ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

.

SCHOOL OF ELECTRONIC SCIENCES

B. Tech in Electronics and Communication Engineering (Honors)

Curriculum and Syllabus
(**2023-24 admitted students**)

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, MahalaxmiVihar,Ghatikia, Bhubaneswar-751029.

Syllabus (Admission Batch: 2023-24)

School/ Department: SCHOOL OF ELECTRONIC SCIENCES

Course: B. Tech **Programme: Electronics and Communication Engineering**

Abbreviation used:

AC	Audit course	LC	Laboratory Course	PA	Practical Assessment
PC	Professional Core	PR	Project/ Practical/ Internship	L	Lecture
PE	Professional Elective	SE	Seminar/ Expert Lecture/ Etc.	T	Tutorial
OE	Open Elective	IA*	Internal Assessment	P	Practical
MC/BS/HS	Mandatory/ Common Course	EA	End-Semester Assessment		
ACC	Advanced Competency Course				
*Internal Assessment Mark (40 marks) consists of (i) Mid Semester (20 marks) (ii) Quiz/ Assignment/Attendance (20 marks)					

Honors Degree in Electronics and Communication Engineering

Sl. No.	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
			L	T	P		IA	EA	PA	Total
1	EI3171	Soft Computing	3	0	0	3	40	60	-	100
2	EI3172	AI Foundations and Applications	3	0	0	3	40	60	-	100
3	EI3584	AI Applications Lab	0	0	3	1.5	-	-	100	100
4	EI4183/ EI4185/ EI4187/ EI4189	Nanoelectronics / Next-Gen Communication / Pattern Recognition/ Introduction to Quantum Computing	3	0	0	3	40	60	-	100
5	EI4191 EI4493	AI and ML for VLSI CAD / Advanced Wireless-Communication System	3	0	0	3	40	60	-	100
6	EI4583 EI4585	AI and ML for VLSI CAD Lab / Advanced Wireless-Communication Lab	0	0	3	1.5	-	-	100	100
7	EI4186 EI4188 EI4190	Advanced Digital Signal Processing / AI in Healthcare / Advanced Embedded Processor Architectures	3	0	0	3	40	60	-	100
Total			15	0	6	18	200	300	200	700

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, MahalaxmiVihar,Ghatikia, Bhubaneswar-751029.

Syllabus (Admission Batch: 2023-24)

SUBJECT NAME	SUBJECT CODE	L-T-P	CREDIT
SOFT COMPUTING	EI3171	3-0-0	3

Prerequisite: NIL

Course Outcomes:

At the end of the course, a student will be able to:

CO1: Acquire the foundational concepts of fuzzy sets, fuzzy inference systems, and their real-life applications.

CO2: Illustrate the structure and functioning of various neural network models and their uses.

CO3: Analyze the application of genetic algorithms to solve engineering optimization problems.

CO4: Evaluate and compare different soft computing techniques for intelligent problem-solving.

Module I: Fuzzy Logic Systems — 04 Hours

Introduction to soft computing and fuzzy logic covering fuzzy sets, fuzzy vs. crisp sets, fuzzy relations, linguistic variables, membership functions, fuzzy operations, fuzzy rules, fuzzy inference, and a fuzzy logic-based case study for air conditioning control.

Module II: Artificial Neural Networks (ANNs) — 08 Hours

Fundamentals of neural networks including artificial neuron models, feedforward networks, recurrent networks, CNN, RBM, and the general architecture and characteristics of neural networks

Module III: Machine Learning Using Neural Networks — 08 Hours

Learning algorithms in neural networks such as backpropagation, MLP, ART, RBFN, Hopfield networks, comparison of MLP and RBFN, hybrid neuro-fuzzy systems, and practical applications of neural networks.

Module IV: Genetic Algorithms and Hybrid Soft Computing Systems — 10 Hours

Basics and principles of genetic algorithms including encoding, fitness function, reproduction, crossover, mutation, inheritance operators, generational cycle, and GA-based optimization techniques.

Total lecture hours: 30 Hours

Text Book:

1. S. Rajasekaran and G. A. V. Pai, Neural Networks, Fuzzy Logic, and Genetic Algorithms, New Delhi, India: PHI.
2. S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing, New Delhi, India: Wiley.
3. D. E. Goldberg, Genetic Algorithms in Search Optimization and Machine Learning, 3rd ed., Boston, MA, USA: Addison Wesley.
4. S. Haykin, Neural Networks: A Comprehensive Foundation, New Delhi, India: PHI.

Reference Book:

1. J. S. R. Jang, C. T. Sun, and E. Mizutani, Neuro-Fuzzy and Soft Computing, New Delhi, India: PHI.
2. N. K. Kasabov, Foundations of Neural Networks, Fuzzy Systems, and Knowledge Engineering, Cambridge, MA, USA: MIT Press, 1996.
3. B. Yegnanarayana, Artificial Neural Networks, New Delhi, India: PHI Learning, 2004.
4. S. Haykin, Neural Networks and Learning Machines, 3rd ed., Upper Saddle River, NJ, USA: Pearson Education, 2008.

