career and they should write down what skills, knowledge, steps are need to be successful in that particular career and how they can get the right opportunity. • Explain to students how to plan short term and long term goals. ➢ Think and write down their short term goals and long terms goals. Teacher can read and discuss (provide basic counselling) about the choices written.
3.	**Group Discussion:** • The class can be divided into groups of 8 - 10 students in each group for a discussion lasting 10 minutes: ➢ Topics can be topical and non-controversial. After each group finishes its discussion, the teacher can give critical feedback including areas of improvement. The teacher should act as a moderator / observer only.
4.	**Team Building Activities:** • The class can be divided into groups of 4-5 students in each group and an activity can

	be given to each group: ➢ The activities chosen for each team should be competitive and should involve every student in the team. The activities can be conducted indoors or outdoors depending on infrastructure.
5.	Public Speaking - (Choose any 2): • Prepared Speech: ➢ Topics are shared with students and they will be given 10 minutes to prepare and 3 minutes to deliver followed by Q&A from audience. Teacher can evaluate each student based on content, communication skills, logical and cohesive presentation of topic, perspective of student, ability to handle questions and respond positively. • Extempore Speech: ➢ Various topics are laid out in front of the audience and each student is to pick one topic and speak about the topic for 5 minutes followed by Q&A from audience. Teacher can evaluate each student based on ability to think on his/her feet, content, communication skills, logical and cohesive presentation of topic, perspective of student, ability to handle questions and respond positively. • Reviewing an Editorial article: ➢ Either using e-paper / printed copy, students have to select a recent editorial (that is non-controversial), read it and explain to the audience what the editor's perspective is and what the student's perspective is. • Book Review: ➢ Each student will orally present to the audience his/her review of a book that he/she has recently read.
6.	Mock Interviews: • Every student has to undergo this session and the teacher should seek the assistance of another faculty member / TPO Officer to act as interview panel. Students will be informed beforehand about the job profile that they are appearing the interview for and they have to come prepared with a printed copy of their resume, formally dressed. Questions will include technical as well as HR. Faculty can choose to give problems that students have to solve using their technical skills. Students will be graded on the basis of their technical knowledge, ability to answer questions well, presentation of self, body language and verbal skills.
7.	Listening and Reading Skills: • Listening Worksheets to be distributed among students ➢ Each student can be given specifically designed worksheets that contain blanks / matching / MCQs that are designed to an audio (chosen by the faculty). Students must listen to the audio (only once) and complete the worksheet as the

	audio plays. This will help reiterate active listening as well as deriving information (listening to information between the lines). ➢ Reading Comprehension Worksheets to be distributed among students. • Teacher can choose reading passages from non-technical domains, design worksheets with questions for students to answer. This will enhance students' reading skills by learning how to skim and scan for information**.**
8.	Writing Skills (Choose any 2): • Letter / Email Writing: ➢ After explaining to the students the highlights of effective writing, students can be asked to write (using digital platforms / paper-based) letter to an organization with the following subject matter: i. Requesting opportunity to present his/her product. ii. Complaining about a faulty product / service. iii. Apologizing on behalf of one's team for the error that occurred. iv. Providing explanation for a false accusation by a client . • Report Writing ➢ After describing various formats to write report and explaining how to write a report, each student should be asked to write a report (digital / paper-based) on any of the following topics: ▪ Industrial visit. ▪ Project participated in. ▪ Business / Research Proposal. • Resume Writing ➢ The teacher should conduct a brief session outlining the importance of a CV / Resume and students can write / type out their own resumes: ▪ Share various professional formats. ▪ Focus on highlighting individual strengths. ▪ Develop personalized professional goals / statement at the beginning of the resume.
9.	Lateral and Creative Thinking: • Every student needs to step out of the linear thinking and develop lateral and creative thinking. Teacher can develop creative activities in the classroom / lab that will help students enhance their creative thinking. Some of the suggested activities: ➢ Each group (3-4 students) can be given random unrelated items and they will be given 20 mins to come up with creative ideas on how the objects can be used for activities / purposes other than its intended one. ➢ Each student is given a random line and he/she has to spin a fictional story and tell it to the class (3 minutes). Each story should have a beginning, middle and end.

