VARDHAMAN
COLLEGE OF ENGINEERING

CURRICULUM
For
Master of Technology
Digital Electronics and Communication Systems

Under

Choice Based Credit System (CBCS)

M. Tech. - Regular Two-Year Degree Program
(For batches admitted from the Academic Year 2025 - 2026)

August 2025

VARDHAMAN COLLEGE OF ENGINEERING
(Autonomous)
Affiliated to **JNTUH,** Approved by **AICTE,** Accredited by **NAAC** with **A++** Grade
Kacharam, Shamshabad, Hyderabad- 501 218, Telangana, India
www.vardhaman.org, info@vardhaman.org

Department Vision

To produce competent engineers with social responsibility to address the global challenges in the field of Electronics and Communication Engineering.

Department Mission

M1: Promote active learning strategies to facilitate student centric learning.

M2: Provide self learning capabilities to enhance employability and entrepreneurial skills.

M3: Inculcate human values and ethics to make learners sensitive towards societal issues.

M4: Strengthen core competencies among the learners through experiential curriculum.

Program Educational Objectives (PEOs)

PEO1: Graduates will continue perpetual learning to contribute new knowledge and apply innovatively in an appropriate context within the field of VLSI and Communication systems.

PEO2: Graduates will have the ability to identify potential problems to pursue research in multidisciplinary domains.

PEO3: Graduates will demonstrate their leadership qualities to address professional, ethical and societal issues.

Knowledge and Attitude Profile (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost,reuse of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

Program Outcomes (POs)

PO1: An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: An ability to demonstrate a high level of mastery and specialization in the field of Digital Electronics and Communication Systems.

PO4: An ability to conceptualize and design innovative electronic and communication systems by applying advanced theoretical and practical knowledge.

PO5: An ability to integrate hardware and software subsystems for developing optimized and reliable Digital and VLSI-based communication solutions.

United Nations Sustainable Development Goals (SDGs)

SDG1: **No Poverty** – End poverty in all its forms everywhere.

SDG2: **Zero Hunger** – End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

SDG3: **Good Health and Well-Being** – Ensure healthy lives and promote well-being for all at all ages.

SDG4: **Quality Education** – Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

SDG5: **Gender Equality** – Achieve gender equality and empower all women and girls.

SDG6: **Clean Water and Sanitation** – Ensure availability and sustainable management of water and sanitation for all.

SDG7: **Affordable and Clean Energy** – Ensure access to affordable, reliable, sustainable and modern energy for all.

SDG8: **Decent Work and Economic Growth** – Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

SDG9: **Industry, Innovation and Infrastructure** – Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

SDG10: **Reduced Inequalities** – Reduce inequality within and among countries.

SDG11: **Sustainable Cities and Communities** – Make cities and human settlements inclusive, safe, resilient and sustainable.

SDG12: **Responsible Consumption and Production** – Ensure sustainable consumption and production patterns.

SDG13: **Climate Action** – Take urgent action to combat climate change and its impacts.

SDG14: **Life Below Water** – Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

SDG15: **Life on Land** – Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

SDG16: Peace, Justice and Strong Institutions – Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.

SDG17: Partnerships for the Goals – Strengthen the means of implementation and revitalize the global partnership for sustainable development.

I M.Tech. I Semester												
#	Course Code	Title of the Course	Category	Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
				CI		LI	TW + SL	H	C	CIE	SEE	Total
				L	T	P	SL					
Theory Courses												
1	B7401	CMOS Digital IC Design	PC	45	-	-	45	90	3	40	60	100
2	B7402	Advanced Communications and Networks	PC	45	-	-	45	90	3	40	60	100
3	B7001	Research Methodology and IPR	MC	30	-	-	30	60	2	40	60	100
Professional Elective – I												
4	B7451	Low Power VLSI Design	PE	45	-	-	45	90	3	40	60	100
	B7452	Scripting Languages for Design Automation										
	B7453	Embedded Real Time Operating Systems										
	B7454	Advanced Computer Architectures										
Professional Elective – II												
5	B7455	Ad-hoc and Wireless Sensor Networks	PE	45	-	-	45	90	3	40	60	100
	B7456	Coding Theory and Techniques										
	B7457	Speech Signal Processing										
	B7458	Machine Learning and Deep Learning										
Practical Courses												
6	B7403	CMOS Digital IC Design Laboratory	PC	-	-	60	-	60	2	40	60	100
7	B7404	Advanced Communications and Networks Laboratory	PC	-	-	60	-	60	2	40	60	100
Audit Course												
8		Audit Course - I	AC	30	-	-	-	30	0	100	-	100
Total				240	0	120	210	570	18	380	420	800

I M.Tech. II Semester													
#	Course Code	Title of the Course	Category	Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
				CI		LI	TW + SL	H	C	CIE	SEE	Total
				L	T	P	SL					
Theory Courses												
1	B7405	FPGA based System Design	PC	45	-	-	45	90	3	40	60	100
2	B7406	Advanced Digital Signal Processing	PC	45	-	-	45	90	3	40	60	100
Professional Elective – III												
3	B7459	VLSI Functional Verification Methodologies	PE	45	-	-	45	90	3	40	60	100
	B7460	Physical Design Automation with AI										
	B7461	IoT Architectures and System Design										
	B7462	Machine Learning for Robotics										
Professional Elective – IV												
4	B7463	Wireless MIMO Communications	PE	45	-	-	45	90	3	40	60	100
	B7464	Cognitive Radio Networks										
	B7465	Multimedia Signal Processing										
	B7466	Computer Vision										
Practical Courses												
5	B7407	FPGA based System Design Laboratory	PC	-	-	60	-	60	2	40	60	100
6	B7408	Advanced Digital Signal Processing Laboratory	PC	-	-	60	-	60	2	40	60	100
Experiential Learning Course												
7	B7041	Mini-Project with seminar	PW	-	-	-	90	90	2	40	60	100
8		Dissertation Work Review - I	PW	-	-	-	-	-	-	-	-	-
Audit Course												
9		Audit Course - II	AC	30	-	-	-	30	0	100	-	100
Total				210	0	120	270	600	18	380	420	800

II M.Tech. I Semester													
#	Course Code	Title of the Course	Category	Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
				CI		LI	TW + SL	H	C	CIE	SEE	Total
				L	T	P	SL					
Professional Elective – V												
1	B7467	Design for Testability	PE	45	-	-	45	90	3	40	60	100
	B7468	Hardware Software Co-Design										
	B7469	Software Defined Radio										
	B7470	Optimization Techniques										
Open Elective												
2	B7081	Business Analytics	OE	45	-	-	45	90	3	40	60	100
	B7082	Waste to Energy										
	B7083	Operations Research										
	B7084	Blockchain Technology										
	B7085	Cyber Security										
Experiential Learning Course												
3	B7042	Dissertation Work Review – II	PW	-	-	-	270	270	6	100	-	100
Total				90	0	0	360	450	12	180	120	300

II M.Tech. II Semester													
#	Course Code	Title of the Course	Category	Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
				CI		LI	TW + SL	H	C	CIE	SEE	Total
				L	T	P	SL					
Experiential Learning Course												
1	B7043	Dissertation Work Review – III	PW	-	-	-	270	270	6	100	-	100
2	B7044	Dissertation Viva-Voce	PW	-	-	-	630	630	14	-	100	100
Total				0	0	0	900	900	20	100	100	200

List of Audit Courses

#	Course Code	Title of the Course
1	B7091	Disaster Management
2	B7092	Value Education
3	B7093	Constitution of India
4	B7094	Stress Management by Yoga
5	B7095	Pedagogy Studies
6	B7096	English for Research Paper Writing

Common Abbreviations Used in the Curriculum

PC	–	Professional Core	L	–	Lecture Hours
MC	–	Mandatory Course	T	–	Tutorial Hours
AC	–	Audit Course	P	–	Practical Hours
PE	–	Professional Elective	TW	–	Team Work
OE	–	Open Elective	SL	–	Self Learning
PW	–	Project Work	H	–	Hours
CI	–	Classroom Instruction	C	–	Credits
LI	–	Laboratory Instruction	CIE	–	Continuous Internal Evaluation
SDG	–	Sustainable Development Goals	SEE	–	Semester End Examination

I M.Tech. I Semester

B7401 – CMOS Digital IC Design

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course provides an in-depth understanding of the principles, methodologies, and tools used in the design of high-performance, low-power digital integrated circuits using CMOS technology. The course begins by introducing the fundamental quality metrics of digital design, including cost, functionality, robustness, and power. It delves into combinational logic circuit design using static and dynamic logic styles, including pass-transistor and transmission gate logic. It provides knowledge on sequential logic circuit design, timing concepts, and pipelining strategies. Students will also explore different implementation strategies, from full custom to semi-custom approaches, including the use of standard cells, compiled cells, and IP cores. The course concludes with a critical study of interconnect challenges in modern ICs, emphasizing parasitic effects and advanced techniques to mitigate delay, power, and signal integrity issues.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation, and Infrastructure
SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

B7401.1. Analyze the quality metrics of digital IC design and assess trade-offs in design decisions.

B7401.2. Develop combinational logic circuits using static and dynamic CMOS logic styles to meet design constraints.

B7401.3. Construct sequential logic circuits including latches, flip-flops, and pipelined registers, and assess their timing behavior.

B7401.4. Differentiate between custom, semi-custom, and array-based implementation strategies for digital ICs.

B7401.5. Analyze the impact of interconnect parasitics on circuit performance while employing advanced interconnect techniques to mitigate related issues.

Course Syllabus

Unit-I:

Quality Metrics of a Digital Design: Cost, Functionality, Robustness, Power, Energy Consumption, Wire: Interconnect Parameters, Electrical Wire Models. CMOS Inverter - Static CMOS inverter, Switching threshold and noise margin concepts, Dynamic behavior, Dynamic Power consumption, Static Consumption, Stick diagram, and Layout.

Unit-II:

Designing Combinational Logic Circuits in CMOS: Static CMOS Design- Complementary CMOS, Ratioed Logic, Pass-Transistor Logic, CMOS transmission gate logic, Dynamic CMOS Design- Basic Principles of

Dynamic Logic, Speed and Power Dissipation of Dynamic Logic, Issues in Dynamic Design, Cascading Dynamic Gates.

Unit-III:

Designing Sequential Logic Circuits: Static latches and registers, Bi-stability principle, MUX-based latches, Master-Slave edge-triggered register, Static SR flip-flops, Dynamic latches and registers, Alternative Register Styles, Concept of pipelining, Non-bistable sequential circuit. .

Unit-IV:

Implementation Strategies for Digital ICs: From Custom to Semicustom and Structured Array Design Approaches, Custom Circuit Design, Cell-Based Design Methodology- Standard Cell, Compiled Cells, Macro-cells, Megacells and Intellectual Property, Semi-Custom Design Flow, Array-Based Implementation Approaches- Pre-diffused (or Mask-Programmable) Arrays, Pre-wired Arrays.