CO-PO-PSO MAPPING

SOFT COMPUTING															
Course outcome	**Program Outcomes**												**Program Specific Outcomes**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO l	PSO 2	PSO 3
CO1	3	2	1	2	2	1	1	1	1	1	1	1	3	2	1
CO2	3	2	2	2	2	1	1	1	1	1	1	1	3	3	2
CO3	3	2	3	3	3	1	1	1	1	1	1	2	3	3	2
CO4	3	3	3	3	3	1	1	1	1	1	1	2	3	3	3
Average	3.0	2.25	2.25	2.5	2.5	1.0	1.0	1.0	1.0	1.0	1.0	1.5	3.0	2.75	2.0
Level of Correlation: 3 - High 2 - Medium 1 – Low															

SUBJECT NAME	SUBJECT CODE	L-T-P	CREDIT
ARTIFICIAL INTELLIGENCE: FOUNDATIONS AND APPLICATIONS	**EI3172**	**3-0-0**	**3**

Prerequisite: Control System Engineering, Hydraulics and Fluid Machines, Thermodynamics

Course Outcomes:

At the end of the course, a student will be able to:

- **CO1:** Identify the historical evolution, architecture, and application domains of Artificial Intelligence systems.
- **CO2:** Apply various knowledge representation techniques.
- **CO3:** Implement fundamental AI methods
- **CO4:** Analyze AI problem-solving under real-world constraints

Module I: **7 Hours**

Introduction to AI: Historical Evolution and AI today, Architecture of AI Systems, Domains and Scope of AI Applications

Module II: **7 Hours**

Knowledge Representation Methods: State Space Representation, Logical Representations, Knowledge Graphs,

Module III: **8 Hours**

Basic Artificial Intelligence Methods: Decision-tree learning, Supervised and Unsupervised learning, Classification and Regression, Support Vector Machines, Neural Networks (Basics), Reinforcement Learning, Tools: Tensor Flow, ML Flow etc.

Module IV: **8 Hours**

Real-World Considerations: Contract search, anytime search, Memory-bounded search, Search with Real-time adjustments, Observability (full / partial), Information (known / unknown), State (deterministic / stochastic), Periodicity (discrete / continuous).

Total lecture hours: **30 Hours**

Text Book:

1. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig, 3rd Edition, Prentice Hall, 2009.
2. Principles of Artificial Intelligence, Nils J. Nilsson, Morgan Kaufmann, 1982

Reference Book:

1. Artificial Intelligence: A New Synthesis, Nils J. Nilsson, 1st Edition, Morgan Kaufmann, 1998
2. Heuristic Search: Theory and Applications, Stefan Edelkamp and Stefan Schroedl, 1st Edition, Morgan Kaufmann, 2011
3. Logic in Computer Science: Modelling and Reasoning about Systems, Michael Huth and Mark Ryan, 2nd Edition, Cambridge University Press, 2004.
4. The Cambridge Handbook of Artificial Intelligence, Keith Frankish and William M. Ramsey (ediitors), Cambridge University Press, 2014.

CO-PO-PSO MAPPING

ARTIFICIAL INTELLIGENCE: FOUNDATIONS ANDAPPLICATIONS															
Course outcome	**Program Outcomes**												**Program Specific Outcomes**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO l	PSO 2	PSO 3
CO1	3	-	-	-	1	-	-	-	-	2	-	2	3	2	2
CO2	3	2	2	1	2	-	-	-	-	1	-	2	3	2	2
CO3	3	3	2	2	3	-	-	-	-	1	1	3	3	2	2
CO4	3	3	2	3	2	-	-	-	-	2	1	3	3	2	2
Average	3	2	1.5	1.5	2	0	0	0	0	1.5	0.5	2.5	3	2	2
Level of Correlation: 3 - High 2 - Medium 1 - Low															

SUBJECT NAME	SUBJECT CODE	L-T-P	CREDIT
NANOELECTRONICS	EI4183	3-0-0	3

Prerequisite: Quantum Physics for Nanostructures.

Course Outcomes:

At the end of the course, a student will be able to:

CO1: Analyze nanostructures and their applications in quantum electronic devices.
CO2: Apply the fundamentals of molecular electronics.
CO3: Investigate single-electron devices and carbon-based nanoelectronic devices.
CO4: Evaluate spintronics and the working principles of spin-based devices.

Module I: Introduction to Nanoelectronics **08 Hours**

Limitations of conventional MOSFETs at nanoscales, MOSFET scaling and implications, ballistic transport and quantum confinement, nanostructures and quantum electronic devices including quantum wells/wires/dots, density of states in low-dimensional structures, resonant tunneling phenomena and applications in diodes/transistors.

Module II: Molecular Electronics & Single-Electron Device **08 Hours**

Limitations of conventional MOSFETs at nanoscales, MOSFET scaling and implications, ballistic transport and quantum confinement, nanostructures and quantum electronic devices including quantum wells/wires/dots, density of states in low-dimensional structures, resonant tunneling phenomena and applications in diodes/transistors.

Module III: Carbon Nanoelectronics & Spintronics **07 Hours**

Carbon nanotubes (SWCNTs/MWCNTs), 1D quantization and van Hove singularities, CNT fabrication and CNT FET characteristics, graphene electronic structure and GNRFETs, spintronics fundamentals, spin diodes, and spin transistors.

Module IV: Current Nanoelectronic Devices **07 Hours**

Quantum effects in MOSFETs, strained silicon, fully depleted SOI-MOSFET, double-gate MOSFET, FinFET, ballistic transport, conductance quantization, and quantum point contact devices.

Total lecture hours: **30 Hours**

Text Book:

1. S. Oda and D. K. Ferry, Nanoscale Silicon Devices. Boca Raton, FL, USA: CRC Press, 2015.
2. K. Goser and P. Glösekötter, Nanoelectronics and Nanosystems. Berlin, Germany: Springer, 2005.
3. C. N. R. Rao and A. Govindaraj, Nanotubes and Nanowires. London, UK: RSC Publishing, 2005.
4. G. W. Hanson, Fundamentals of Nanoelectronics. Hoboken, NJ, USA: Wiley, 2008

Reference Book:

1. S. Datta, Lessons from Nanoelectronics. Singapore: World Scientific, 2015.
2. K. Goser et al., Nanoelectronics and Nanosystems. Berlin, Germany: Springer-Verlag, 2004.
3. S. Datta, Quantum Transport: From Atom to Transistor. Cambridge, UK: Cambridge Univ. Press, 2005.
4. M. Dragoman and D. Dragoman, Principles of Nanoelectronics. Berlin, Germany: Springer, 2009.