	➢ Each group (3-4 students) can be given a fictional / hypothetical dangerous situation and they have to find a solution to that problem. They can present it to the other teams who will then get the opportunity to pick flaws in the ideas.
10.	Presentation Skills: Every student will have to choose a topic of his/her choice and make a 5-minute presentation using audio-video aids / PPT. The topic can either be technical or non-technical. Focus and evaluation of each presentation should be the depth of knowledge about the topic, originality of perspective on the topic, well-researched or not, verbal and non-verbal skills and ability to answer questions effectively. Plagiarism should be discredit and students should be warned about it.
11.	Expert Lecture: Highlighting the need to manage stress and time, experts from the fields of health and fitness, counselling, training, medical or corporate HR can be invited to deliver a participatory session that focus on helping students to cope with parental, social, peer and career pressures.

Virtual LAB Link:

1. Virtual English Communication Lab:
https://ve-iitg.vlabs.ac.in/

Note: Additional (min.3) tutorials are to be performed using Virtual Lab

Savitribai Phule Pune University
Second Year of Electronics Engineering

VLSI Design & Technology (2019 Course)

204200: Project Based Learning

Teaching Scheme:	Credit	Examination Scheme:
Practical: 04 hrs. / week	02	Term Work: 50 Marks

Preamble:

The main stream engineering education follows traditional classroom teaching, in which the major focus is mainly on the lecturer and the student has very little (if any) choice on the learning process. However rapid development in engineering and technology requires adopting a teaching approach that would assist students not only in developing a core set of industry relevant skills, but also enable them to adapt to changes in their professional career.

PBL is an approach to design Electronic Systems Curricula for making electronics more appealing to students. Since electronics is an important grounding for other disciplines (computer science, signal processing, and communications), this approach proposes the development of multidisciplinary projects using the PBL strategy for increasing the attractiveness of the curriculum. Promoting electronics as grounding for other disciplines can be done by defining a new curriculum that includes practical courses (laboratories) in which the students develop whole systems involving multidisciplinary knowledge.

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

- To emphasize project-based learning activities that are long-term, interdisciplinary and student-centric.
- To inculcate independent and group learning by solving real world problem with the help of available resources.
- To be able to develop application based on the fundamentals of electronics and communication engineering by possibly the integration of previously acquired knowledge.
- To get practical experience in all steps in the life cycle of the development of electronic systems: specification, design, implementation, and testing.
- To be able to select and utilize appropriate hardware and software tools to design and analyze the proposed system.
- To provide every student the opportunity to get involved either individually or as a group so as to develop team skills and learn professionalism.

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

CO1: Identify the real-world problem (possibly of interdisciplinary nature) through a rigorous literature survey and formulate / set relevant aim and objectives.

CO2: Contribute to society through proposed solution by strictly following professional ethics and safetymeasures.

CO3: Propose a suitable solution based on the fundamentals of electronics and communication engineering bypossibly the integration of previously acquired knowledge.

CO4: Analyze the results and arrive at valid conclusion.

CO5: Use of technology in proposed work and demonstrate learning in oral and written form.CO6: Develop ability to work as an individual and as a team member.

Group Structure:

Working in supervisor/mentor –monitored groups. The students plan, manage and complete a task/project/activity which addresses the stated problem.

1. Create groups of 5 (five) to 6 (six) students in each class

Project Selection:

Survey through journals, patents or field visit (A problem can be theoretical, practical, social, technical, symbolic, cultural and/or scientific), check the physibility of solution, analyze the problem, design and find the values of components.

There are no commonly shared criteria for what constitutes an acceptable project. Projects vary greatly in the depth of the questions explored, the clarity of the learning goals, the content and structure of the activity.

The problem-based project-oriented model for learning is recommended. The model begins with the identifying of a problem, often growing out of a question or "wondering". This formulated problem then stands as the starting point for learning. A problem can be theoretical, practical,

social, technical, symbolic, cultural and/or scientific and grows out of students' wondering within different disciplines and professional environments. As stated in the preamble as electronics is an important grounding for other disciplines (computer science, signal processing, and communications), the project topic can be Interdisciplinary in nature. However, the chosenproblem must involve the application of electronics and communication engineering fundamentals. Out of the total developed system setup, the project based model/activity preferably involve electronic components/hardware/software. Although in a genuine case project idea/model/ simulation model may be allowed.

