COEP Technological University, Pune

(A Unitary Public University of Govt. of Maharashtra)

School of Engineering and Technology

B. Tech.

Electronics and Telecommunication Engineering

Curriculum Structure & Detailed Syllabus

Effective from: A.Y. 2026-27

Mobile Communication and Networks						
Course Code			**Examination Scheme**			
Teaching Scheme	2-0-2-1		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	CIE: 50	ESE: 50	--

Course Outcomes: At the end of the course, students will demonstrate the ability to

1. Explain the concepts of cellular system, mobility, multiple access and the supporting technologies
2. Apply concepts of GSM and CDMA technologies to understand design of the higher generation technologies like 4G, 5G
3. Compare performance of various higher generation technologies and analyze challenges of latest technologies like 5G for any one case study
4. Analyze radio propagation in wireless systems with understanding of different indoor and outdoor propagation models related to diverse types of fading, path loss models

Unit 1: Cellular Concept: System Design Fundamentals **[4 Hrs]**

Cellular system design, Frequency reuse, Co channel and adjacent channel interference, Interference reduction techniques and methods to improve cell coverage, Frequency management and channel assignment techniques, improving the capacity of cellular system and related design problems, concepts of cell splitting, handover concepts in cellular system.

- V. K. Garg, J. E. Wilkes, "Principle and Application of GSM", Pearson Education, chapter 4

Unit 2: GSM Architecture and Interfaces **[4 Hrs]**

Introduction to GSM subsystems, GSM architecture, details of following blocks in GSM (Mobile station, Base station systems, Switching subsystems, Home location registers, Visiting location registers, Equipment identity register, Echo canceller), GSM Interfaces, GSM Logical Channels importance, Data Encryption in GSM, Mobility Management, Call Flows in GSM, Spectral efficiency calculations with multiple access technologies like TDMA, FDMA, Comparison of these technologies based on their signal separation techniques, advantages, disadvantages and applications.

- V. K. Garg, J. E. Wilkes, "Principle and Application of GSM", Pearson Education, chapters 3, 5, 7, 9 (only 9.4), 11
- V. K. Garg, "IS-95 CDMA & CDMA 2000", Pearson Education, chapter 1, 2

Unit 3: Code Division Multiple Access **[3 Hrs]**

CDMA technology, RAKE receiver, IS 95 system Architecture, Air Interface, Forward Link, Reverse link, Physical and Logical channels of IS 95 CDMA, IS 95 CDMA Call Processing, soft Handoff, Comparison of GSM and CDMA technology, Spectral efficiency calculations for CDMA, Evolution of IS 95 (CDMA One) to CDMA 2000, CDMA 2000 layering structure and channels, 3G system example WCDMA.

- V. K. Garg, "IS-95 CDMA & CDMA 2000", Pearson Education, chapter 4, 5, 6, 7, 8, 10 (upto 10.2) and 15.
- For WCDMA and CDMA 2000 additional material to be referred and web links will be provided

Unit 4: Mobile Radio Propagation	[6 Hrs]

Concept of large-scale path losses and small-scale fading, Large Scale Path Loss, Free Space Propagation Model, Reflection, Ground Reflection (Two-Ray) Model, Diffraction, Scattering, Practical Link Budget Design using Path Loss Models, Outdoor Propagation Models, Indoor Propagation Models, Signal Penetration into Buildings, Small Scale Fading and Multipath Propagation, Impulse Response Model, Multipath Measurements, Parameters of Multipath channels, Types of Small-Scale Fading: Time Delay Spread; Flat, Frequency selective, Doppler Spread; Fast and Slow fading.

- T. S. Rappaport, "Wireless Communications Principles and Practice", II Ed. PHI, chapter 4, 5 (upto 5.6)
- NPTEL "Wireless Communication" lectures can be referred

Unit 5: Higher Generation Cellular Standards	[7 Hrs]

Evolution of 2.5 G to 4G standards, supporting technologies, GPRS Architecture and node functionalities, Changes in N/W architecture from 2G to 2.5G, GPRS Interfaces, Identifiers, Logical and Physical channels, GPRS Call setup procedures – Attach/Detach/PDP context/LA-RA Update, GPRS services, 2.75 G Standards: EDGE, 3G Network Architecture, Changes in N/W architecture, 3G Services. Limitation of 3G and motivation for 4G, 3G to 4G Evolution path, Changes in N/W arch from 3G to 4G, 4G Introduction and vision, LTE enabler Technologies: OFDMA, SC-FDMA, MIMO etc. adaptive multiple antenna techniques, radio resource management, QOS requirements for 4G. LTE Network architecture, interfaces and node functionalities, LTE identifiers, LTE Services, LTE Protocol stack, Logical, Physical and Transport Channels, LTE Call Procedures.