CO-PO-PSO MAPPING

NANOELECTRONICS															
Course outcome	**Program Outcomes**												**Program Specific Outcomes**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO l	PSO 2	PSO 3
CO1	3	2	2	2	1	0	0	0	0	0	0	0	2	2	0
CO2	3	2	2	2	1	0	0	0	0	0	0	0	2	3	0
CO3	3	3	2	2	2	0	0	0	0	0	0	0	3	3	1
CO4	3	3	3	2	2	0	0	0	0	0	0	0	3	3	1
Average	3.0	2.5	2.25	2.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	2.75	0.5
Level of Correlation: 3 - High 2 - Medium 1 - Low															

SUBJECT NAME	SUBJECT CODE	L-T-P	CREDIT
NEXT-GEN COMMUNICATION	EI4185	3-0-0	3

Prerequisite: Communication Systems and Wireless Networks

Course Outcomes:

At the end of the course, a student will be able to:

- **CO1:** Analyse the foundational concepts and emerging trends in next-generation communication technologies including 5G, IoT, edge computing, and AI-based communication systems.
- **CO2:** Apply principles of 5G, IoT, cloud/fog computing, and AI to design, implement, and optimize modern communication networks and services.
- **CO3:** Analyse the technical challenges, security, privacy, and performance aspects of next-generation communication architectures and propose effective solutions.
- **CO4:** Evaluate the societal, ethical, and economic impacts of next-generation communication technologies and their applications in various industries.

Module I: Introduction to Next-Gen Communication — 04 Hours

Overview of next-generation communication systems Evolution of communication technologies Key drivers and challenges in next-gen communication Applications and use cases of next-gen communication Future trends and expectations in next-gen communication

Module II: 5G and Beyond — 08 Hours

Introduction to 5G and its key features 5G architecture and network components 5G radio access technologies (NR, mmWave, Massive MIMO) 5G core network and services (SDN, NFV, network slicing) 5G deployment scenarios and use cases (eMBB, URLLC, mMTC) Emerging technologies for beyond 5G (6G, terahertz communication, quantum communication)

Module III: Internet of Things (IoT) Communication — 08 Hours

Introduction to IoT and its communication requirements IoT communication protocols (LPWAN, Zigbee, LoRaWAN, etc.) IoT communication architectures and network topologies IoT applications and use cases (smart cities, industrial IoT, healthcare, etc.) IoT security and privacy considerations Emerging trends in IoT communication (5G-IoT integration, edge computing, AIoT)

Module IV: Artificial Intelligence (AI) in Communication — 08 Hours

Introduction to AI and its applications in communication Machine learning and deep learning techniques for communication AI-driven communication network management and optimization AI-enabled communication services (speech recognition, natural language processing, etc.) AI for network security, resource allocation, and quality of service (QoS) Ethical, legal, and social implications of AI in communication

Total lecture hours: 30 Hours

Text Book:

1. "5G NR: The Next Generation Wireless Access Technology" by Erik Dahlman, Stefan Parkvall, and Johan Skold
2. "Internet of Things: Principles and Paradigms" by RajkumarBuyya, Amir VahidDastjerdi, and Siddhartha Misra
3. "Cloud Computing: Concepts, Technology & Architecture" by Thomas Erl, Ricardo Puttini, and Zaigham Mahmood
4. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig "Quantum Communication, Computing, and Measurement" by Prem Kumar, GerdLeuchs, and Thomas Scheidler

Reference Book:

1. Fundamentals of 5G Mobile Networks by Jonathan Rodriguez
2. Internet of Things: A Hands-On Approach by ArshdeepBahga and Vijay Madisetti

3. Fog and Edge Computing: Principles and Paradigms edited by RajkumarBuyya and Satish Narayana Srirama
4. Machine Learning and AI for Communications by F. Perez-Cruz, G. Leus, and C. S. Hong

CO-PO-PSO MAPPING

NEXT-GEN COMMUNICATION															
Course outcome	**Program Outcomes**												**Program Specific Outcomes**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO l	PSO 2	PSO 3
CO1	3	2	2	1	1	1	1	1	1	1	1	1	3	2	2
CO2	3	3	3	2	2	3	2	2	1	1	1	1	3	3	3
CO3	3	3	3	2	2	3	2	2	1	1	1	1	3	2	2
CO4	2	2	1	3	3	1	1	1	2	3	3	3	2	1	1
Average	2.75	2.5	2.25	2	2	2	1.5	1.5	1.25	1.5	1.5	1.5	2.75	2	2
Level of Correlation: 3 - High 2 - Medium 1 – Low															

SUBJECT NAME	SUBJECT CODE	L-T-P	CREDIT
PATTERN RECOGNITION	EI4187	3-0-0	3

Prerequisite: Vector Spaces and Linear Algebra, Probability Theory, and Statistics.
Course Outcomes:
At the end of the course, a student will be able to:

- **CO1:** Analyze the fundamental concepts, mathematical foundations, and classification strategies in pattern recognition.
- **CO2:** Apply statistical and machine learning techniques for pattern classification and clustering.
- **CO3:** Analyze and implement feature selection and extraction methods for real-world datasets.
- **CO4:** Evaluate and compare modern pattern recognition algorithms using performance metrics and soft computing techniques.

Module I: Introduction and mathematical Preliminaries **06 Hours**
Introduction to pattern recognition: definition, applications, goals; types of problems: supervised, unsupervised, semi-supervised; mathematical foundations including linear algebra (vectors, matrices, rank, eigenvalues, eigenvectors), vector spaces, orthogonality, SVD; review of probability and Bayes theorem; classification vs. clustering; Bayesian decision theory.