Ethical Practices, team work and project management:

Use IEEE standards for project manufacturing, respect the time of others, attend the reviews, poster presentation and model exhibitions, strictly follow the deadline of project completion, comply with all legislation requirements that govern workplace health and safety practices.

Effective Documentation:

In order to make our engineering graduates capable to prepare effective documentation, it is required for the students to learn the effective writing skills. The PBL final report is expected to consist of the Literature Survey, Problem Statement, Aim and Objectives, System Block Diagram, System Implementation Details, Discussion and Analysis of Results, Conclusion, System Limitations and Future Scope. Many freely available software tools (for instance Medley (Elsevier), Grammerly) are expected to be used during the preparation of PBL synopsis and final report. It is expected that the PBL guides/mentors shall teach students about utilizing valid sources of information (such as reference papers, books, magazines, etc) related to their PBL topic.

Evaluation & Continuous Assessment:

The institution/head/mentor is committed to assessing and evaluating both student performance and program effectiveness. Progress of PBL is monitored regularly on weekly basis. Weekly review of the work is necessary. During process of monitoring and continuous assessment and evaluation the individual and team performance is to be measured. PBL is monitored and continuous assessment is done by supervisor /mentor and authorities. Students must maintain an institutional culture of authentic collaboration, self-motivation, peer-learning and personal responsibility. The institution/department should support students in this regard through guidance/orientation programs and the provision of appropriate resources and services. Supervisor/mentor and Students must actively participate in assessment and evaluation processes.

It is recommended that the all activities are required to be recorded and regularly. A regular assessment of PBL work is required to be maintained at the department in PBL log book by students. It is expected that the PBL log book must include following:

1. Weekly monitoring by the PBL guide,

2. Assessment sheet for PBL work review by PBL guide and PBL Evaluation Committee (PEC).

The PEC structure shall consist of Head of the department, 1/2 senior faculties of the department and one industry expert (optional). Continuous Assessment Sheet (CAS) is to be maintained by the department.

Recommended parameters for assessment, evaluation and weightage:

1. Idea Inception (kind of survey). (10%)
2. Outcome (Participation/ publication, copyright, patent, product in market). (50%)
3. Documentation (Gathering requirements, design & modeling, implementation/execution, use of technology and final report, other documents). (15%)
4. Attended reviews, poster presentation and model exhibition. (10%)
5. Demonstration (Poster Presentation, Model Exhibition etc). (10%).
6. Awareness /Consideration of - Environment/ Social /Ethics/ Safety measures/Legal aspects. (5%)

Learning Resources

Reference Books / Research Articles:

1. John Larmer, John R. Mergendoller, and Suzie Boss, “Setting the Standard for Project Based Learning”.
2. John Larmer and Suzie Boss, “Project Based Teaching: How to Create Rigorous and Engaging Learning Experiences”.
3. Erin M. Murphy and Ross Cooper, “Hacking Project Based Learning: 10 Easy Steps to PBL and Inquiry”. M. Krašna, "Project based learning (PBL) in the teachers' education,"39th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO), Opatija, 2016, pp. 852-856, doi: 10.1109/MIPRO.2016.7522258.
4. J. Macias- Guarasa, J.M. Montero, R. San-Segundo, A. Araujo and O. Nieto-Taladriz, "A project based learning approach to design electronic systems curricula", IEEE transactions on Education, vol.49, no. 3, pp. 389-397, Aug. 2006, doi: 10.1109/TE.2006.879784

Web resources:

- Project-Based Learning, Edutopia, March 14, 2016.
- What is PBL? Buck Institute for Education.
- www.howstuffworks.com
- www.wikipedia.org

Savitribai Phule Pune University
Second Year of Electronics Engineering

VLSI Design & Technology (2019 Course)

204201: Mandatory Audit Course - 4

Teaching Scheme:	Credit	Examination Scheme:
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List of Courses to be opted (Any one) under Mandatory Audit Course 4

- Enhancing Soft Skills and Personality
- Language & Mind
- Emotional Intelligence
- German II
- Human Behaviour
- Speaking Effectively

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 whichmake 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.