- T. S. Rappaport, "Wireless Communications Principles and Practice", II Ed. PHI, chapter 2
- V. K. Garg, J. E. Wilkes, "Principle and Application of GSM", Pearson Education, chapter 1, 2
- For the advanced topics, additional material to be referred and web links will be provided

Unit 6: Introduction to 5G	[4 Hrs]

Drivers for 5G, 5G Roadmap and Vision, 5G Enabler technologies, Key building Blocks (High Level View), 5G current state and development, Recent Trends in Telecommunication domain.

- For the advanced topics, additional material to be referred and web links will be provided

Textbooks:

[1]	Vijay K. Garg, "Wireless Communication and Networking", Elsevier, Morgan Kaufmann, Reprinted 2012.
[2]	Vijay K. Garg, J. E. Wilkes, "Principle and Application of GSM", Pearson Education, Fifth Impression 2008.
[3]	Vijay K. Garg, "IS-95 CDMA & CDMA 2000", Pearson Education, Fourth Impression 2009.
[4]	T. S. Rappaport, "Wireless Communications Principles and Practice", PHI, II Edition, 2006.

Reference Books:

[1]	T. L. Singal, "Wireless Communications", Tata McGraw Hill, 2010.
[2]	William C. Y. Lee, "Mobile Cellular Telecommunication system", Tata McGraw Hill, II Edition, 2008.
[3]	Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", John Wiley & Sons, 2015.

Mobile Communication and Networks Lab

Teaching Scheme	Practical: 2 hrs/week	**Examination Scheme**	
Credits	1	**CIE: 50**	**Oral (ESE): 50**

Course Outcomes: At the end of the laboratory work, students will demonstrate the ability to

1. Explain GSM handset (4G) working by carrying out detail sections study like, keyboard, display, battery, SIM, User Interface section and fault analysis
2. Apply knowledge of GSM AT commands for different applications and 3G system features using hardware platform and Proteus software
3. Analyze effect on CDMA performance by varying different types of PN codes, chip rate, spreading factor, processing gain

4. Develop awareness of system design using open-source simulator platform GNU radio, Proteus 5. Create 5G related different scenarios, testing and prepare case study using suitable platform
List of Experiments
1. Understanding Cellular Fundamentals like Frequency Reuse, Architecture, Interference, Path Environment, Coverage and Capacity using wireless communication software.
2. Knowing GSM and CDMA Network concepts like Call Management, Call Setup, call release, Handover, GSM Security and Power Control, Handoff Process, Rake Receiver, Capacity of CDMA using wireless communication software.
3. To study various GSM AT Commands and understand its usages, different UI features; it includes understanding of 3G Communication System with features like transmission of voice and video calls, SMS, MMS, TCP/IP, HTTP, GPS and File system in 3G network.
4. Study of direct sequence spread spectrum (DSSS) technique for CDMA, observe effect on performance of CDMA with variation of types of PN codes, chip rate, spreading factor, processing gain.
5. To learn and develop concepts of AT command using Proteus software: • Interface GSM 900 modem to serial monitor and get the output of commands • Interface GSM 900 modem to Arduino and make communication between them and see the output of serial monitor and different commands • Interface GSM 900 modem to serial monitor and perform the send & received SMS command
6. To design any one of the following using GNU radio: • Implementation of AM Transmitter and Receiver • Implementation of Narrow band FM Transmitter and Receiver • Implementation of SSB Transmitter and Receiver • Implementation of BPSK Transmitter and Receiver • Implementation of UP converter Hier Block • Design of Low pass filter with particular cut off frequency • Design of high pass filter with particular cut off frequency • Design of band pass filter with two different cut off frequencies
7. To Study 4G kit and its different sections in detail and observe the effect of fault insertion techniques.
8. To study various AT Commands on 4G kit and understand its usages, develop an APP using AT commands.
9. With the help of suitable simulation platform, develop 5G related different scenarios and performance testing parameters (for at least 2 applications).
10. Develop and implement any one use case based on 5G technology.
Mobile Communication and Networks Self-study (S) [1 hr/week]
Students will study additional topics for MCN; it will support better understanding of the 6 units of theory, and it will enhance Practical experimentation & assignments.
1. Frequency spectrum allocation for mobile communication and actual frequency usage by individual user for different application requirement 2. Numbering plan used by service provider for providing unique number to user and number portability feature used by service providers 3. Charging plan for mobile users based on individual user usage and facilities availed (prepaid, post-paid, fixed usage plan) 4. GSM identifiers (IMEI, IMSI, TMSI) need, structure 5. Handset comparison (any 4 handsets including individual model) based on 8-10 features (like processor, memory, storage, battery, camera, connectivity, advanced features, etc.) 6. Comparison of TDMA, FDMA and CDMA based on technique, advantages, limitation and its usage 7. Security features in GSM and CDMA, comparison based on technique used, its advantages, limitation