Module II: Pattern Recognition basics **08 Hours**
Bayesian decision theory, Classifiers, Discriminant functions, Decision surfaces, Parameter estimation methods, Hidden Markov models, dimension reduction methods, Fisher discriminant analysis, Principal component analysis, non-parametric techniques for density estimation, non-metric methods for pattern classification, unsupervised learning, algorithms for clustering: K-means, Hierarchical and other methods

Module III: Feature Selection and extraction **08 Hours**
Problem statement and uses, Branch and bound algorithm, Sequential forward and backward selection, Cauchy Schwartz inequality, Feature selection criteria function: Probabilistic separability based and Interclass distance based, Feature Extraction: principles

Module IV: Recent advancements in Pattern Recognition **08 Hours**
Classifier comparison: accuracy, precision, recall, ROC curves; covariance, correlation, and statistical significance; data condensation and feature clustering; data visualization techniques: t-SNE, PCA plots; probability density estimation; soft computing techniques: fuzzy C-means (FCM), genetic algorithms, neuro-fuzzy models; case studies: handwriting recognition, face recognition, biomedical data classification.

Total lecture hours: **30 Hours**

Text Book:

1. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
2. Richard O. Duda, Peter E. Hart, David G. Stork, Pattern Classification, Wiley, 2nd Ed., 2001.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer, 2009.
4. SergiosTheodoridis, Introduction to Pattern Recognition: A MATLAB Approach, Academic Press, 2010.

Reference Book:

1. K. Fukunaga, Statistical Pattern Recognition, Academic Press, 2000.
2. S. Theodoridis and K. Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009.
3. Earl Gose, Richard Johnsonbaugh, Steve Jost, Pattern Recognition and Image Analysis, Prentice Hall.
4. Milan Sonka, Vaclav Hlavac, Roger Boyle, Image Processing, Analysis, and Machine Vision, Cengage Learning.

CO-PO-PSO MAPPING

PATTERN RECOGNITION															
Course outcome	**Program Outcomes**												**Program Specific Outcomes**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO l	PSO 2	PSO 3
CO1	3	3	2	2	2	0	0	0	1	1	0	1	3	2	0
CO2	3	3	3	2	3	0	0	0	1	1	1	2	3	3	1
CO3	2	3	2	2	2	0	0	0	1	1	0	1	3	2	0
CO4	3	3	3	3	3	0	0	0	1	2	0	2	3	3	1
Average	2.75	3	2.5	2.25	2.5	0	0	0	1	1.25	0.25	1.5	3	2.5	0.5
Level of Correlation: 3 - High 2 - Medium 1 – Low															

SUBJECT NAME	SUBJECT CODE	L-T-P	CREDIT
INTRODUCTION TO QUANTUM COMPUTING	EI4189	3-0-0	3

Prerequisite: Basic knowledge of Linear Algebra, Probability Theory, and introductory concepts of Classical Computing.

Course Outcomes:

At the end of the course, a student will be able to:

CO1: Apply the fundamental concepts of quantum mechanics to quantum computing.

CO2: Analyze quantum entanglement, Bell inequalities, and protocols like superdense coding and teleportation.

CO3: Implement basic quantum algorithms and cryptographic techniques.

CO4: Simulate quantum computations using quantum programming environments such as IBM Q.

Module I: Introduction to Quantum Mechanics and Linear Algebra 04 Hours

Basics of quantum mechanics, linear algebra for quantum computing, quantum states in Hilbert space, Bloch sphere, density operators, generalized measurements, and no-cloning theorem.

Module II: Quantum correlations 08 Hours

Bell inequalities, quantum entanglement, Schmidt decomposition, superdense coding, and quantum teleportation.

Module III: Quantumcryptography, gates and algorithms 08 Hours

Quantum key distribution, universal set of quantum gates, quantum circuits, Solovay-Kitaev theorem, Deutsch-Jozsa algorithm, and introduction to quantum factoring.

Module IV: Programming a quantum computer 10 Hours

IBM Q platform, Qiskit programming, simulation of quantum gates and circuits, quantum measurement, state visualization, and analysis.

Total lecture hours: 30 Hours

Text Book:

1. P. Kaye, R. Laflamme, and M. Mosca, An Introduction to Quantum Computing. Oxford, U.K.: Oxford Univ. Press, 2007.
2. C. Bernhardt, Quantum Computing for Everyone. Cambridge, MA, USA: MIT Press, 2020.
3. D. McMahon, Quantum Computing Explained. Hoboken, NJ, USA: Wiley-Interscience, IEEE Press, 2008.

Reference Book:

1. M. A. Nielsen and I. L. Chuang, Quantum Computation and Quantum Information. Cambridge, U.K.: Cambridge Univ. Press, 2013.
2. E. G. Rieffel and W. H. Polak, Quantum Computing: A Gentle Introduction. Cambridge, MA, USA: MIT Press, 2014.

CO-PO-PSO MAPPING

INTRODUCTION TO QUANTUM COMPUTING															
Course outcome	**Program Outcomes**												**Program Specific Outcomes**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO l	PSO 2	PSO 3
CO1	3	2	2	1	1	0	0	0	0	1	0	1	3	2	0
CO2	2	3	2	1	1	0	0	0	1	1	0	1	3	3	0
CO3	2	3	3	2	2	0	0	0	1	1	0	1	3	3	0
CO4	2	2	3	2	3	0	0	0	2	1	0	1	3	3	1
Average	2.25	2.5	2.5	1.5	1.75	0	0	0	1.0	1.0	0	1.0	3.0	2.75	0.25
Level of Correlation: 3 - High 2 - Medium 1 – Low															

SUBJECT NAME	SUBJECT CODE	L-T-P	CREDIT
AI AND ML FOR VLSI CAD	EI4191	3-0-0	3

Prerequisite: Basics of electronic circuits and devices.

Course Outcomes:

At the end of the course, a student will be able to:

- **CO1:** Apply the fundamental principles of Artificial Intelligence and Machine Learning.
- **CO2:** Design AI and ML algorithms to automate and optimize various aspects of the VLSI CAD process.
- **CO3:** Apply Machine Learning to enhance design rule checking processes, identifying violations and suggesting design fixes.
- **CO4:** Implement AI/ML techniques for automated layout generation.