Unit-V:

Coping with Interconnect: Introduction, Capacitive Parasitics, Resistive Parasitics, Inductive Parasitics, Advanced Interconnect Techniques, Reduced-Swing Circuits, Current-Mode Transmission Techniques.

Books and Materials

Text Books:

1. Rabaey, Jan M. *Digital Integrated Circuits: Design.* Pearson Education.
2. Kang, Sung-Mo, and Yusuf Leblebici. *CMOS Digital Integrated Circuits: Analysis and Design.* Tata McGraw-Hill, 2003.

Reference Books:

1. Weste, Neil H. E., and Kamran Eshraghian. *Principles of CMOS VLSI Design: A Systems Perspective.* McGraw-Hill, 2005.

B7402 – Advanced Communications and Networks

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course offers an in-depth study of wireless communication systems, beginning with spread spectrum techniques and their application in CDMA systems. It covers equalization and diversity methods to combat multipath fading, along with adaptive algorithms and RAKE receiver design. The course explores 4G technologies such as OFDM, MIMO, smart antennas, and software-defined radio. It also examines Bluetooth and ZigBee architectures, protocol stacks, and applications within WPANs. Further, it describes Wireless MAN standards like IEEE 802.16, mesh networking, cognitive radio, and LPWAN technologies such as Sigfox and LoRa, enabling students to analyze and design efficient wireless systems across different network scales.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education

SDG 9 – Industry, Innovation, and Infrastructure

SDG 11 – Sustainable Cities and Communities

Course Outcomes

After the completion of the course, the student will be able to:

B7402.1. Explain the principles of spread spectrum techniques and analyze their application in CDMA systems.

B7402.2. Apply equalization algorithms and diversity techniques to mitigate multipath effects in wireless communication..

B7402.3. Analyze the performance of 4G technologies including OFDM, MIMO, and adaptive modulation in real-time systems.

B7402.4. Analyze the architectures, protocol stacks, and application domains of Bluetooth and ZigBee in Wireless Personal Area Network (WPAN) scenarios.

B7402.5. Design a wireless MAN using IEEE 802.16, cognitive radio, or LPWAN technologies considering routing and roaming requirement.

Course Syllabus

Unit-I:

Spread Spectrum (SS) and CDMA Systems: Concept of Spread Spectrum, Requirements of Direct-Sequence Spread Spectrum, Frequency-Hopping Spread Spectrum Systems, Operational Advantages of SS Modulation, Coherent Binary Phase-Shift Keying DSSS, Quadrature Phase-Shift Keying DSSS, Requirements of Spreading Codes, Multipath Path Signal Propagation, Critical Challenges of CDMA.

Unit-II:

Equalization and Diversity: Fundamentals of Equalization, Equalizers in a Communications Receiver, Linear Equalizers, on Linear Equalization, Algorithms for Adaptive Equalization: Zero Forcing Algorithm, Least Mean Square Algorithm, Recursive Least Squares Algorithm, Diversity Techniques, Practical Space Diversity considerations, RAKE Receiver.

Unit-III:

Fourth Generation Systems and New Wireless Technologies: Introduction, 4G Features and Challenges, Applications of 4G, 4G Technologies: Multicarrier Modulation, Smart Antenna Techniques, OFDM-MIMO Systems, Adaptive Modulation and Coding with Time-Slot Scheduler. Bell Labs Layered Space Time (BLAST) System, Software-Defined Radio. .

Unit-IV:

Wireless Personal Area Network — Bluetooth: Introduction, The Wireless Personal Area Network. Bluetooth (IEEE 802.15.1), Bluetooth Protocol Stack, Bluetooth Link Types, Bluetooth Security, Bluetooth Usage Models, Bluetooth Applications. **ZigBee Technology:** ZigBee Components and Network Topologies, IEEE 802.15.4 LR-WPAN Device Architecture, Applications.

Unit-V:

Wireless MAN: Wireless MAN Standards, 802.16 Wireless MAN Standards, Metropolitan Area Mesh Networks, Implementing Wireless MANs, Wireless Mesh Network Routing, Network Independent Roaming, Gigabit Wireless LANs, Cognitive Radio, Sigfox / LoRa.

Books and Materials

Text Books:

1. Garg, Vijay. *Wireless Communications and Networking.* 1st ed., Elsevier, 2014.
2. Rappaport, Theodore S. *Wireless Communications: Principles and Practice.* 2nd ed., PHI Learning, 2002.

Reference Books:

1. Stallings, William. *Wireless Communications and Networking.* PHI Learning, 2003.

B7001 – Research Methodology and IPR

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
30	0	0	30	60	2	40	60	100

Course Description

Course Overview

Research is an art of scientific investigation. Research is an original contribution to the existing stock of knowledge making for its advancement. It is the pursuit of truth with the help of study, observation, comparison and experiment. This course will help students to understand about the research process, tools, importance of ethics. Students can learn about the law of patent and copyrights and knowledge on IPR (Intellectual Property rights).

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 16 – Peace, Justice and Strong Institutions

Course Outcomes

After the completion of the course, the student will be able to:

B7001.1. Identify an appropriate research problem in their suitable domain.
B7001.2. Construct a well-structured research paper and scientific presentations.
B7001.3. Express the importance of research ethics in scientific community.
B7001.4. Explore on various component of IPR and process of filing.
B7001.5. Gain knowledge on patents and copyrights.

Course Syllabus

Unit-I:

Research Problem: Scope and objectives, Selection criteria, Research Problems, Research Approaches, Data collection, Data analysis, Ethics, Instrumentation, Interpretation.

Unit-II:

Literature Studies: Effective literature studies, Types of literature review, Process and Purpose, Survey, Critical analysis, classification and comparison, case study, identifying the knowledge gap and propose a action plan.

Unit-III:

Technical Writing: Effective Report/Article/Thesis writing, tools required, documentation using suitable application (Word, LaTeX, Pages), data representation using graphs, bar diagrams, pi-charts, preparation of manuscript, plagiarism, presentation of research work, Abstract and Conclusion.

Unit-IV:

Research proposal: Problem defining, national and international Scenario of proposed research, key factors, cost and contingencies, preparing timeline for research plan, funding agencies, collaboration, product and patent development.

Unit-V:

Patent Rights and IPR: Process of Patenting and Development, Copyright, Trademark, Licensing and transfer of technology, Patent information and databases, New Developments in IPR, Administration of Patent System, Trade Secret, Copyright Infringement.

Books and Materials

Text Books:

1. C.R. Kothari, Gaurav Garg, Research Methodology : Methods And Techniques, New Age International Publishers; 4th edition, 2019
2. P Suganda Devi, Research Methodology: A Handbook for Beginners, Notion Press; 1st edition, 2017

Reference Books:

1. Brad Sherman and Lionel Bently, Intellectual Property Law, Oxford University Press, 4th edition, 2014

PROFESSIONAL ELECTIVE-I

B7451 – Low Power VLSI Design

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces various strategies and methodologies for designing low power circuit. It describes the many issues facing designers at architectural, logic, circuit and device levels and presents some of the techniques that have been proposed to overcome these difficulties. This course is a dynamic research area driven by battery–powered portable computing and wireless communications products. It has become critical to the continued progress of high performance and reliable microelectronic systems. The course addresses the concepts, principles and techniques to reduce the power in VLSI systems.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education

SDG 9 – Industry, Innovation, and Infrastructure

SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

B7451.1. Analyze the sources of power dissipation in MOSFET.

B7451.2. Examine the power estimation techniques using various approaches in low power circuit design.

B7451.3. Analyze the power optimization and trade-off techniques in digital circuits.

B7451.4. Develop low voltage CMOS circuits using low power design techniques.

B7451.5. Apply the advanced techniques to design low power VLSI circuits.

Course Syllabus

Unit-I:

Physics of Power Dissipation in CMOS: Introduction, sources of power dissipation, designing for low power. Physics of power dissipation in MOSFET devices-MIS structure, long channel and sub-micron MOSFET, Gate induced Drain leakage, Power dissipation in CMOS-Short circuit dissipation, dynamic dissipation, and load capacitance. Low Power VLSI Design Limits-Principles of Low power design, hierarchy of limits, fundamental limits, material, device, circuit and system limits.

Unit-II:

Power Estimation in CMOS Circuits: Modelling of signals, Signal Probability Calculation, Probabilistic Techniques for Signal Activity Estimation. Statistical Techniques- Estimating Average Power in Combinational and Sequential Circuits, Estimation of Glitching Power, Power Estimation using Input Vector Compaction

Unit-III:

Design of Low Power Circuits: Transistor and Gate Sizing, Sizing an Inverter Chain, Transistor and Gate Sizing for Dynamic Power Reduction, Transistor Sizing for Leakage Power Reduction- Network Restructuring

and Reorganization, Transistor Network Restructuring, Transistor Network Partitioning and Reorganization- Special Latches and Flip-flops: Self-gating Flip-flop, Combinational Flip-flop, Double Edge Triggered Flip-flop.

Unit-IV:

Design and Test of Low Voltage CMOS Circuits: Introduction, circuit design styles, leakage current in deep sub- micrometer transistors, device design issues, minimizing short channel effect, low voltage circuit design techniques using reverse Vgs, multiple threshold voltages, multiple supply voltages

Unit-V:

Special Techniques: Power Reduction in Clock Networks, CMOS Floating Node, Low Power Bus, Delay Balancing, Low Power Techniques for SRAM. Advanced Techniques- Adiabatic Computation, Pass Transistor Logic Synthesis, Asynchronous Circuits

Books and Materials

Text Books:

1. Roy, Kaushik, and Sharat C. Prasad. *Low-Power CMOS VLSI Circuit Design.* Wiley India, 2000.
2. Yeap, Gary. *Practical Low-Power Digital VLSI Design.* Springer Science & Business Media, 1998.

Reference Books:

1. Chandrakasan, Anantha P., and Robert W. Brodersen. *Low-Power CMOS Design.* IEEE Press, 1998.
2. Piguet, Christian. *Low-Power CMOS Circuits: Technology, Logic Design and CAD Tools.* CRC Press, Taylor & Francis, 2006.