8. Mobile Jammers: need, specification, design criteria, installation precautions, permissions 9. Health hazards due to base station radiation, mobile radiation and user device facts 10. Mobile signal strength measurement at 15 different places, prepare observation table and comment on the results obtained, giving proper justification. The signal measurement should include: Indoor places, different floors, outdoor environment, daytime, nighttime, rainy days, user stationery, user on move (2-wheeler, bus, metro), tunnels/subway, bridges etc. 12. Base station cell site selection and installation for different situations like urban, dense urban, high rise urban areas, suburban, rural areas, ad hoc situations (stadium, military, accident prone areas (flood), emergency rescue, special events in institute etc.); study the differences and comparison. 13. Coverage concept, shadow region, LOS and NLOS communication comparison. 14. Enabler Technologies for supporting higher generation technologies 15. 5G use cases development and demonstration

Next Generation Computer Architecture						
Course Code			**Examination Scheme**			
Teaching Scheme	2-0-2-1		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	CIE: 50	ESE: 50	--
Course Outcomes: Students will be able to:						
1. Understand and Analyze advanced processor architectures and performance metrics 2. Evaluate multi-core and parallel architectures 3. Apply concepts of GPU and heterogeneous computing 4. Analyze modern memory and storage systems 5. Compare domain-specific architectures 6. Explore emerging trends in next-generation computing systems						
Unit 1: Fundamentals of Advanced Computer Architecture						**[6 Hrs]**
Review of basic computer architecture concepts, Instruction Set Architecture (ISA), evolution Performance metrics and benchmarking, Pipelining and superscalar architecture, Instruction-level parallelism (ILP)						
Unit 2: Multi-Core and Many-Core Architectures						**[6 Hrs]**
Multi-core processors: design and challenges, Cache coherence protocols (MSI, MESI, MOESI), Memory consistency models, Interconnection networks (Bus, Mesh, NoC), Case study of modern processors						
Unit 3: Parallel Computing Architectures						**[8 Hrs]**
Thread-level parallelism (TLP), SIMD, MIMD architectures, GPU architecture and programming basics, Vector processors, VLIW Architecture, Parallel programming models (OpenMP, CUDA overview)						
Unit 4: Memory Systems and Storage Innovations						**[8 Hrs]**
Advanced cache design, Virtual memory enhancements, non-volatile memory (NVM, MRAM, PCM) ,3D memory and High Bandwidth Memory (HBM), Storage-class memory						
Unit 5: Domain-Specific and AI Architectures						**[8 Hrs]**
AI/ML accelerators (TPU, NPU), Tensor processing architectures, FPGA-based acceleration, Edge AI hardware, Neuromorphic computing basics						

Self-Study (SS): Emerging Trends in Computer Architecture	**[8 Hrs]**
Quantum computing basics, Approximate computing, Reconfigurable computing, green computing and energy-efficient architectures, Security in modern processors	

Textbooks:	
[1]	Computer Architecture: A Quantitative Approach, John L. Hennessy and David A. Patterson, 6th Edition, Morgan Kaufmann (Elsevier), 2019, ISBN: 978-0128119051
[2]	Structured Computer Organization, Andrew S. Tanenbaum and Todd Austin, 6th Edition, Pearson, 2013, ISBN: 978-0132916528
Reference Books:	
[1]	Computer Organization and Design RISC-V Edition, David A. Patterson and John L. Hennessy, 2nd Edition, Morgan Kaufmann, 2020, ISBN: 978-0128203316
[2]	Parallel Computer Architecture, David Culler, Jaswinder Pal Singh, Anoop Gupta, Morgan Kaufmann, 1999, ISBN: 978-1558603436
[3]	GPU Computing Gems Emerald Edition, Wen-mei W. Hwu, Morgan Kaufmann, 2011, ISBN: 978-0123849885
[4]	Domain-Specific Architectures, John L. Hennessy and David A. Patterson, 1st Edition, Morgan Kaufmann, 2018, ISBN: 978-0128203316.