Module I: **08 Hours**

Overview of AI and ML applications in VLSI CAD, Basics of supervised and unsupervised learning, Introduction to neural networks and decision trees

Application of AI for pattern recognition in IC design, Feature extraction and classification techniques, Case studies on pattern recognition in layout design

Module II: **08 Hours**

Optimization algorithms in VLSI design- Genetic algorithms, simulated annealing, and particle swarm optimization, Application of ML for automatic optimization in CAD tools

Module III: **08 Hours**

Design Rule Checking with ML- Enhancing design rule checking using Machine Learning, Classification and regression models for DRC, Case studies on DRC optimization with ML

Module IV: **06 Hours**

Automated Layout Generation- AI/ML techniques for automated layout generation, Considerations for area, power, and signal integrity in layout design, Case studies on automated layout generation

Total lecture hours: **30 Hours**

Text Book:

1. Kumar, Abhishek. Machine Learning Techniques for VLSI Chip Design. John Wiley & Sons, 2023.

Reference Book:

1. Joobbani, R. An Artificial Intelligence Approach to VLSI Routing. Springer Science & Business Media, 2012.

CO-PO-PSO MAPPING

AI AND ML FOR VLSI CAD															
Course outcome	**Program Outcomes**												**Program Specific Outcomes**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO l	PSO 2	PSO 3
CO1	3	3	3	3	1	1	1	1	1	1	-	1	3	3	3
CO2	3	3	3	3	1	1	1	1	1	1	-	1	3	3	3
CO3	3	3	3	3	2	1	1	1	1	1	-	1	3	3	3
CO4	3	3	3	3	1	1	1	1	1	1	-	1	3	3	3
Average	3.0	3.0	3.0	3.0	1.3	1.0	1.0	1.0	1.0	1.0	0.0	1.0	3.0	3.0	3.0
Level of Correlation: 3 - High 2 - Medium 1 – Low															

SUBJECT NAME	SUBJECT CODE	L-T-P	CREDIT
ADVANCED WIRELESS COMMUNICATION SYSTEM	**EI4493**	**3-0-0**	**3**

Prerequisite: Analog and Digital Communication

Course Outcomes:

At the end of the course, a student will be able to:

- **CO1:** Demonstrate a deep understanding of modern wireless communication channel models and their statistical behavior.
- **CO2:** Analyze advanced modulation and coding techniques for wireless systems.
- **CO3:** Design and evaluate MIMO systems and multi-carrier modulation schemes.
- **CO4:** Investigate current and emerging technologies in advanced wireless networks like 5G and beyond.

Module I: **04 Hours**

Wireless Channel Characteristics: Path loss, Shadowing, Fading Small-Scale and Large-Scale Fading Channel Impulse Response and Delay Spread Doppler Spread and Coherence Time Statistical Channel Models: Rayleigh, Rician, Nakagami Time and Frequency Selectivity

Module II: **08 Hours**

Adaptive Modulation Schemes (QAM, QPSK, OFDM variants) Spread Spectrum and Multicarrier Modulation Error Control Coding: Turbo Codes LDPC Codes Bit-Interleaved Coded Modulation (BICM) Channel Capacity and Information Theory Concepts

Module III: **08 Hours**

MIMO Fundamentals and Channel Capacity Spatial Diversity and Spatial Multiplexing MIMO Detection Techniques: ZF, MMSE, SIC OFDM Principle and Implementation Peak-to-Average Power Ratio (PAPR) and Mitigation MIMO-OFDM Integration in LTE/5G

Module IV: **08 Hours**

Overview of 5G Architecture and Use Cases Millimeter-Wave Communication and Beamforming Massive MIMO and Hybrid Beamforming Non-Orthogonal Multiple Access (NOMA) Intelligent Reflecting Surfaces (IRS) 6G Visions: Terahertz, Cell-Free MIMO, AI for Wireless

Total lecture hours: **30 Hours**

Text Book:

1. Tse, D., &Viswanath, P. (2005). Fundamentals of Wireless Communication. Cambridge University Press.
2. Rappaport, T. S. (2002). Wireless Communications: Principles and Practice (2nd ed.). Pearson Education.
3. Goldsmith, A. (2005). Wireless Communications. Cambridge University Press.

Reference Book:

1. MIMO-OFDM Wireless Communications with MATLAB by Yong Soo Cho et al., Wiley.
2. Wireless Communications by Andrea Goldsmith, Cambridge University Press.
3. 5G NR: The Next Generation Wireless Access Technology by Erik Dahlman, Stefan Parkvall, and Johan Skold, Academic Press.
4. Principles of Communication Systems Simulation with Wireless Applications by William H. Tranter et al., Pearson.

CO-PO-PSO MAPPING

ADVANCED WIRELESS COMMUNICATION SYSTEM															
Course outcome	**Program Outcomes**												**Program Specific Outcomes**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO l	PSO 2	PSO 3
CO1	3	3	2	2	2	1	-	-	-	1	-	2	3	2	1
CO2	3	3	3	2	3	-	-	-	-	1	-	2	3	3	2
CO3	3	3	3	3	3	-	-	-	1	2	1	3	3	3	2
CO4	3	2	3	2	3	1	1	2	2	2	2	3	3	3	3
Average	3	2.75	2.75	2.25	2.75	1	1	2	1.5	1.5	1.5	2.5	3	2.75	2
Level of Correlation: 3 - High 2 - Medium 1 – Low															

SUBJECT NAME	SUBJECT CODE	L-T-P	CREDIT
AI AND ML FOR VLSI CAD LAB	**EI4583**	**0-0-3**	**1.5**

Prerequisite: Basic Programming Skills

Course Outcomes:

At the end of the course, a student will be able to:

CO1: Apply basic machine learning techniques to digital logic and circuit datasets.
CO2: Analyze standard cell characteristics using regression models for power and delay estimation.
CO3: Implement classification algorithms to distinguish different types of logic or standard cells.
CO4: Develop simple models for chip layout.