B7452 – Scripting Languages for Design Automation

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course provides a comprehensive introduction to Linux operating system essentials, scripting languages, and automation tools widely used in system administration and software development. Students will gain hands-on experience with Linux commands, file system management, user permissions, and shell utilities. The course covers fundamental and advanced concepts of PERL, including data structures, file processing, and process management. Additionally, students will learn the basics of TCL/Tk for scripting and GUI development, focusing on control flow, string manipulations, and process handling. The course also introduces Python programming, emphasizing control structures, data handling, modular programming, exception handling, and core libraries. By the end of the course, students will be equipped to automate tasks, develop scripts, and manage system-level processes using these powerful scripting languages.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 8 – Decent Work and Economic Growth
SDG 9 – Industry, Innovation, and Infrastructure

Course Outcomes

After the completion of the course, the student will be able to:

B7452.1. Apply Linux commands for file system, user management, and process control tasks.
B7452.2. Develop automation scripts using PERL for data processing and system operations.
B7452.3. Implement TCL/Tk scripts for control flow, file handling, and basic GUI applications.
B7452.4. Apply Python programming constructs for modular coding, file I/O, and exception handling.
B7452.5. Analyze script performance and optimize code for efficient system-level automation.

Course Syllabus

Unit-I:

LINUX Basics: Introduction to Linux, File System of Linux, General usage of Linux Kernel and Basic Commands, Linux users and group, Permissions for file, directory and users, Searching a file and directory, zipping and unzipping concepts.

Unit-II:

PERL Basics: History and Concepts of PERL - Scalar Data - Arrays and List Data - Control structures – Hashes - Basics I/O - Regular Expressions – Functions - Miscellaneous control structures - Formats.

Unit-III:

Advanced Topics in PERL: Directory access - File and Directory manipulation - Process Management - Packages and Modules.

Unit-IV:

TCL Basics: An Overview of TCL and Tk -Tcl Language syntax – Variables – Expressions – Lists - Control flow – procedures - Errors and exceptions - String manipulations. Accessing files- Processes. Applications - Controlling Tools - Basics of Tk.

Unit-V:

Python: Introduction to Python – Using Python interpreter – Control flow Tools – Data structures – Modules, Input and Output – Errors and Exceptions – Classes – Brief tour on standard library.

Books and Materials

Text Books:

1. Petersen, Richard. *Linux: The Complete Reference.* 6thed., McGraw-Hill Education, 2012.
2. Van Rossum, Guido, and Fred L. Drake, Jr., editors. *Python Tutorial: Release 3.2.3.* Python Software Foundation, 2012.
3. Wall, Larry, Tom Christiansen, and John Orwant. *Programming Perl.* 4th ed., O'Reilly Media, 2012.
4. Ousterhout, John K., and Ken Jones. *Tcl and the Tk Toolkit.* 2nd ed., Pearson Education, 2010.

Reference Books:

1. Shotts, William. *The Linux Command Line: A Complete Introduction.* No Starch Press, 2012.

B7453 – Embedded Real Time Operating Systems

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course provides a structured introduction to Real-Time Operating Systems (RTOS) with a focus on embedded applications. It covers essential concepts such as multitasking, scheduling, inter-process communication, memory and resource management, and device interfacing. The course emphasizes practical understanding through examples from VxWorks, QNX, and other RTOS platforms. Students will gain insights into real-time constraints, system-level programming, and techniques for effective RTOS deployment in embedded systems, preparing them for industry-focused real-time software development.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education

SDG 9 – Industry, Innovation, and Infrastructure

SDG 11 – Sustainable Cities and Communities

Course Outcomes

After the completion of the course, the student will be able to:

B7453.1. Implement real-time operating system concepts to design task scheduling mechanisms for embedded systems.

B7453.2. Evaluate multitasking models and scheduling algorithms to determine their impact on system performance in real-time applications.

B7453.3. Utilize inter-process communication techniques such as semaphores, message queues, and shared memory for task synchronization in RTOS environments.

B7453.4. Examine memory management policies, timer services, and interrupt handling strategies in commercial and open-source RTOS platforms.

B7453.5. Execute RTOS porting procedures using Board Support Packages (BSPs) for deployment on embedded target hardware.

Course Syllabus

Unit-I:

Overview of RTOS and VxWorks: Need for RTOS, RTOS for Embedded Applications, Issues & Challenges in Real-Time Systems, Key Concepts in Real-Time Computing, POSIX 1003.13 Standard, RTOS for Embedded Systems, Multiprocessor Support, Fault Tolerance and Redundancy Management

Unit-II:

Real-Time Multitasking and Scheduling: Multitasking Basics, Scheduling Fundamentals, Real-Time Task Models, Performance Metrics, Preemptive Priority Scheduling, Rate Monotonic Analysis (RMA), Earliest Deadline First (EDF), Schedulability Factors and Overheads, Aperiodic Event Handling, Task Scheduling in VxWorks/QNX/MicroC/OS-II/OSEK

Unit-III:

Inter-Process Communication and Synchronization: Shared Memory, Pipes and Message Queues, Binary and Counting Semaphores, Bounded & Unbounded Priority Inversion, Priority Inheritance and Ceiling Protocols, Mutual Exclusion Mechanisms, Event Flags, IPC in VxWorks/QNX/MicroC/OS-II/OSEK.

Unit-IV:

Resource Management and System Services: Deadlock Scenarios and Handling, Memory Management Policies, Timer Services and Watchdog Timers, Interrupt Handling Mechanisms, Signals and Exception Handling, Resource Management in VxWorks/QNX/MicroC/OS-II/OSEK

Unit-V:

I/O Systems, File Systems, Networking, and RTOS Deployment: Device Drivers and Data Transfer Methods, I/O APIs and Subsystems, File Systems in Embedded RTOS, Networking Protocols (TCP/IP, Sockets, FTP, TELNET, RPC), RTOS Booting and Initialization, Board Support Packages (BSPs), Kernel Reconfiguration and Porting to Embedded Targets.

Books and Materials

Text Books:

1. Penumuchu, C. V. *Simple Real-Time Operating System: A Kernel Inside View for a Beginner.* Trafford Publishing, 2007.
2. Jane, W. S., and Liu. *Real-Time Systems.* Prentice-Hall, 2000.
3. Burns, Alan. *Real-Time Systems and Their Programming Languages.* 4th ed., Addison-Wesley, 2005.

Reference Books:

1. Shaw, A. C. *Real-Time Systems and Software.* John Wiley, 2001.
2. Laplante, P. A. *Real-Time Systems Design and Analysis: An Engineer's Handbook.* IEEE Press/PHI, 2001.

B7454 – Advanced Computer Architectures

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course explores the architectural principles of modern high-performance computing systems, focusing on processors, memory hierarchies, and scalable parallel architectures. Topics include multiprocessors, SIMD and vector processors, cache coherence, interconnection networks, and multithreading techniques. The course also covers pipelining, superscalar execution, and software strategies for parallel programming and code optimization. Students will gain insights into system design trade-offs and develop skills to analyze, model, and implement performance-driven computing solutions.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education

SDG 9 – Industry, Innovation, and Infrastructure

SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

B7454.1. Explain processor and memory hierarchy concepts, including multiprocessors, vector processors, and virtual memory technologies.

B7454.2. Analyze system performance attributes by evaluating bus architectures, cache organizations, and memory consistency models.

B7454.3. Evaluate parallel architectures, interconnection networks, cache coherence mechanisms, and multithreaded system designs.

B7454.4. Develop pipeline execution models and superscalar techniques for RISC processors addressing performance bottlenecks.

B7454.5. Utilize parallel programming models, languages, and optimization techniques for efficient code generation in scalable architectures.

Course Syllabus

Unit-I:

Processors and Memory Hierarchy: Multiprocessors and Multicomputers, Multivector and SIMD computers, Architectural Development Tracks, Processors and Memory Hierarchy, Advanced Processor Technology, Superscalar and vector Processor, Virtual memory technology.

Unit-II:

Fundamentals of Computer Design: Elements of modern computers-System attributes to performance Bus, Cache and Shared memory Bus Systems, Cache Memory Organizations, Shared memory Organization, Sequential and weak consistency models.

Unit-III:

Parallel and Scalable Architectures: Multiprocessor System Interconnects, Cache Coherence and Synchronization Mechanisms, Message Passing Mechanism, Vector Processing Principles, Multivector Multiprocessors, Performance-Directed Design Rules, Fujitsu VP2000 and VPP500, SIMD Computer Organizations, Implementation models, The MasPar MP-1 Architecture Latency, Hiding Techniques, Principles of Multithreading, Scalable and Multithreaded Architectures, The Tera Multiprocessor System.

Unit-IV:

Pipelining and Superscalar Techniques: Basics of a RISC Instruction set, Implementation of five stage Pipeline for a RISC processor, Performance issues, hurdle of pipelining, simple implementation of MIPS, extending the MIPS pipeline to handle multicycle operations, cross cutting issues.

Unit-V:

Software for Parallel Programming: Parallel programming models, parallel languages and compilers, code optimization and scheduling, scalar optimization with basic blocks, code generation and scheduling, trace scheduling compilation, parallelization and wave fronting, software pipelining, parallel programming environments, Y-MP, Paragon and CM-5 environment development.

Books and Materials

Text Books:

1. Hwang, Kai, and Naresh Jotwani. *Advanced Computer Architecture.* McGraw-Hill, 2011.
2. Hennessy, John L., and David A. Patterson. *Computer Architecture: A Quantitative Approach.* 3rd ed., Morgan Kaufmann, 2003.

Reference Books:

1. Hwang, A. Kai. *Advanced Computer Architecture.* McGraw-Hill, 1987.
2. Sia, D., T. Fountain, and P. Kacsuk. *Advanced Computer Architectures: A Design Space Approach.* Addison-Wesley, 2000.

PROFESSIONAL ELECTIVE-II

B7455 – Ad Hoc and Wireless Sensor Networks

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces the fundamentals of Wireless LANs, PANs, Ad Hoc Wireless Networks, and Sensor Networks, focusing on their architectures, protocols, and key challenges. It covers standards like IEEE 802.11, HIPERLAN, Bluetooth, and Home RF. This course will explore MAC and Routing Protocols designed for dynamic, infrastructureless networks, including contention-based, hybrid, and power-aware approaches. This course also addresses Transport Layer Protocols and their adaptations for Ad Hoc environments. Finally, it covers Sensor Network Architecture, data gathering, MAC protocols, and quality metrics.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation, and Infrastructure
SDG 11 – Sustainable Cities and Communities

Course Outcomes

After the completion of the course, the student will be able to:

B7455.1. Apply the characteristics and design considerations of Ad Hoc Wireless Networks to solve communication challenges in dynamic network environments.

B7455.2. Analyze the operation and the performance of MAC layer protocols of Ad Hoc wireless networks.

B7455.3. Apply different routing protocols to develop suitable routing strategies for Ad Hoc wireless networks.

B7455.4. Analyze the operation and the performance of transport layer protocol of Ad Hoc wireless networks.

B7455.5. Analyze sensor network architecture and evolving standards to identify challenges and propose improvements in network performance.