Next Generation Computer Architecture Lab

Course Outcomes: Students will be able to:

1. Learners will develop the ability to model superscalar execution, exploit instruction-level parallelism, and simulate vector processors for enhanced throughput.
2. Students will be able to evaluate multi-core and parallel architectures
3. Participants will gain proficiency in cache coherence protocols, memory consistency models, and interconnection networks to assess scalability and reliability in multi-core systems.
4. Students will acquire hands-on experience with GPU programming using CUDA and analyze AI accelerator case studies to measure efficiency in heterogeneous computing platforms.
5. Learners will critically assess innovations in memory systems,advanced accelerator technologies, preparing them to evaluate next-generation computing paradigms.

Evaluation Scheme:
Students have to select any three experiments to support their corner stone project.

Experiments:
1.Study of ISA simulation and benchmarking
2. Study of pipeline Hazard Analysis
3. Superscalar execution
4. Learning cache coherence protocol
5. GPU Programming and speedup
6. Multicore programming using Open MP
7. Vector processor simulation
8. Understanding memory hierarchy and apply memory element for the project
9. AI Accelerator case study
10. Out-of-Order execution engine
11. Edge AI using Neural Processing Units

Digital Audio Processing	
Teaching Scheme (L-T-P-S)	3-0-0-1 (L-T-P-S)
Credits	3
Course Code	PEC-03
Examination Scheme	Theory: TA 20 | MSE 30 | ESE 50
Course Outcomes	
Students will be able to: **1.** Explain characteristics of audio signals, sampling, quantization, and psychoacoustic principles. **2.** Analyze digital audio recording and reproduction systems and associated conversion techniques. **3.** Apply digital signal processing techniques in time and frequency domain for audio signals. **4.** Evaluate audio compression techniques and coding standards based on performance and perceptual models. **5.** Design and implement digital audio processing systems for real-world applications.	
Unit 1: Fundamentals of Digital Audio and Psychoacoustics [6 Hrs]	
Characteristics of audio and music signals; bandwidth, amplitude, frequency representation; digitization of audio signals; sampling theorem; quantization; dynamic range; signal-to-noise ratio; signal-to-quantization noise ratio; dithering; noise shaping; oversampling; human auditory system; threshold of hearing; loudness perception; frequency masking; temporal masking; critical bands; sound propagation; microphone characteristics; loudspeaker characteristics.	
Unit 2: Digital Audio Recording and Reproduction Systems [6 Hrs]	
Audio acquisition process; input signal conditioning; anti-aliasing filtering; sample-and-hold circuits; analog-to-digital conversion; uniform quantization; oversampling A/D conversion; sigma-delta modulation; noise sources and errors; digital-to-analog conversion; reconstruction filtering; interpolation; noise shaping; equalization; post-processing; practical implementation issues in digital audio systems.	
Unit 3: Audio Signal Processing Techniques [7 Hrs]	
Time-domain and frequency-domain representation of audio signals; Fourier transform; Short-Time Fourier Transform (STFT); time-frequency analysis; multirate signal processing; filter banks; subband decomposition; digital filtering techniques; FIR and IIR filters; audio effects including echo, reverberation, mixing, and dynamic range processing; digital mixing; common DSP techniques for audio processing.	