List of Experiments: (At least 10 experiments should be done)

EXP 1 : Simulate basic gates (AND, OR, NOT) using Python functions.
EXP 2 : Use ML to classify gates based on input-output patterns.
EXP 3 : Predict delay and power of standard cells using ML regression models.
EXP 4 : Use decision trees or random forests to predict skew or delay in clock trees.
EXP 5 : Predict routing congestion in GDS layouts using convolutional neural networks.
EXP 6 : Simulate process variations and predict chip yield using ML models.
EXP 7 : Use a genetic algorithm to find optimal gate sizes for minimal power.
EXP 8 : Convert a netlist into a graph and apply GNNs for property prediction (e.g., critical path).
EXP 9 : Train an SVR model to estimate power consumption from RTL-level metrics.
EXP 10 : Use k-means or autoencoders to detect anomalies/defects in chip layouts.
EXP 11 : Use reinforcement learning to place cells optimally on a chip layout.
EXP 12 : Group similar netlists using K-means clustering.
EXP 13 : Use SVM to classify standard cells based on area, power, and delay.
EXP 14 : Generate input-output data from a Verilog module for ML training.
EXP 15 : Predict whether a region of the chip will have congestion.

Text Book:

1. Chiplunkar, Niranjan N., Kotari, Manjunath, VLSI CAD, PHI Learning, 2011
2. AurélienGéron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow– , Shroff/O'Reilly; Third edition. 2022

Reference Book:

1. Tom M. Mitchell, Machine Learning, McGraw Hill Education; First Edition, 2017

CO-PO-PSO MAPPING

AI AND ML FOR VLSI CAD LAB															
Course outcome	**Program Outcomes**												**Program Specific Outcomes**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO l	PSO 2	PSO 3
CO1	3	3	3	3	3	1	1	1	3	3	1	1	3	3	3
CO2	3	3	3	3	3	2	2	1	3	3	1	1	3	3	3
CO3	3	3	3	3	3	3	2	2	3	3	2	2	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3.0	3.0	3.0	3.0	3.0	2.3	2.0	1.8	3.0	3.0	1.8	1.8	3.0	3.0	3.0
Level of Correlation: 3 - High 2 - Medium 1 - Low															

SUBJECT NAME	SUBJECT CODE	L-T-P	CREDIT
ADVANCED WIRELESS COMMUNICATION LAB	**EI4585**	**0-0-3**	**1.5**

Prerequisite: Analog and Digital Communication, Antenna and Wave Propagation, Digital Signal Processing

Course Outcomes:

At the end of the course, a student will be able to:

- **CO1:** Characterize wireless communication systems, cellular architecture, and fading environments.
- **CO2:** Evaluate performance metrics of wireless systems using simulation and hardware-based tools.
- **CO3:** Design and validate RF front-end components, transmission lines, and antenna systems in a wireless environment.
- **CO4:** Implement and test modulation/demodulation techniques, access schemes, and diversity methods using tools like MATLAB, Python, or SDR platforms.

LIST OF EXPERIMENTS (ANY 10)

EXP 1 : Study of wireless communication system components and test setup
EXP 2 : Measurement and analysis of path loss using a wireless trainer kit
EXP 3 : Simulation of Rayleigh and Rician fading channels; compare signal fluctuations
EXP 4 : Measurement of Signal-to-Noise Ratio (SNR) in wireless links
EXP 5 : Frequency reuse concept in cellular networks using MATLAB
EXP 6 : Study of multiple access techniques (TDMA, FDMA, CDMA)
EXP 7 : Channel estimation and equalization techniques using MATLAB
EXP 8 : Study of fading channels and diversity schemes (SISO, SIMO, MIMO)
EXP 9 : Simulation of Massive MIMO System performance
EXP 10 : MIMO Channel Modeling and Capacity Analysis
EXP 11 : OFDM system simulation and PAPR reduction techniques
EXP 12 : Simulation of OFDM-based communication system
EXP 13 : Study and simulation of spread spectrum techniques (DSSS, FHSS)
EXP 14 : Introduction to SDR and implementation of basic wireless functions
EXP 15 : Bit Error Rate (BER) performance analysis in noisy wireless channels
EXP 16 : Mini-project:

Text Book:

1. T.S. Rappaport, Wireless Communications: Principles and Practice, Pearson Education
2. William C.Y. Lee, Mobile Cellular Telecommunications: Analog and Digital Systems, McGraw Hill
3. Andrea Goldsmith, Wireless Communications, Cambridge University Press
4. Simon Haykin& Michael Moher, Modern Wireless Communications, Pearson

Reference Book:

1. David Tse and PramodViswanath, Fundamentals of Wireless Communication, Cambridge University Press
2. Theodore S. Rappaport, Principles of Communication Systems Simulation with Wireless Applications, Prentice Hall
3. B. P. Lathi and Zhi Ding, Modern Digital and Analog Communication Systems, Oxford University Press
4. Agrawal D.C., Wireless Communication, Wheeler Publishing

CO-PO-PSO MAPPING

ADVANCED WIRELESS COMMUNICATION LAB															
Course outcome	**Program Outcomes**												**Program Specific Outcomes**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO l	PSO 2	PSO 3
CO1	3	2	2	1	2	1	-	-	-	-	-	-	3	2	-
CO2	3	3	3	2	3	2	-	-	-	-	-	-	3	3	-
CO3	3	3	3	3	3	2	-	-	-	-	-	1	3	3	-
CO4	3	3	3	3	3	2	-	-	-	-	-	1	3	3	-
Average	3.0	2.75	2.75	2.25	2.75	1.75	-	-	-	-	-	0.5	3.0	2.75	-
Level of Correlation: 3 - High 2 - Medium 1 - Low															

SUBJECT NAME	SUBJECT CODE	L-T-P	CREDIT
ADVANCED DIGITAL SIGNAL PROCESSING	EI4186	3-0-0	3

Prerequisite: Signals and Systems, Digital Signal Processing, Linear Algebra, Probability and Random Processes, Mathematics for Engineers.