Course Syllabus

Unit-I:

Wireless LANs and PANs: Introduction, Fundamentals of WLANS, IEEE 802.11 Standards, HIPERLAN Standard, Bluetooth, Home RF. AD HOC WIRELESS NETWORKS: Introduction, Issues in Ad Hoc Wireless Networks.

Unit-II:

MAC Protocols: Introduction, Issues in Designing a MAC protocol for Ad Hoc Wireless Networks, Design goals of a MAC Protocol for Ad Hoc Wireless Networks, Classifications of MAC Protocols, Contention - Based Protocols, Contention - Based Protocols with reservation Mechanisms, Contention – Based MAC Protocols with Scheduling Mechanisms, MAC Protocols that use Directional Antennas, Other MAC Protocols.

Unit-III:

Routing Protocols: Introduction, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classification of Routing Protocols, Table –Driven Routing Protocols, On– Demand Routing Protocols, Hybrid

Routing Protocols, Routing Protocols with Efficient Flooding Mechanisms, Hierarchical Routing Protocols, Power – Aware Routing Protocols.

Unit-IV:

Transport Layer Protocols: Introduction, Issues in Designing a Transport Layer Protocol for Ad Hoc Wireless Networks, Design Goals of a Transport Layer Protocol for Ad Hoc Wireless Networks, Classification of Transport Layer Solutions, TCP Over Ad Hoc Wireless Networks, Other Transport Layer Protocol for Ad Hoc Wireless Networks.

Unit-V:

Sensor Network Architecture: Introduction, Sensor Network Architecture, Data Dissemination, Data Gathering, MAC Protocols for Sensor Networks, Location Discovery, Quality of a Sensor Network, Evolving Standards, Other Issues.

Books and Materials

Text Books:

1. Murthy, C. Siva Ram, and B. S. Manoj. *Ad Hoc Wireless Networks: Architectures and Protocols.* PHI, 2004.
2. Sarangapani, Jagannathan. *Wireless Ad-Hoc and Sensor Networks: Protocols, Performance and Control.* CRC Press, 2011.

Reference Books:

1. Toh, C. K. *Ad-Hoc Mobile Wireless Networks: Protocols & Systems.* 1st ed., Pearson Education, 2002.
2. Raghavendra, C. S., and Krishna M. Sivalingam. *Wireless Sensor Networks.* Springer, 2004.

B7456 – Coding Theory and Techniques

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course offers a foundational and advanced understanding of error control coding, which is critical for ensuring reliable digital communication and data storage. It delves into the theoretical principles of various coding techniques, including linear block codes, cyclic codes, convolutional codes, and modern coding strategies such as LDPC, Turbo, and Space-Time codes. Students will learn the encoding and decoding mechanisms, analyze code performance, and explore applications across real-world digital communication systems. The course equips learners with the necessary tools to design robust coding schemes that enhance data integrity and system reliability.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education

SDG 9 – Industry, Innovation, and Infrastructure

SDG 11 – Sustainable Cities and Communities

Course Outcomes

After the completion of the course, the student will be able to:

B7456.1. Describe the concepts of information theory, types of errors, and error control strategies used in digital communication systems.

B7456.2. Design Linear Block Codes and Cyclic Codes to detect and correct errors using standard encoding and decoding methods

B7456.3. Develop convolutional code structures and apply decoding algorithms for efficient error correction.

B7456.4. Compare the performance of LDPC and Turbo Codes using iterative decoding techniques in practical scenarios.

B7456.5. Analyze Space-Time coding schemes to improve diversity and throughput in MIMO communication systems.

Course Syllabus

Unit-I:

Coding for Reliable Digital Transmission and Storage: Mathematical model of In formation, A Logarithmic Measure of Information, Average and Mutual Information and Entropy, Types of Errors, Error Control Strategies. Linear Block Codes- Introduction to Linear Block Codes, Syndrome and Error Detection, Minimum Distance of a Block code, Error-Detecting and Error-correcting Capabilities of a Block code, Standard array and Syndrome Decoding, Hamming Codes. Applications of Block codes for Error control in data storage system.

Unit-II:

Cyclic Codes: Description, Generator and Parity-check Matrices, Encoding, Syndrome Computation and Error Detection, Decoding, Cyclic Hamming Codes, shortened cyclic codes, Error-trapping decoding for cyclic codes, Majority logic decoding for cyclic codes.

Unit-III:

Convolutional Codes: Encoding of Convolutional Codes, Structural and Distance Prop erties, maximum likelihood decoding, Sequential decoding, Majority- logic decoding of Convolution codes. Application of Viterbi Decoding and Sequential Decoding, Applications of Convolutional codes in ARQ system

Unit-IV:

Turbo Codes: LDPC Codes- Codes based on sparse graphs, Decoding for binary erasure channel, Log-likelihood algebra, Brief propagation, Product codes, Iterative decoding of product codes, Concatenated convolutional codes- Parallel concatenation, The UMTS Turbo code, Serial concatenation, Parallel concatenation, Turbo decoding.

Unit-V:

Space-Time Codes: Introduction, Digital modulation schemes, Diversity, Orthogonal space- Time Block codes, Spatial Multiplexing: General Concept, Iterative APP Preprocessing and Per-layer Decoding, Linear Multilayer Detection, Original BLAST Detection, QL Decomposition and Interface Cancellation.

Books and Materials

Text Books:

1. Lin, Shu, and Daniel J. Costello, Jr. *Error Control Coding: Fundamentals and Applications.* Prentice Hall, Inc., 1983.
2. Rhee, Man Young. *Error Correcting Coding Theory.* McGraw-Hill, 1989.

Reference Books:

1. Sklar, Bernard. *Digital Communications: Fundamentals and Applications.* Pearson Education, 2001.
2. Proakis, John G. *Digital Communications.* 5th ed., McGraw-Hill, 2008.
3. Moon, Todd K. *Error Correction Coding: Mathematical Methods and Algorithms.* Wiley India, 2006.
4. Bose, Ranjan. *Information Theory, Coding and Cryptography.* 2nd ed., McGraw-Hill, 2009.

B7457 – Speech Signal Processing

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

Speech Processing offers a practical and theoretical understanding of how human speech can be processed by computers. It covers Fundamentals of Digital Speech Processing, Time domain models for speech processing, linear predictive coding analysis, Homomorphic speech processing, Automatic speech and Speaker Recognition. The course involves practical concepts also where the student will build working speech recognition systems, build their own synthetic voice and build a complete telephone spoken dialog system. This work will be based on existing toolkits. Details of algorithms, techniques and limitations of state of the art speech systems will also be presented. This course is designed for students wishing understand how to process real data for real applications, applying statistical and machine learning techniques and algorithms as well as working with limitations in the technology.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education

SDG 9 – Industry, Innovation, and Infrastructure

SDG 10 – Reduced Inequalities

Course Outcomes

After the completion of the course, the student will be able to:

B7457.1. Interpret an electrical equivalent of Speech Production system.

B7457.2. Calculate LPC coefficients that can be used to Synthesize or compress the speech.

B7457.3. Design a Homomorphic Vocoder for coding and decoding of speech.

B7457.4. Generate the speech and can design an isolated word recognition system using HMM.

B7457.5. Analyze the features for Automatic speaker recognition and classification system.

Course Syllabus

Unit-I:

Fundamentals of Digital Speech Processing: Anatomy & Physiology of Speech Organs, The process of Speech Production, Acoustic Phonetics, Articulatory Phonetics, The Acoustic Theory of Speech Production-Uniform lossless tube model, effect of losses in vocal tract, effect of radiation at lips, Digital models for speech signals.

Unit-II:

Time Domain Models for Speech Processing: Introduction-Window considerations, Short time energy and average magnitude Short time average zero crossing rate, Speech Vs Silence discrimination using energy and zero crossing, Pitch period estimation using a parallel processing approach, The short time autocorrelation function, The short time average magnitude difference function, Pitch period estimation using the autocorrelation function.

Unit-III:

Linear Predictive Coding (LPC) Analysis: Basic principles of Linear Predictive Analysis: The Autocorrelation Method, The Covariance Method, Solution of LPC Equations: Cholesky Decomposition Solution for Covariance Method, Durbin's Recursive Solution for the Autocorrelation Equations, Comparison between the Methods of Solution of the LPC Analysis Equations, Applications of LPC Parameters: Pitch Detection using LPC Parameters, Formant Analysis using LPC Pa Homomorphic Speech Processing.

Unit-IV:

Homomorphic Speech Processing: Introduction, Homomorphic Systems for Convolution: Properties of the Complex Cepstrum, Computational Considerations, The Complex Cepstrum of Speech, Pitch Detection, Formant Estimation, The Homomorphic Vocoder. Speech Enhancement: Nature of interfering sounds, Speech enhancement techniques: Single Microphone Approach : spectral subtraction, Enhancement by re-synthesis, Comb filter, Wiener filter, Multi microphone Approach.

Unit-V:

Automatic Speech & Speaker Recognition: Basic pattern recognition approaches, Parametric representation of speech, Evaluating the similarity of speech patterns, Isolated digit Recognition System, Continuous digit Recognition System. Hidden Markov Model (HMM) for Speech: Hidden Markov Model (HMM) for speech recognition, Viterbi algorithm, Training and testing using HMMS. Speaker Recognition: Recognition techniques, Features that distinguish speakers, Speaker Recognition Systems: Speaker Verification System, Speaker Identification System.

Books and Materials

Text Books:

1. Rabiner, L. R., and Ronald W. Schafer. *Digital Processing of Speech Signals.* Pearson Education, 1978.
2. O'Shaughnessy, Douglas. *Speech Communications: Human and Machine.* 2nd ed., Wiley India, 2000.
3. Rabiner, L. R., and Ronald W. Schafer. *Digital Processing of Speech Signals.* Pearson Education, 2000.

Reference Books:

1. Quatieri, Thomas F. *Discrete-Time Speech Signal Processing: Principles and Practice.* Pearson Education, 2002.

B7458 – Machine learning and Deep learning

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course provides fundamental knowledge of Machine Learning (ML) and Deep Learning (DL) methodologies. It addresses basic concepts like supervised and unsupervised learning, feature engineering, classification, regression, and clustering. Topics in advanced deep learning, including neural networks, convolutional neural networks (CNNs), optimization methods, and contemporary architectures such as LSTM, Autoencoders, Transformers, and GANs, are also addressed. Students will get experience with traditional machine learning models and deep learning frameworks applied to practical issues such as image classification, object detection, and anomaly detection. Focus is directed on the mathematical foundations for constructing robust intelligent systems.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 8 – Decent Work and Economic Growth
SDG 9 – Industry, Innovation, and Infrastructure

Course Outcomes

After the completion of the course, the student will be able to:

B7458.1. Comprehend and distinguish among numerous machine learning paradigms, including supervised, unsupervised, semi-supervised, and reinforcement learning.