Unit 4: Audio Coding and Compression [8 Hrs]
Audio coding formats: WAV coding formats for CD; Digital Audio Broadcast (DAB). Waveform coding: PCM, Delta Modulation, ADPCM, Dolby DTS. Psychoacoustic coding: Transform coding, QMF and MDCT, MPEG I, II, IV Audio, Advanced Audio Coding and MP3. Perceptual audio quality measurement (PEAQ). Lossless coding: Meridean Lossless Packing for DVD-Audio, Direct Stream Digital for Sony/Philips Super Audio CD, Blu-Ray audio.
Unit 5: Advanced Topics and Applications [8 Hrs]
Digital audio restoration; detection of clicks, pops, and noise; estimation of corrupted samples; prediction-error techniques; least-square gap filling; background noise reduction; short-time spectral attenuation; music synthesis: sinusoidal modelling, additive synthesis, FM synthesis, wavetable synthesis; MIDI representation; spatial audio; 3D sound; sound localisation; HRTF modeling; surround sound systems; digital audio watermarking; time-domain and frequency-domain techniques; multimedia audio applications; streaming and broadcasting systems.
Textbooks
[1] K. C. Pohlmann, "Principles of Digital Audio", McGraw-Hill, 6th Edition, 2011. **[2]** Soumya Sen, Anjan Dutta, Nilanjan Dey, "Audio Processing and Speech Recognition", 1st Edition, Springer, 2019.
Reference Books
[1] Gold, B.; Morgan, N.; Ellis, D., "Speech and Audio Signal Processing: Processing and Perception of Speech and Music", 2nd revised ed., Wiley-Blackwell, 2011. **[2]** Sadaoki Furui, "Digital Speech Processing, Synthesis and Recognition", 2nd Edition.
Note
[1] To measure CO1, questions may be of the type – define, state, explain fundamentals of digital audio and psychoacoustics. [2] To measure CO2, questions may be of the type – explain, describe, analyze audio recording and conversion systems. [3] To measure CO3, questions will be based on application of signal processing techniques to audio signals. [4] To measure CO4, questions may involve analysis, evaluation, and comparison of audio compression standards. [5] To measure CO5, questions may include design-based problems and real-world application scenarios.

Microwave Theory and Techniques						
Course Code			**Examination Scheme**			
Teaching Scheme	3-0-0-1		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3					

Course Outcomes: Students will be able to:

1. Calculate the cut off wavelength, cut off frequency, group and phase velocity of the given rectangular waveguide.
2. Compare the features of rectangular and circular waveguide for given parameters.
3. Design microwave components such as power dividers, hybrid junctions, microwave filters and ferrite devices.
4. Analyse and design simple radar systems and the associated signal processing, at block diagram level.
5. Implement simple microwave and RADAR based communication system and will be in a position to understand the developments in the technology of advanced communication.

Fundamentals of Microwaves and Waveguides: **[8 Hrs]**

Microwave band designations, Advantages, applications and hazards of Microwaves, Propagation of microwave rectangular waveguides, TE and TM modes, Guide wavelength, Group and Phase Velocity, Power losses and power handling capacity of rectangular waveguide, Circular waveguides, Cavity Resonators.

Microwave Passive Components: **[8 Hrs]**

Scattering Parameters, Microwave junctions – E-Plane, H-Plane, Magic TEE and Rat race ring, Directional Couplers, Ferrite devices – Isolator, Circulator and Gyrator, Microwave Filters, Microwave Antennas – Horn and Dish.

Microwave Active Components **[8 Hrs]**

Microwave Tubes - Klystron and Magnetron, Slow wave devices – Helix TWT, Solid state microwave devices – Transferred Electron Devices (TED): Gunn diode, Varactor diodes, Avalanche Transit time devices: READ diode, IMPATT diode and BARITT diode, other diodes - PIN diode, Tunnel (Esaki) diode with their applications as an oscillator and an amplifier.

RADAR Fundamentals: **[6 Hrs]**

Basic block diagram of RADAR, RADAR performance factors – RADAR range equation, factors influencing range, effect of noise. Basic pulse RADAR, Scanning, Tracking.

RADAR Systems **[6 Hrs]**

Doppler **effect**, CW Doppler RADAR, FM CW RADAR, MTI, Display methods.

Microwave and RADAR Based Communication Systems **[6 Hrs]**

Analog Microwave Communication, Satellite Communication, Digital Microwave Communication.