Course Outcomes:

At the end of the course, a student will be able to:

- **CO1:** Analyze FIR/IIR filters via windowed, impulse-invariance, bilinear, lattice, and all-pass structures, considering stability and response.
- **CO2:** Implement decimation, interpolation, and rational sampling-rate conversion systems, including multistage and filter-bank architectures, optimizing efficiency.
- **CO3:** Develop adaptive FIR and lattice-ladder filters using LMS and RLS algorithms for noise cancellation, system identification, and signal prediction.
- **CO4:** Estimate autocorrelation and power spectra from finite data via periodograms, DFT, and nonparametric/parametric methods for signal characterization.

Module I: **06 Hours**

Overview of DSP, Characterization in time and frequency, FFT Algorithms, Digital filter design and structures: Basic FIR/IIR filter design &structures, design techniques of linear phase FIR filters, IIR filters by impulse invariance, bilinear transformation, FIR/IIR Cascaded lattice structures, and Parallel all pass realization of IIR

Module II: **08 Hours**

Introduction, Decimation by a Factor D, Interpolation by a Factor I, Sampling Rate Conversion by a Rational Factor I/D, Implementation of Sampling Rate Conversion: Multistage Implementation of Sampling Rate Conversion, Sampling Rate Conversion of Band-pass Signals, Sampling Rate Conversion by an Arbitrary Factor: Applications of Multirate Signal Processing, Digital Filter Banks.

Module III: **08 Hours**

Applications of Adaptive Filters, Adaptive Direct–form FIR filters, The LMS Algorithm, The Recursive Least Square algorithm, Adaptive Lattice Ladder filters.

Module IV: **08Hours**

Estimation of Spectra from Finite-Duration Observations of Signals, Computation of the Energy Density Spectrum, Estimation of the Autocorrelation and Power Spectrum of Random Signals: The Period gram, The Use of the DFT in Power Spectrum Estimation, Nonparametric Methods for Power Spectrum Estimation: Parametric Methods for Power Spectrum Estimation.

Total lecture hours: **30 Hours**

Text Book:

1 J.G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Pearson Education, 2005.
2. S.K. Mitra, Digital Signal Processing: A Computer-Based Approach, McGraw Hill Education (India), 2013, 4th Edition.
3. S. Haykin and T. Kailath, Adaptive Filter Theory, Pearson Education, 2005, 4th Edition.

Reference Book:

1. Nagoorkani, Digital Signal Processing, Tata McGraw-Hill Education
2. A.V. Oppenheim, R.W. Schafer, Digital Signal Processing, Pearson Education, 2004.
3. S. Haykin, Adaptive Filter Theory, Pearson Education, 2002.

CO-PO-PSO MAPPING

ADVANCED DIGITAL SIGNAL PROCESSING															
Course outcome	**Program Outcomes**											**Program Specific Outcomes**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO l	PSO 2	PSO 3
CO1	3	2	3	2	3	–	–	–	–	–	–	2	3	2	1
CO2	3	2	3	1	3	–	–	–	–	–	–	2	3	3	1
CO3	3	2	3	2	3	–	–	–	–	–	–	2	3	3	1
CO4	3	3	2	2	2	–	–	–	–	–	–	2	3	2	1
Average	3	2.3	2.8	1.8	2.8	–	–	–	–	–	–	2	3	2.5	1
Level of Correlation: 3 - High 2 - Medium 1 – Low															

SUBJECT NAME	SUBJECT CODE	L-T-P	CREDIT
AI IN HEALTH CARE	EI4188	3-0-0	3

Prerequisite: NIL

Course Outcomes:

At the end of the course, a student will be able to:

- **CO1:** Demonstrate core AI techniques to healthcare scenarios.
- **CO2:** Apply AI and ML models for analyzing medical data.
- **CO3:** Evaluate ethical, legal, and societal implications of AI in healthcare.
- **CO4:** Design innovative, AI-driven healthcare solutions integrating knowledge from data science and biomedical systems.

Module I: Introduction to AI in Health Care — 08 Hours

Overview of health care industry and its challenges Introduction to artificial intelligence (AI) and machine learning (ML) in health care Ethical, legal, and social implications of AI in health care Use cases and applications of AI in health care, such as diagnostics, personalized medicine, telemedicine, etc. Current state and future prospects of AI in health care

Module II: Data Science and Analytics in Health Care — 08 Hours

Basics of health care data and its characteristics (structured, unstructured, big data, etc.) Data collection, pre-processing, and management in health care Statistical analysis and visualization of health care data Machine learning techniques for health care data analysis, such as classification, regression, clustering, etc. Feature selection and feature engineering for health care data Evaluation and validation of AI models in health care

Module III: Applications of AI in Health Care — 08 Hours

Medical image analysis using AI, including computer-aided diagnosis (CAD), radiomics, etc. Natural language processing (NLP) for health care, including clinical documentation, electronic health records (EHRs), etc. Predictive modelling and risk stratification for diseases and conditions Personalized medicine and treatment recommendation using AI Health care monitoring and wearables, including remote patient monitoring (RPM), Internet of Things (IoT) devices, etc. AI-powered decision support systems for health care providers

Module IV: Ethics, Privacy, Challenges in AI Health Care — 6 Hours

Ethical considerations in AI in health care, including fairness, bias, interpretability, etc. Privacy and security challenges in health care data and AI models Regulatory frameworks. Challenges and limitations of AI in health care, including data quality, interoperability, clinical adoption, etc. Future prospects and impact of AI on health care delivery, outcomes, and patient experience Opportunities for innovation and entrepreneurship in AI health care Case studies and real-world examples of successful AI implementations in health care.

Total lecture hours: 30 Hours

Text Book:

1. A. K. Aggarwal, A. Samuels, and D. V. Samuels, Artificial Intelligence in Health Care: Anticipating Challenges, Ethics, and Governance.
2. J. D. Kelleher, B. Mac Namee, and A. D'Arcy, Machine Learning for Healthcare: Techniques, Tools, and Applications.
3. A. Chang, AI in Healthcare: Building a Safer, Smarter, and Healthier Future.