B7458.2. Implement suitable feature engineering, model selection, and evaluation techniques for both tabular and unstructured data types.

B7458.3. Execute and evaluate the efficacy of regression and classification algorithms.

B7458.4. Develop and optimize deep neural networks, particularly convolutional neural networks (CNNs)to address practical challenges.

B7458.5. Explore and implement advanced deep learning architectures such as LSTM, Transformers, GANs for tasks like image segmentation, object detection, and sequence modeling.

Course Syllabus

Unit-I:

Introduction to Machine Learning: Introduction to ML, , issues related to machine learning: pre-processing, inductive bias, variance, feature extraction, feature selection techniques. Types of Learning (supervised, unsupervised, Reinforcement, Semi, etc.). Types of Data: Tabular, Image, Video, Audio, Sequential training and testing, hypothesis and cost function. Mathematics for machine learning.

Unit-II:

Supervised Learning: Introduction to Regression, Linear Regression, Multiple Linear Regression, Logistic regression, Support Vector Regression, Ensemble learning: Bagging and boosting and different techniques of bagging and boosting.

Unit-III:

Unsupervised Learning: Introduction to Classification, Naïve Bayes,Support Vector Machine, K-nearest neighbors, Decision Tree, construction of decision trees using different algorithms (ID3, C4.5), Random Forest. Clustering: Density-based, Distribution-based, Kmeans, DBSCAN, Gaussian Mixture Models, Mean-shift clustering.

Unit-IV:

Introduction to Deep Learning: History of Deep Learning, DL vs. ML, Loss Function (LMS). Optimization Techniques, Gradient Descent, Batch Optimization. Introduction to Neural Network, Back Propagation Learning. Unsupervised Learning with Deep Network. Convolutional Neural Network, building blocks of CNN (activation, normalization, pooling, padding), Transfer Learning, hyper-parameter tunning, Momentum Optimizer, RMSProp, Adam optimizer. Effective training in Deep Net- early stopping, Dropout, Batch Normalization, Instance Normalization, Group Normalization.

Unit-V:

Recent Trends in Deep Learning: Architectures, Residual Network, Skip Connection Network, Fully Connected CNN, LSTM, Autoencoders, Transformers, Multi-branch CNN, Generative Networks (GAN), Recurrent Neural Nets (RNN), Classical Supervised Tasks with Deep Learning, Image Denoising, Semantic Segmentation, Object Detection, Anomaly Detection, Object tracking.

Books and Materials

Text Books:

1. Mitchell, Tom M. *Machine Learning.* McGraw-Hill, 2017.
2. Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. *Deep Learning.* The MIT Press, 2016.

Reference Books:

1. Bishop, Christopher M. *Pattern Recognition and Machine Learning.* Springer, 2018.
2. Trask, Andrew W. *Grokking Deep Learning.* Manning Publications, 2019.

B7403 – CMOS Digital IC Design Laboratory

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
0	0	60	0	60	2	40	60	100

Course Description

Course Overview

This laboratory course focuses on the design, simulation, and analysis of digital circuits using CMOS technology. Students will gain hands-on experience in schematic design, layout generation, and circuit simulation to evaluate parameters such as propagation delay, rise/fall times, and transient responses. The course covers the implementation of fundamental combinational and sequential circuits, including multiplexers, decoders, encoders, latches, flip-flops, and memory elements using CMOS logic, Pass Transistor Logic, and Transmission Gate Logic. Students will utilize Cadence Virtuoso tools for schematic entry, layout design, and simulation, thereby developing skills essential for digital IC design and verification in VLSI systems.

Course Pre/Co-requisites

CMOS VLSI Design

Relevant SDG(s)

SDG 4 – Quality Education

SDG 9 – Industry, Innovation, and Infrastructure

SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

B7403.1. Design and implement combinational and sequential circuits using CMOS logic and advanced switching techniques.

B7403.2. Apply EDA tools for schematic entry, layout design, and circuit simulation.

B7403.3. Simulate digital circuits to evaluate timing parameters and functional behavior.

B7403.4. Analyze the impact of design choices on circuit performance parameters such as delay, power, and area.

B7403.5. Interpret simulation results to validate circuit functionality and layout correctness.

Course Syllabus

List of Experiments:

1. Draw the CMOS schematic and Layout of the inverter circuit, simulate both schematic and layout to determine propagation delay, rise time fall time and Q point and comment on the results.
2. Draw the CMOS schematic of the 2 input NAND and NOR gate, also draw the layout of the same, and simulate for transient result.
3. Design Half Adder circuit using CMOS logic
4. Design 2:1 Multiplexer circuit using CMOS logic
5. Design 1:2 De-Multiplexer circuit using CMOS logic
6. Design 2 to 4 Decoder circuit using CMOS logic
7. Design 4 to 2 Encoder circuit using CMOS logic

8. Design SR Latch circuit using CMOS logic
9. Design D Latch circuit using CMOS logic
10. Design T flip flop circuit using CMOS logic
11. Design 6-T SRAM circuit using CMOS logic
12. Design Full Adder circuit using Pass Transistor Logic
13. Design 4:1 Multiplexer circuit using Pass Transistor Logic
14. Design Half Subtractor circuit using Transmission Gate Logic

Laboratory Equipment/Software/Tools Required:

1. Computer systems are installed with Cadence Virtuoso Tool

Books and Materials

Text Books:

1. Rabaey, Jan M. *Digital Integrated Circuits: Design.* Pearson Education.
2. Kang, Sung-Mo, and Yusuf Leblebici. *CMOS Digital Integrated Circuits: Analysis and Design.* Tata McGraw-Hill, 2003.

Reference Books:

1. Weste, Neil H. E., and Kamran Eshraghian. *Principles of CMOS VLSI Design: A Systems Perspective.* McGraw-Hill, 2005.

B7404 – Advanced Communications and Networks Laboratory

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
0	0	60	0	60	2	40	60	100

Course Description

Course Overview

Course explore GSM, CDMA, and 4G LTE technologies through hands-on experiments involving AT commands, USRP-based transmitter and receiver design, and modulation analysis using SDR kits. Key hardware experiments include measurement of bit error rates, chip rate calculations, and GSM handset fault analysis. Software simulations using MATLAB cover adaptive equalization, RAKE receivers, and outdoor path loss models such as Free Space, Okumura, and Hata. Additional simulations include routing in wireless mesh and star networks, and spectrum sensing through energy detection algorithms. The course bridges theory and practice, equipping students with practical skills in analysing and developing wireless systems.

Course Pre/Co-requisites

CMOS VLSI Design

Relevant SDG(s)

SDG 4 – Quality Education

SDG 9 – Industry, Innovation, and Infrastructure

SDG 11 – Sustainable Cities and Communities

Course Outcomes

After the completion of the course, the student will be able to:

B7404.1. Demonstrate the ability to analyze and evaluate key parameters in CDMA systems.

B7404.2. Apply GSM and LTE AT commands for mobile communication applications.

B7404.3. Design and implement wireless transmitters and receivers using USRP and SDR kits.

B7404.4. Simulate and evaluate wireless communication components and systems using MATLAB.

B7404.5. Analyze and compare routing protocols and dynamic spectrum access techniques.

Course Syllabus

List of Experiments: A. Hardware-Based Experiments (7):

1. Calculation of chip rate, spreading factor, processing gains of DSSS CDMA for various PN codes.
2. Measurement of Bit Error Rate for DSSS CDMA.
3. Analysis of AT Commands of 4G LTE Smart Phone.
4. Design of Transmitter and Receiver using USRP for wireless communication.
5. Analysis of frequency modulation technique in time and frequency domain using SDR kit.
6. Analysis of Phase modulation technique in time and frequency domain using SDR kit.
7. Study of transmitter and receiver section in mobile handset and measure frequency band for GMSK modulated signal.
8. Study of GSM handset for various signaling and fault-insertion techniques.

B. Software-Based Simulation Experiments (7):

1. Simulation of Adaptive Linear Equalizer using MAT LAB .

2. Simulation of RAKE Receiver for CDMA communication using MAT LAB.
3. Simulation of Outdoor Path loss propagation models using MATLAB.
   a. Free Space Propagation model
   b. Okumura model
   c. Hata model.
4. Routing Performance in Wireless Mesh Networks.
5. Implement an energy detection algorithm to identify unused spectrum bands for dynamic access.
6. Analysis of routing protocols for Star Networks using Network Simulator.

Laboratory Equipment/Software/Tools Required:

1. Modulator & Demodulator (Scientech 2131B) kit
2. GSM Trainer Kit-2133
3. 4G LTE Smart Phone Tech Book
4. Software Defined Radio (NI USRP-2920) Kit.
5. Spectrum Analyzer
6. Software (Scientech 2131B)
7. Lab View 2018
8. Network Simulator(NS2)
9. Computers installed with operating system

Books and Materials

Text Books:

1. Garg, Vijay. *Wireless Communications and Networking.* 1st ed., Elsevier, 2014.
2. Rappaport, Theodore S. *Wireless Communications: Principles and Practice.* 2nd ed., PHI Learning, 2002.

Reference Books:

1. Stallings, William. *Wireless Communications and Networking.* PHI Learning, 2003.

I M.Tech. II Semester

B7405 – FPGA based System Design

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course provides foundational knowledge of FPGA-based digital system design, covering Hardware Description Languages (HDLs), combinational and sequential circuit design, and finite state machine (FSM) development. Students will learn to write and simulate Verilog code for RT-level combinational and sequential circuits, optimize designs for power and performance, and understand FPGA architectures and fabrics. Emphasis is placed on practical design skills, including test bench development, debugging, and system-level integration, enabling students to efficiently prototype digital systems on FPGA platforms using industry-standard methodologies.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education

SDG 9 – Industry, Innovation, and Infrastructure

SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

B7405.1. Design and implement combinational and sequential circuits using Verilog HDL.

B7405.2. Apply RT-level modeling techniques to develop efficient FPGA-based digital systems.

B7405.3. Interpret simulation results to verify and validate digital circuit functionality.

B7405.4. Construct FSM-based solutions for practical digital applications on FPGA.

B7405.5. Examine FPGA fabric architectures to enhance design optimization for power and performance.

Course Syllabus

Unit-I:

Hardware Description Language: Introduction, General description, Basic lexical elements and data types, Data types, Program skeleton, Structural description, Testbench. **FPGA-Based Systems:** Introduction, Basic Concepts, Digital Design and FPGAs, FPGA-Based System Design.

Unit-II:

RT-level combinational circuit: Introduction, Operators, Always block for a combinational circuit, If statement, Case statement, Routing structure of conditional control constructs, General coding guidelines for an always block, Parameter and constant. **Combinational Logic:** Combinational Network Delay, Power and Energy Optimization, Arithmetic Logic.