Self-Study (SS): Contribution of Antenna and Design Analysis **[6 Hrs]**

Antennas – Fundamentals, Dipole, Monopole, Arrays, Microstrip, Horn, Helical, Yagi-Uda, Log-Periodic and Reflector Antennas

1. Balanis, C.A., 2016. *Antenna theory: analysis and design*. John wiley & sons.

Textbooks:

[1]	Kulkarni M, “Microwave and Radar Engineering”, 4th Edition, Umesh Publications, 2012.
[2]	Skolnik, Merrill Ivan. "Introduction to radar systems." SIE, 2017

Reference Books:

[1]	Samuel Y. Liao, “Microwave Devices and Circuits”, 3rd Edition, Pearson Education, 2003.
[2]	David M. Pozar, Microwave Engineering, 4th Edition, Wiley India, 2012.
[3]	Robert E. Collin, Foundation of Microwave Engineering, 2nd Edition, Wiley India, 2012.

Note:	
[1]	To measure CO1, questions may be of the type- define, identify, state, match, list, name etc.
[3]	To measure CO2, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc.
[4]	To measure CO3, questions will be based on applications of core concepts.
[5]	To measure CO4, questions may be of the type- true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc.
	To measure CO5, some questions may be based on self-study topics and comprehension of unseen passages.
[6]	To measure CO6, questions may include analytical case studies, design-based problems, interpretation of experimental or simulated results, and application-oriented scenarios requiring critical evaluation and synthesis of concepts.

<table>
<tr><td colspan="2">ASIC Physical Design</td></tr>
<tr><td>Teaching Scheme (L-T-P-S)</td><td>3-0-0-1 (L-T-P-S)</td></tr>
<tr><td>Credits</td><td>3</td></tr>
<tr><td>Course Code</td><td>–</td></tr>
<tr><td>Examination Scheme</td><td>Theory: TA 20 | MSE 30 | ESE 50</td></tr>
<tr><td colspan="2">Course Outcomes</td></tr>
<tr><td colspan="2">Students will be able to:
1. Illustrate the concepts of the physical design process such as partitioning, floor planning, placement, and routing.
2. Apply the basic timing concepts and STA methodology to address timing violations.
3. Apply the concepts of design optimization algorithms and their application to physical design automation.
4. Identify the design for testability methods for combinational and sequential CMOS circuits.
5. Analyse various techniques for dynamic and leakage power reduction at various levels of abstraction.</td></tr>
<tr><td colspan="2">Unit 1: Physical Design Flow Overview [4 Hrs]</td></tr>
<tr><td colspan="2">Introduction to ASIC and FPGA, technology nodes and scaling challenges, overall flow of physical design, libraries, partitioning, floor planning and placement, timing and clock tree synthesis, parasitic extraction, DRC clean, final stage.</td></tr>
<tr><td colspan="2">Unit 2: Graph Theory [4 Hrs]</td></tr>
<tr><td colspan="2">Circuit representation as graph, shortest path algorithm, minimum spanning tree, weighted graphs, applications in physical design stages.</td></tr>
<tr><td colspan="2">Unit 3: Synthesis, Partitioning, Floor Planning and Placement [10 Hrs]</td></tr>
<tr><td colspan="2">Introduction to EDA tools, design rules, technology files, netlist, partitioning algorithm, floor planning algorithm, block placement, I/O placement, power planning, standard cell placement.</td></tr>
<tr><td colspan="2">Unit 4: Routing, Timing Closure and DRC [8 Hrs]</td></tr>
<tr><td colspan="2">Global routing, detailed routing, signal integrity, cross talk, clock tree synthesis, clock shielding, clock nets, static timing analysis, STA with multiple clocks, critical nets in timing, parasitic extraction.</td></tr>
<tr><td colspan="2">Unit 5: Testing of VLSI Circuits [8 Hrs]</td></tr>
<tr><td colspan="2">Types of faults, fault modeling and simulation, test pattern generation, DFT, BIST.</td></tr>
<tr><td colspan="2">Unit 6: Low Power VLSI Design [6 Hrs]</td></tr>
</table>

Dynamic and static power, clock gating techniques, voltage island, approach of using parallelism and pipeline.
Textbooks
[1] Khosrow Golshan, "Physical Design Essentials: An ASIC Design Implementation Perspective", Springer, 2007. **[2]** Bushnell & Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers, 2000.
Reference Books
[1] P. Rashinkar, Paterson and L. Singh, "Low Power Design Methodologies", Kluwer Academic, 2002. **[2]** S. H. Gerez, "Algorithms for VLSI Design Automation", John Wiley, 1998.
Note
[1] To measure CO1, questions may be of the type – define, identify, state, match, list, name etc. [2] To measure CO2, questions may be of the type – explain, describe, illustrate, evaluate, give examples, compute etc. [3] To measure CO3, questions will be based on applications of core concepts. [4] To measure CO4, questions may be of the type – true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc. [5] To measure CO5, some questions may be based on self-study topics and comprehension of unseen passages.