Reference Book:

1. E. Topol, Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again. New York, NY, USA: Basic Books, 2019.
2. J. Heaton, Artificial Intelligence for Humans, Volume 1: Fundamental Algorithms. St. Louis, MO, USA: Heaton Research, Inc., 2013.

CO-PO-PSO MAPPING

AI IN HEALTH CARE															
Course outcome	**Program Outcomes**												**Program Specific Outcomes**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO l	PSO 2	PSO 3
CO1	3	2	2	2	3	2	-	1	-	-	-	-	3	2	1
CO2	3	3	3	3	3	-	-	2	1	-	-	-	3	3	2
CO3	2	2	2	1	2	3	3	3	2	2	2	2	2	2	2
CO4	3	3	3	3	3	2	1	2	2	2	1	3	3	3	2
Average	2.75	2.5	2.5	2.25	2.75	2.33	1.33	2	1.25	1.33	1	2.5	2.75	2.5	1.75
Level of Correlation: 3 - High 2 - Medium 1 – Low															

SUBJECT NAME	SUBJECT CODE	L-T-P	CREDIT
ADVANCED EMBEDDED PROCESSOR ARCHITECTURES	EI4190	3-0-0	3

Prerequisite: ARM Processor as System-on-Chip

Course Outcomes:

At the end of the course, a student will be able to:

- **CO1:** Apply the concept of pipeline to analyze ARM processor architecture.
- **CO2:** Apply ARM instruction sets and assembly programming for embedded solutions.
- **CO3:** Evaluate architectural support for system development and debugging.
- **CO4:** Analyze ARM processor cores and their applications.

Module I: **8 Hours**

ARM Processor as System-on-Chip: Acorn RISC Machine – Architecture inheritance – ARM programming model – ARM development tools – 3 and 5 stage pipeline ARM organization – ARM instruction execution and implementation – ARM Co-processor interface.

Module II: **7 Hours**

ARM Assembly Language Programming: ARM instruction types – data transfer, data processing and control flow instructions – ARM instruction set – Co-processor instructions, Thumb Instruction set.

Module III: **8 Hours**

Architectural Support for System Development: Advanced Microcontroller bus architecture – ARM memory interface – ARM reference peripheral specification – Hardware system prototyping tools – ARMulator – Debug architecture.

Module IV: **7 Hours**

ARM Processor Cores: ARM7TDMI, ARM8, ARM9TDMI, ARM10TDMI, The AMULET Asynchronous ARM Processors-AMULET1. Embedded ARM Applications: The VLSI Ruby II Advanced Communication Processor, The VLSI ISDN Subscriber Processor, The OneCTM VWS22100 GSM chip, The Ericssion-VLSI Bluetooth Baseband Controller, The ARM7500 and ARM7500FE.

Total lecture hours: **30 Hours**

Text Book:

1. ARM System on Chip Architecture – Steve Furber – 2nd ed., 2000, Addison Wesley Professional.
2. Design of System on a Chip: Devices and Components – Ricardo Reis, 1st ed., 2004, Springer.
3. ARM Architecture Reference Manual – David Seal, Addison-Wesley, 2001.

Reference Book:

1. Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology) – Jason Andrews – Newnes, BK and CDROM.
2. System on Chip Verification – Methodologies and Techniques – Prakash Rashinkar, Peter Paterson and Leena Singh L, 2001, Kluwer Academic Publishers.
3. The Designer’s Guide to the Cortex-M Processor Family – Trevor Martin, Newnes, 2013.

CO-PO-PSO MAPPING

ADVANCED EMBEDDED PROCESSOR ARCHITECTURES															
Course outcome	**Program Outcomes**												**Program Specific Outcomes**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO l	PSO 2	PSO 3
CO1	3	2	2	1	1	1	1	1	1	1	-	1	3	3	3
CO2	3	3	3	3	2	1	1	1	1	1	-	1	3	3	3
CO3	3	2	3	2	2	1	1	1	1	1	-	1	3	3	3
CO4	3	2	3	2	3	1	1	1	1	1	-	1	3	3	3
Average	3	2.25	2.75	2	2	1	1	1	1	1	0	1	3	3	3
Level of Correlation: 3 - High 2 - Medium 1 - Low															

SUBJECT NAME	SUBJECT CODE	L-T-P	CREDIT
ARTIFICIAL INTELLIGENCE AND ITS APPLICATIONS LAB	**EI3584**	**0-0-3**	**1.5**

Prerequisite: Fundamental of Artificial Intelligence

Course Outcomes:

At the end of the course, a student will be able to:

- **CO1:** Understand the fundamental principles and recent advancements in next-generation communication technologies such as 5G, 6G, IoT, and edge computing.
- **CO2:** Explore and analyze the role of Artificial Intelligence and Machine Learning in optimizing wireless communication systems and network management.
- **CO3:** Design and develop a prototype or simulation-based solution that integrates AI techniques with a chosen next-gen communication application.
- **CO4:** Effectively communicate technical ideas, project findings, and implementation challenges through documentation and presentations.

LIST OF EXPERIMENTS (ANY 10)

Mini-project on recent trends in Next-Gen communication with the application of AI

CO-PO-PSO MAPPING

ARTIFICIAL INTELLIGENCE AND ITS APPLICATIONS LAB															
Course outcome	**Program Outcomes**												**Program Specific Outcomes**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	–	2	–	–	–	–	–	–	1	3	2	–
CO2	3	3	2	2	3	–	–	–	–	–	–	2	3	3	2
CO3	2	3	2	3	3	–	–	–	–	–	–	2	3	3	2
CO4	–	–	–	–	2	1	–	2	3	3	2	1	2	–	–
Average	2.0	2.0	1.25	1.25	2.5	0.25	0	0.5	0.75	0.75	0.5	1.5	2.75	2.0	1.0
Level of Correlation:				3 - High			2 - Medium			1 - Low					