Unit-III:

Regular Sequential Circuit: Introduction, HDL code of the FF and register, Simple design examples, Testbench for sequential circuits, Case study - LED time-multiplexing circuit, Stopwatch, FIFO buffer. .

Unit-IV:

Sequential Machines: Introduction, The Sequential Machine Design Process, Sequential Design Styles, Rules for Clocking, Performance Analysis, Power Optimization. **FSM:** Introduction, FSM code development, Design examples - Rising-edge detector, Debouncing circuit, Testing circuit.

Unit-V:

FPGA Fabrics: Introduction, FPGA Architectures, SRAM-Based FPGAs, Permanently Programmed FPGAs, Chip I/O, Circuit Design of FPGA Fabrics, Architecture of FPGA Fabrics.

Books and Materials

Text Books:

1. Chu, Pong P. *FPGA Prototyping by Verilog Examples.* John Wiley & Sons, Inc., 2008.
2. Wolf, Wayne. *FPGA-Based System Design.* Prentice Hall PTR, Englewood Cliffs, New Jersey, 2004.

Reference Books:

1. Palnitkar, Samir. *Verilog HDL: A Guide to Digital Design and Synthesis.* 2nd ed., Prentice Hall, 2003.
2. Padmanabhan, T. R., and B. Bala Tripura Sundari. *Design through Verilog HDL.* Wiley-Interscience, 2004.
3. Trimberger, Stephen M. *Field-Programmable Gate Array Technology.* 1st ed., Springer International, 1997.

B7406 – Advanced Digital Signal Processing

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

The course includes a review of the linear constant-coefficient system properties covered in an undergraduate DSP course, and then examines a variety of multi rate filter structures, time-varying and adaptive systems, fast algorithms, and other topics like applications on adaptive filters using different algorithms like LMS and RLS which are relevant to the research areas of the students. In this course power spectrum estimation is discussed in detail using parametric and non-parametric methods.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education

SDG 9 – Industry, Innovation, and Infrastructure

SDG 11 – Sustainable Cities and Communities

Course Outcomes

After the completion of the course, the student will be able to:

B7406.1. Interpret design of FIR and IIR digital filters along with realization techniques.

B7406.2. Apply multi rate signal processing techniques to design poly phase filters, QMF, digital filter banks etc.

B7406.3. Design and analyze linear prediction filters and solution to normal equations.

B7406.4. Analyze adaptive filters and its applications using various algorithms.

B7406.5. Estimate the various power spectrum techniques using parametric and nonparametric methods.

Course Syllabus

Unit-I:

Overview of DSP: 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 in variance, bi-linear transformation, FIR/IIR Cascaded lattice structures, parallel realization of IIR.

Unit-II:

Multi Rate DSP: Multi rate DSP, Decimators and Interpolators, Sampling rate conversion, multistage decimator & interpolator, poly phase filters, QMF, digital filter banks, Applications in sub band coding.

Unit-III:

Linear Prediction & Optimum Linear Filters: Linear prediction & optimum linear filters, stationary random process, forward-backward linear prediction filters, solution of normal equations, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction. .

Unit-IV:

Adaptive Filters: Adaptive Filters, Applications, Gradient Adaptive Lattice, Minimum mean square criterion, LMS algorithm, Recursive Least Square algorithm

Unit-V:

Estimation of Spectra from Finite: Duration observations of Signals. Non parametric methods for power spectrum estimation, parametric methods for power spectrum estimation, minimum-variance spectral estimation, Eigen analysis algorithms for spectrum estimation.

Books and Materials

Text Books:

1. Proakis, John G., and Dimitris G. Manolakis. *Digital Signal Processing: Principles, Algorithms, and Applications.* 4th ed., Prentice Hall, 2007.
2. Fliege, Norbert J. *Multirate Digital Signal Processing: Multirate Systems, Filter Banks, Wavelets.* 1st ed., John Wiley and Sons Ltd., 1999.

Reference Books:

1. Suter, Bruce W. *Multirate and Wavelet Signal Processing.* 1st ed., Academic Press, 1997.
2. Hayes, Monson H. *Statistical Digital Signal Processing and Modeling.* John Wiley & Sons Inc., 2002.

PROFESSIONAL ELECTIVE-III

B7459 – VLSI Functional Verification Methodologies

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course provides a comprehensive introduction to functional verification using SystemVerilog and the Universal Verification Methodology (UVM). Starting with foundational SystemVerilog language constructs and object-oriented programming, the course gradually introduces advanced verification concepts including randomization, coverage, and inter-process communication. Building on this foundation, students learn the UVM framework for creating reusable and scalable testbenches, focusing on UVM components, sequences, transactions, and transaction-level modeling (TLM). Hands-on exercises and real-world examples solidify understanding, preparing students for practical verification challenges in ASIC and FPGA design environments.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education

SDG 9 – Industry, Innovation, and Infrastructure

SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

B7459.1. Write basic SystemVerilog testbenches using data types, control statements, and functions.

B7459.2. Use object-oriented programming and randomization to create flexible and reusable testbenches.

B7459.3. Measure verification quality using functional coverage in SystemVerilog.

B7459.4. Build UVM testbenches using components like tests, drivers, monitors, and agents.

B7459.5. Use UVM sequences and communication ports to send transactions and collect results.

Course Syllabus

Unit-I:

SystemVerilog Fundamentals: Verification Guidelines – Introduction, verification process, basic testbench functionality, testbench components, simulation environment phases, testbench performance. Data Types – built-in data types, arrays, linked lists, creating new types and user-defined structures, constants, strings. Procedural Statements and Routines – tasks, functions, and void functions, routine arguments, returning from a routine. Local data storage, time values.

Unit-II:

Testbench and OOP Concepts: Connecting the Testbench and Design – separating the testbench and design, the interface construct, stimulus timing, interface driving and sampling, connecting it all together, program-module interactions, SystemVerilog assertions. Basic OOP – define a class, creating new objects, object deallocation, class routines, dynamic objects, copying objects, building a testbench. Randomization – Introduction, randomization in SystemVerilog, constraint details, solution probabilities, valid and in-line constraints, iterative and array constraints, random control, random generators, random device configuration.

Unit-III:

Advanced Concepts for UVM Readiness: Threads and Interprocess Communication – working with threads, interprocess communication, events, semaphores, mailboxes, building testbench with threads and IPC. Advanced OOP and Testbench Guidelines – inheritance, factory patterns, type casting and virtual methods, composition, inheritance, and alternatives, copying an object, callbacks. Functional Coverage – coverage types, strategies, anatomy of a cover group, triggering, data sampling, cross coverage.

Unit-IV:

UVM Infrastructure: Introduction, UVM Components, UVM Tests, UVM Transactions, UVM Sequences.

Unit-V:

UVM Integration & TLM (Transaction-Level Modeling) Communication: UVM Agents, Using Analysis Ports in a Testbench, Put and Get Ports in Action, UVM Reporting

Books and Materials

Text Books:

1. Spear, Chris. *SystemVerilog for Verification: A Guide to Learning the Testbench Language Features.* 2nd ed., Springer, 2014.
2. Salemi, Ray. *UVM Primer: A Step-by-Step Introduction to the Universal Verification Methodology.* Mentor Graphics, 2014.

Reference Books:

1. Mathur, Ashok B. *Advanced Functional Verification: Concepts and Techniques.* Springer, 2021. 2. Bhasker, J., and Rakesh Chadha. *SystemVerilog for Verification: A Guide to Learning the Testbench Language Features.* Prentice Hall, 2007. 3. Bergeron, Janick. *SystemVerilog for Verification: A Guide to Learning the Testbench Language Features.* 3rd ed., Springer, 2012.

B7460 – Physical Design Automation with AI

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces the VLSI physical design flow, covering structural, logic, and transistor-level design. It explores key stages such as layout design, compaction, placement, partitioning, floorplanning, and routing. Classical algorithms for constraint graph modeling, placement, and routing are discussed in depth. High-level synthesis concepts like hardware modeling, scheduling, allocation, and assignment are included. The course provides foundational knowledge in supervised, unsupervised, and reinforcement learning. Students learn feature engineering and apply ML models to circuit representation and optimization. Applications of AI/ML in congestion prediction, timing slack estimation, and DRC classification are covered. Advanced techniques like Graph Neural Networks and Deep Learning are introduced for design automation.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 8 – Decent Work and Economic Growth
SDG 9 – Industry, Innovation, and Infrastructure

Course Outcomes

After the completion of the course, the student will be able to:

B7460.1. Analyze the VLSI design flow and identify the role of automation tools in structural, logic, transistor-level, and layout design.

B7460.2. Apply appropriate algorithms for layout compaction, placement, partitioning, and floorplanning in physical design stages.

B7460.3. Evaluate routing strategies and algorithms for local, global, and channel routing with respect to design constraints.

B7460.4. Demonstrate understanding of high-level synthesis tasks such as hardware modeling, scheduling, allocation, and assignment using algorithmic techniques.

B7460.5. Integrate machine learning techniques including supervised, unsupervised, and deep learning to solve problems in physical design automation such as congestion prediction and timing estimation.

Course Syllabus

Unit-I:

Introduction to VLSI Design Flow: VLSI design automation tools- algorithms and system design. Structural and logic design. Transistor level design. Layout design. Verification methods. Design management tools.

Unit-II:

Layout, Placement and Partitioning: Layout Compaction, Design rules, Problem formulation, Algorithms for constraint graph compaction, Placement and partitioning, Circuit representation, Placement algorithms, Partitioning.

Unit-III:

Floor planning and Routing: Floor planning concepts, Shape functions and floor plan sizing, Types of local routing problems, Area routing, Channel routing, Global routing, Algorithms for global routing. Hardware models for high level synthesis, internal representation, allocation, assignment and scheduling, scheduling algorithms, Assignment problem

Unit-IV:

Machine Learning Fundamentals: Supervised and unsupervised learning, Feature engineering for circuit representation, Neural networks, Decision trees, SVM, KNN basics, Introduction to Deep Learning and Reinforcement Learning

Unit-V:

AI/ML for Physical Design Automation: ML applications: Congestion prediction, timing slack estimation, DRC classification, Reinforcement Learning for placement and floorplanning, Graph Neural Networks for netlist analysis and circuit modelling, Deep learning for parasitic extraction and delay estimation

Books and Materials

Text Books:

1. Gerez, S. H. *Algorithms for VLSI Design Automation.* John Wiley & Sons, 2002.
2. Sherwani, N. A. *Algorithms for VLSI Physical Design Automation.* Kluwer Academic Publishers, 2002.
3. Sait, Sadiq M., and Habib Youssef. *VLSI Physical Design Automation: Theory and Practice.* World Scientific, 1999.