Research Methodology	
Teaching Scheme (L-T-P-S)	2-0-0-0 (L-T-P-S)
Credits	2
Course Code	–
Examination Scheme	Theory: TA 20 | MSE 30 | ESE 50
Course Outcomes	
Students will be able to: **1.** Understand fundamentals of research, types of research, and research problem formulation. **2.** Apply research design, data collection methods, and sampling techniques. **3.** Analyze and interpret data using statistical tools and software. **4.** Evaluate research findings, write technical papers, and follow ethical practices. **5.** Develop and present a research proposal addressing real-world engineering problems.	
Module 1: Foundations of Research Methodology [8 Hrs]	
Meaning and objectives of research; characteristics and significance of research in engineering; types of research (basic, applied, qualitative, quantitative, exploratory, descriptive, experimental); steps in	

the research process; identification and formulation of research problems; defining research objectives and scope; literature review techniques (systematic review, use of digital libraries, citation tracking); identification of research gaps and novelty; formulation of hypotheses and research questions; variables and their types; research ethics and integrity; overview of interdisciplinary and industry-oriented research. S: Case studies from engineering research papers.
Module 2: Research Design and Data Collection [8 Hrs]
Concept and importance of research design; types of research design (exploratory, descriptive, analytical, experimental); identification of variables and control mechanisms; sampling techniques (probability and non-probability sampling methods); sample size determination; data collection methods (surveys, interviews, observations, experiments); design of questionnaires and schedules; scaling techniques (Likert scale, semantic differential scale); reliability and validity of data collection instruments; sources of data (primary and secondary); ethical considerations in data collection. S: Design a survey for an engineering problem.
Module 3: Data Analysis and Interpretation [8 Hrs]
Fundamentals of statistical analysis; types of data and measurement scales; descriptive statistics (mean, median, mode, variance, standard deviation); inferential statistics and probability concepts; hypothesis testing procedures (t-test, chi-square test, ANOVA); correlation and regression analysis; model fitting and interpretation of results; error analysis and confidence intervals; use of statistical and computational tools (MATLAB, Python, SPSS, Excel); data preprocessing and cleaning techniques; data visualization methods; interpretation and presentation of analytical results. S: Data analysis using sample dataset.
Module 4: Technical Writing and Research Ethics [6 Hrs]
Structure and components of a research paper (abstract, introduction, methodology, results, discussion, conclusion); techniques for effective technical writing and scientific communication; referencing styles (IEEE, APA, MLA) and citation management tools; avoidance of plagiarism and use of plagiarism detection tools; research ethics and integrity; authorship guidelines and publication ethics; basics of Intellectual Property Rights (IPR) including patents, copyrights, and trademarks; writing technical reports, project reports, and dissertations; preparation of research proposals; effective presentation skills. S: Write a mini research paper.
Self-Study (SS): Emerging Research Trends [6 Hrs]
Role of Artificial Intelligence and Machine Learning in research and innovation; interdisciplinary and multidisciplinary research approaches in engineering; open science practices, reproducible research, and research data management; use of digital research tools (reference managers, collaborative platforms, preprint servers); case studies of recent advancements and real-world research applications.
Textbooks
[1] C.R. Kothari, "Research Methodology: Methods and Techniques", New Age International Publishers. **[2]** John W. Creswell, "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches".
Reference Books

[1] Booth, Colomb, Williams, "The Craft of Research", University of Chicago Press.
[2] Paul D. Leedy, "Practical Research: Planning and Design".

Note

[1] To measure CO1, questions may be of the type – define, list, recall concepts. [2] To measure CO2, questions may be of the type – explain, describe, apply methods. [3] To measure CO3, questions will be based on analyze and interpret data. [4] To measure CO4, questions may involve evaluate, justify, critique. [5] To measure CO5, design and present research work.