Reference Books:

1. Rubin, Steven M. *Computer Aids for VLSI Design.* Addison-Wesley Publishing, 1987.
2. Sarrafzadeh, Majid, and C. K. Wong. *An Introduction to VLSI Physical Design.* McGraw-Hill (International Edition), 1996.
3. *Proceedings of the Design Automation Conference (DAC) and International Conference on Computer-Aided Design (ICCAD): Papers on Machine Learning in Electronic Design Automation.*
4. *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems.* IEEE, ongoing publication.

A7461 – IoT Architectures and System Design

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces the fundamentals of the Internet of Things (IoT), covering its evolution, architecture, enabling technologies, and application domains. It emphasizes wireless communication protocols, IoT device interfacing using platforms like Raspberry Pi, and hands-on development of basic IoT applications. Students will explore IoT system design challenges, including security, scalability, and integration with emerging technologies like AI, Blockchain, and 5G. The course equips learners with theoretical cum practical skills for designing and deploying IoT-based solutions.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education

SDG 9 – Industry, Innovation, and Infrastructure

SDG 11 – Sustainable Cities and Communities

Course Outcomes

After the completion of the course, the student will be able to:

B7461.1. Explain IoT evolution, system characteristics, and enabling technologies, including sensing and actuation components for IoT applications.

B7461.2. Interpret IoT reference architectures and functional views to assess system deployment and operational strategies.

B7461.3. Apply WPAN technologies and IP-based protocols to establish wireless communication in IoT networks.

B7461.4. Develop simple IoT applications by configuring Raspberry Pi interfaces and integrating sensors and actuators.

B7461.5. Examine IoT system design challenges and explore emerging solutions involving AI, Blockchain, and 5G technologies.

Course Syllabus

Unit-I:

Introduction to IoT: Definition and Evolution of IoT, IoT growth, Application areas of IoT, Characteristics of IoT, Physical design of IoT, IoT stack, Enabling technologies, IoT levels, IoT sensing and actuation, Sensing types, Actuator types.

Unit-II:

IoT Architectures: IoT reference Model & Architecture, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

Unit-III:

Wireless Technologies for IoT: WPAN Technologies for IoT: IEEE 802.15.4, Zigbee, HART, NFC, Z-Wave, Bluetooth, Bluetooth Low Energy (BLE), Beacons. IP Based Protocols for IoT: IPv6, 6LowPAN, RPL, REST, AMQP, HTTP, CoAP, MQTT. Edge Connectivity and Protocols.

Unit-IV:

IoT Physical Devices and End Points: Introduction to Raspberry Pi, Linux on Raspberry Pi, Raspberry Pi interfaces- (Serial, SPI, I2C), Programming Raspberry Pi with Python-Controlling LED with Raspberry Pi, Interfacing IR Sensor and LDR, Overview of other IoT Devices (pcDuino , Beagle Bone Black, Cubie Board).

Unit-V:

IoT System Design and Challenges: Challenges associated with IoT, Emerging pillars of IoT, Domain Applications: Agricultural IoT, Vehicular IoT, Healthcare IoT, Smart Cities and Smart Metering, Industrial IoT (IIoT), Smart Cards and Automation. Emerging technologies: AI & IoT, Blockchain for IoT, and 5G integration IoT,IoT Security Challenges.

Books and Materials

Text Books:

1. Misra, Sudip, Anandarup Mukherjee, and Arijit Roy. *Introduction to IoT.* Cambridge University Press, 2021.
2. Hanes, David, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, and Jerome Henry. *IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things.* Cisco Press, 2017.

Reference Books:

1. Bahga, Arshdeep, and Vijay Madisetti. *Internet of Things: A Hands-On Approach.* Universities Press, 2015.
2. daCosta, Francis. *Rethinking the Internet of Things: A Scalable Approach to Connecting Everything.* Apress Publications, 2013.
3. Pfister, Cuno. *Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud.* O'Reilly Media, 2011.
4. Raj, Pethuru, and Anupama C. Raman. *The Internet of Things: Enabling Technologies, Platforms, and Use Cases.* CRC Press, 2017.
5. Vasudevan, Shriram K., R. M. D. Sundaram, and Abhishek S. Nagarajan. *Internet of Things.* John Wiley & Sons, 2013.
6. Banzi, Massimo, and Michael Shiloh. *Make: Getting Started with Arduino.* Shroff Publishers / Maker Media, 2014.

A7462 – Machine Learning for Robotics

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces machine learning concepts with a focused lens on their applications in robotics. It emphasizes the development of intelligent robotic systems capable of perceiving, reasoning, and adapting through data-driven techniques. Students will explore supervised and unsupervised learning methods, dimensionality reduction, deep learning techniques for robotic vision, and reinforcement learning for autonomous decision-making. The course also integrates neuro-fuzzy and hybrid systems to address uncertainties in dynamic robotic environments. By the end of the course, students will gain theoretical knowledge of how machine learning algorithms enable robots to sense, interpret, and interact with the world intelligently.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 8 – Decent Work and Economic Growth
SDG 9 – Industry, Innovation, and Infrastructure

Course Outcomes

After the completion of the course, the student will be able to:

B7462.1. Understand the fundamental concepts and types of machine learning and evaluate their roles in robotic systems

B7462.2. Apply unsupervised learning techniques like clustering and PCA to process and interpret sensory data in robotics.

B7462.3. Analyze supervised learning models and assess their suitability for classification and control tasks in robotics.

B7462.4. Interpret the architecture and function of deep learning models and reinforcement learning methods for autonomous robotic behavior.

B7462.5. Analyze the role of neuro-fuzzy and hybrid learning systems in handling uncertainty and adaptability in robotic decision-making.

Course Syllabus

Unit-I:

Introduction to Machine Learning and Robotics Applications: Introduction, Key ML Terminologies model, training, testing, loss function, Bias-variance tradeoff, overfitting, underfitting, Evaluation metrics, Confusion matrix, ML in robotics: perception, control, navigation, decision making.

Unit-II:

Unsupervised Learning for Robotic Perception: Clustering methods (K-means, Hierarchical and DBSCAN), Dimensionality reduction (PCA, t-SNE, Feature extraction from sensor data (LIDAR, Vision)), Applications in Robotics (object segmentation, terrain mapping, anomaly detection).

Unit-III:

Supervised Learning Models in Robotics: Classification and Regression - Logistic regression, Decision trees, Random Forests, Support Vector Machines, K-Nearest Neighbors, Applications – Terrain classification, object recognition, fault detection in actuators.

Unit-IV:

Deep Learning and reinforcement Learning for Robotic Intelligence: CNN Architecture, Convolution and Pooling operations, Recurrent Neural Networks, LSTM, MDPs, Q-learning, Applications – object detection, path following, gesture recognition, autonomous navigation.

Unit-V:

Neuro-Fuzzy and Hybrid Learning Systems: Fuzzy logic and fuzzy interference systems, Adaptive Neuro-Fuzzy inference system, Hybrid models combining fuzzy logic and neural networks, Applications – Human robot interaction, Soft-robot control, Adaptive decision-making in uncertain environments.

Books and Materials

Text Books:

1. Murphy, Kevin P. *Machine Learning: A Probabilistic Perspective.* MIT Press, 2012.
2. Corke, Peter. *Robotics, Vision and Control: Fundamental Algorithms in MATLAB.* Springer, 2011.
3. Russell, Stuart, and Peter Norvig. *Artificial Intelligence: A Modern Approach.* 4th ed., Pearson, 2021.

Reference Books:

1. Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. *Deep Learning.* MIT Press, 2016.
2. Duda, Richard O., Peter E. Hart, and David G. Stork. *Pattern Classification.* 2nd ed., Wiley India, 2012.
3. Sutton, Richard S., and Andrew G. Barto. *Reinforcement Learning: An Introduction.* 2nd ed., MIT Press, 2018.
4. Jang, J. S. R., C. T. Sun, and E. Mizutani. *Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence.* Pearson Education, 2008.

PROFESSIONAL ELECTIVE-IV

A7463 –Wireless MIMO Communications

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course provides an in-depth study of Multiple-Input Multiple-Output (MIMO) wireless communication systems, covering their fundamental concepts, diversity techniques, and the characteristics of wireless fading channels. It explores classical and generalized fading distributions, along with analytical MIMO channel models such as fully correlated, Kronecker, and keyhole models, and parallel decomposition techniques. The course delves into power allocation strategies uniform, adaptive, and near-optimal for maximizing channel capacity in various MIMO configurations, including i.i.d. Rayleigh, correlated Rayleigh, and keyhole channels. Students will learn the design, analysis, and performance evaluation of space-time coding techniques, including Alamouti codes, orthogonal space-time block codes (OSTBC), differential OSTBC, space-time trellis codes (STTC), and turbo codes, under Rayleigh and Rician fading conditions. The course also examines MIMO detection methods such as maximum likelihood, zero forcing, and MMSE, emphasizing their performance trade-offs. Finally, it addresses advanced topics like spatial modulation, cooperative MIMO, cognitive radio, multiuser MIMO, femtocell-based systems, and large-scale MIMO for emerging 5G and beyond wireless networks, equipping learners with both theoretical foundations and practical insights for modern wireless communication system design.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education

SDG 9 – Industry, Innovation, and Infrastructure

SDG 11 – Sustainable Cities and Communities

Course Outcomes

After the completion of the course, the student will be able to:

B7463.1. Apply the principles of diversity techniques and fading channel models to analyze the performance of MIMO systems under various wireless propagation conditions.

B7463.2. Analyze classical and generalized fading distributions and their impact on MIMO channel modeling.

B7463.3. Apply power allocation strategies such as uniform, adaptive, and near-optimal schemes to maximize the capacity of different MIMO channel configurations.

B7463.4. Analyze the performance of space-time coding schemes over Rayleigh and Rician fading channels with respect to symbol error rate and channel correlation.

B7463.5. Apply and analyze various MIMO detection techniques and evaluate their role in advanced MIMO-based wireless systems.

Course Syllabus

Unit-I:

MIMO Systems: Introduction, Diversity in wireless communications, Wireless fading channel characteristics, MIMO transmit diversity Schemes, advantages and applications of MIMO systems. Fading Distributions: Classical fading distributions, Generalized fading distributions.

Unit-II:

Analytical MIMO channel models: Fully correlated MIMO, Separately correlated (Kronecker) MIMO channel model, Uncorrelated (keyhole) MIMO channel model, MIMO channel parallel decomposition

Unit-III:

Power allocation in MIMO systems: Uniform, adaptive and near optimal power allocation. MIMO Channel Capacity: Capacity of i.i.d. Rayleigh fading MIMO channels, Capacity of separately correlated Rayleigh fading MIMO channel, Capacity of keyhole Rayleigh fading MIMO channel.