Internship (OJT-2)

Teaching Scheme (L-T-P-S)	– (L-T-P-S)
Credits	1
Course Code	–
Examination Scheme	Theory: – Laboratory: CIE 50 | ESE 50

Course Outcomes

Students will be able to:

1. Apply theoretical knowledge from semesters 1–6 to professional or research work contexts.
2. Develop professional communication skills and workplace conduct.
3. Critically reflect on personal learning and identify gaps in knowledge.
4. Produce a structured technical report documenting the internship experience.
5. Present work clearly and respond to questions from academic and professional evaluators.

Duration and Mode

Minimum Duration: 6-8 weeks during the summer break after 6th Semester. Mode: In-person, Hybrid, or Remote – all modes are acceptable, subject to faculty mentor's basic approval.

Eligible Internship Formats

[1] Industry/Company Internship: Any registered company (startup, SME, MNC, PSU).
[2] Internal Institute Internship: Under a faculty mentor within the same institute on a defined project.
[3] Research/Academic Institute: Any IIT, NIT, IISc, IISER, university, or government R&D lab.
[4] Entrepreneurship/Self-Started Venture: Student develops a product, prototype, or startup idea registered with the institute entrepreneurship cell.
[5] Open Source/Self-Directed Technical Project: Contribution to a recognised open-source project or an independent technical project with faculty mentor pre-approval.

Assessment Scheme

A. Internship Report: 60 Marks – Evaluated by Internal Faculty Mentor + External Supervisor. Criteria: Structure and completeness; Technical content and depth; Reflection and learning; Mapping to curriculum; Language and references. B. Presentation and Viva: 40 Marks – Evaluated by Internal Faculty Mentor + External Supervisor. Criteria: Clarity of communication; Technical understanding; Q&A/Viva response. Total: 100 Marks.
Note
1. [CO1] Assessed through Internship Report – Methodology and Key Learnings sections. 2. [CO2] Assessed through Presentation and Viva – Clarity of communication and Q&A handling. 3. [CO3] Assessed through Internship Report – Curriculum Mapping and Challenges sections. 4. [CO4] Assessed through Internship Report – overall structure, completeness, and referencing. 5. [CO5] Assessed through Presentation and Viva – technical understanding and independent articulation of work done.

MOOCs Courses Identified – NPTEL/SWAYAM

- An Introduction to Artificial Intelligence
- Advanced Computer Architecture
- Introduction to Machine Learning
- Discrete Mathematics
- Reinforcement Learning
- Deep Learning
- Advanced Computer Networks
- Cloud Computing
- Natural Language Processing
- Hardware Security
- Foundations of Cyber Physical Systems
- Understanding Incubation and Entrepreneurship
- Power Management Integrated Circuits

Internship cum Capstone Project	
Teaching Scheme (L-T-P-S)	0-0-6-2 (L-T-P-S)
Credits	3
Course Code	–
Examination Scheme	Theory: – Laboratory: CIE 60 | ESE 40
Course Outcomes	
Students will be able to: **1.** Apply multidisciplinary engineering knowledge to identify, analyze, and address a real-world engineering problem. **2.** Design and develop a working prototype or solution as a capstone deliverable demonstrating technical competence. **3.** Conduct systematic investigation including literature review, problem formulation, methodology, and result analysis. **4.** Work effectively in a professional environment and demonstrate project management, communication, and teamwork skills. **5.** Present technical work through written reports and oral presentations to academic and industry panels.	
Phase 1: Problem Identification and Literature Review	
Identification of a real-world or industry problem; comprehensive literature survey; definition of project scope, objectives, and methodology.	
Phase 2: Design and Development	

Detailed design, simulation or prototyping, and iterative development of the proposed solution.
Phase 3: Testing and Validation
Systematic testing, result analysis, performance evaluation, and comparison with existing approaches.
Phase 4: Report and Presentation
Final technical report submission and project demonstration/viva.
Assessment Scheme
Continuous Internal Evaluation (CIE): 50 Marks – Based on progress presentations, interim reports, and supervisor evaluation. End Semester Evaluation (ESE): 50 Marks – Based on final report quality, project demonstration, and viva conducted by internal and external examiners. Total: 100 Marks.
Note
1. [CO1] Assessed through problem statement, literature review, and project report introduction. 2. [CO2] Assessed through working prototype or deliverable and technical report. 3. [CO3] Assessed through methodology, data analysis, and result chapters. 4. [CO4] Assessed through progress presentations, teamwork, and supervisor evaluation. 5. [CO5] Assessed through final presentation, viva, and technical report quality.