Unit-IV:

Space-Time Codes: code design criteria, Alamouti space-time codes, SER analysis of Alamouti space-time code over fading channels, Space-time block codes: OSTBC for real signals, OSTBC for complex signal constellations, Symbol error rate (SER) for OSTBC over spatially correlated Rayleigh fading MIMO channel, Differential OSTBC, Space-time trellis codes: STTC trellis diagram, STTC encoder, Performance analysis of Space-time codes over separately correlated MIMO channel: Rayleigh fading MIMO channel, Rician fading MIMO channel, Space-time turbo codes.

Unit-V:

MIMO detection: Maximum likelihood (ML) detector, Linear sub-optimal detectors, ZF detector, MMSE detector. Advances in MIMO wireless communications: Spatial modulation, MIMO based cooperative communication and cognitive radio, multiuser MIMO, cognitive-femtocells and large MIMO systems for 5G wireless.

Books and Materials

Text Books:

1. Kshetrimayum, Rakhesh Singh. *Fundamentals of MIMO Wireless Communications.* 2017.
2. Biglieri, Ezio, and Robert Calderbank, et al. *MIMO Wireless Communications.* Cambridge University Press, 2007.

Reference Books:

1. Clerckx, B., and C. Oestges. *MIMO Wireless Networks.* 2nd ed., Elsevier Academic Press, 2013.
2. Duman, T. M., and A. Ghrayeb. *Coding for MIMO Communication Systems.* John Wiley & Sons, 2007.
3. Costa, N., and S. Haykin. *Multiple-Input Multiple-Output Channel Models.* John Wiley & Sons, 2010.
4. Choi, J. *Optimal Combining & Detection.* Cambridge University Press, 2010.
5. Chokhalingam, A., and B. S. Rajan. *Large MIMO Systems.* Cambridge University Press, 2014.

B7464 – Cognitive Radio Networks

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course covers essential concepts at the intersection of intelligent wireless communication and dynamic spectrum utilization. It begins with the evolution and architecture of Software-Defined Radio (SDR) and Cognitive Radio (CR), highlighting their benefits, enabling technologies, and regulatory frameworks. The course introduces the cognitive radio architecture, cognition cycle, and core components that enable intelligent spectrum sensing and decision-making. Key topics include primary user detection techniques, spectrum sharing models, and dynamic spectrum access strategies. It further explores optimization and learning algorithms for efficient spectrum management and extends into practical applications such as IoT, M2M communication, and smart infrastructure. The course also introduces spectrum trading concepts, including pricing and auction models for secondary markets. Through a balance of theoretical principles and real-world use cases, students gain a solid foundation for research and development in next-generation wireless communication systems.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation, and Infrastructure
SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

B7463.1. Describe the architecture, functions, and enabling technologies of Software-Defined Radio and Cognitive Radio systems.

B7463.2. Analyze the cognitive radio architecture and cognition cycle for dynamic and intelligent spectrum access.

B7463.3. Apply spectrum sensing techniques and evaluate performance trade-offs in cognitive radio networks.

B7463.4. Develop optimization and learning algorithms for efficient dynamic spectrum allocation and access.

B7463.5. Apply cognitive radio in IoT and smart applications, and analyze spectrum trading for efficient spectrum use.

Course Syllabus

Unit-I:

Introduction to Software-Defined Radio and Cognitive Radio: Evolution of Software Defined Radio and Cognitive radio: definitions, goals, benefits, architectures, relations with other radios, issues, enabling technologies, radio frequency spectrum and regulations, Overview of IEEE 802.22 standard for broadband wireless access in TV bands.

Unit-II:

Cognitive Radio Architecture: Cognitive Radio – functions, components and design rules, Cognition cycle –orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture.

Unit-III:

Spectrum sensing and dynamic spectrum access: Introduction – Primary user detection techniques – energy detection, feature detection, matched filtering, cooperative detection and other approaches, Fundamental Tradeoffs in spectrum sensing, Spectrum Sharing Models of Dynamic Spectrum Access - Unlicensed and Licensed Spectrum Sharing, Fundamental Limits of Cognitive Radio.

Unit-IV:

Optimization and Learning in Spectrum Access: Dynamic Spectrum Access (DSA) strategies: Spectrum broker, centralized dynamic spectrum access, distributed dynamic spectrum access, Optimization techniques in DSA: Linear programming, Convex programming, Non-linear, Integer, Dynamic, and Stochastic programming, learning algorithms and protocols.

Unit-V:

Cognitive Radio Applications and Spectrum Trading: Applications of Cognitive Radio in IoT, M2M communications, smart grids, and smart cities. Enabling technologies and communication protocols for CR-based IoT systems. Introduction to spectrum trading, pricing models, and auction-based spectrum allocation.

Books and Materials

Text Books:

1. Wyglinski, Alexander M., Maziar Nekovee, and Thomas Hou. *Cognitive Radio Communications and Networks.* Academic Press, Elsevier, 2010.
2. Fette, Bruce. *Cognitive Radio Technology.* Newnes, 2006.
3. Chen, Kwang-Cheng, and Ramjee Prasad. *Cognitive Radio Networks.* John Wiley & Sons, 2009.

Reference Books:

1. Arslan, Huseyin, editor. *Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems.* Springer, 2007.
2. Doyle, Linda E. *Essentials of Cognitive Radio.* Cambridge University Press, 2009.

B7465 – Multimedia Signal Processing

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces the fundamental concepts and technologies of multimedia systems, including multimedia production, sharing, and distribution. It covers graphics and image representation, color models, video fundamentals, analog and digital video, display interfaces, and the basics of digital audio such as digitization, MIDI, and audio transmission. Students will learn multimedia data compression techniques, both lossless and lossy, along with standards like JPEG, JPEG2000, H.261, and H.263. The course explores MPEG standards (MPEG-1, MPEG-2, MPEG-4, MPEG-7) and advanced video coding methods including H.264 and H.265, focusing on motion compensation, quantization, and entropy coding. Audio compression techniques, including ADPCM, psychoacoustics, MPEG audio standards, and modern codecs, are also discussed. Finally, the course addresses multimedia information sharing, retrieval methods, and content-based search, preparing students for applications in streaming, storage, and digital libraries.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation, and Infrastructure
SDG 10 – Reduced Inequalities

Course Outcomes

After the completion of the course, the student will be able to:

B7465.1. Explain the fundamentals of multimedia systems, including data representation for multimedia signals.

B7465.2. Apply lossless and lossy compression algorithms for image, audio, and video data.

B7465.3. Analyze the performance of multimedia compression standards for real time applications.

B7465.4. Analyze the performance of audio compression techniques in realtime audio signal compression applications.

B7465.5. Apply concepts of multimedia information retrieval and content-based search in digital libraries.

Course Syllabus

Unit-I:

Introduction to Multimedia: Tasks and Concerns, Multimedia Production, Sharing and Distribution, Graphics and Image Data Representation, Colour in Image and Video, Fundamental Concepts in Video, Analog Video, Digital Video, Video Display Interfaces, and Basics of Digital Audio: Digitization of Sound, MIDI, Quantization and Transmission of Audio.

Unit-II:

Multimedia Data Compression: Concepts of Information Theory, Lossless Compression Algorithms: Run-Length Coding, Variable-Length Coding, Arithmetic Coding, Lossless Image Compression, Lossy Compression

Algorithms: DCT, KL Transform, Wavelet-Based Coding, Image Compression Standards, JPEG2000, JPEG-LS, JBIG and JBIG2 standards, Basic Video Compression Techniques, H.261, and H.263.

Unit-III:

MPEG Video Coding Standards:MPEG-1 standard, Motion Compensation in MPEG-1, MPEG-2 standard, MPEG-2 Scalabilities, MPEG-4 standard, Video Object-Based Coding in MPEG-4, Synthetic Object Coding in MPEG-4, MPEG-4 Parts, Profiles and Levels, MPEG-7 standard, Descriptor (D), Description Scheme (DS), Description Definition Language (DDL).

Unit-IV:

New Video Coding Standards: H.264 coding, Quantization and Scaling, Entropy Coding, Context-Adaptive Variable Length Coding, Context-Adaptive Binary Arithmetic Coding, H.265 coding, Motion Compensation, Intra Coding, Discrete Sine Transform, Entropy and Special Coding Modes, H.264 and H.265 Profiles, Comparisons of Video Coding Efficiency.

Unit-V:

Audio Compression Techniques: ADPCM in Speech Coding, Vocoders, Psychoacoustics, MPEG Audio, MPEG Audio Compression Algorithm, MPEG-2 AAC, MPEG-4 Audio, Other Audio Codecs, OggVorbis, MPEG-7 Audio and Beyond, Multimedia Information Sharing and Retrieval, Content-Based Retrieval in Digital Libraries.

Books and Materials

Text Books:

1. Li, Ze-Nian, Mark S. Drew, and Jiangchuan Liu. *Fundamentals of Multimedia.* 2nd ed., Springer, 2014.
2. Bovik, Alan C. *The Essential Guide to Video Processing.* 1st ed., Academic Press, 2009.

Reference Books:

1. Banerji, A., and A. M. Ghosh. *Multimedia Technologies.* McGraw Hill Education (India) Private Limited, 2012.
2. Parekh, Ranjan. *Principles of Multimedia.* 3rd ed., CRC Press, 2025.

B7466 – Computer Vision

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

The course introduces fundamental concepts and techniques in computer vision and image processing, along with their well-known application areas. It is designed to equip students with the knowledge and skills required to understand and work with cutting-edge technologies in machine vision. By completing this course, students will develop a strong foundation to pursue careers in research and industry. The curriculum covers essential methods in computer vision and image processing, enabling students to analyze, implement, and innovate solutions in this domain. Additionally, students will explore opportunities for automation using image processing and computer vision technologies, preparing them to contribute to advancements and research in the field.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education

SDG 9 – Industry, Innovation, and Infrastructure

SDG 11 – Sustainable Cities and Communities

Course Outcomes

After the completion of the course, the student will be able to:

B7466.1. Explain the fundamental concepts of computer vision, image formation, geometric transformations, and mathematical foundations.

B7466.2. Apply image representation, preprocessing, and filtering techniques for image enhancement and segmentation.

B7466.3. Apply feature extraction techniques to extract application dependentfeatures.

B7466.4. Analyze classification algorithms and dimensionality reduction techniques for image recognition tasks.

B7466.5. Analyze the impact of machine learning models on computer vision applications.

Course Syllabus

Unit-I:

Introduction: Introduction, Goals of Computer Vision, concept of pattern recognition, Computer Vision Applications, Image Formation process, Radiometry, 2D Geometric Transformations, Mathematical foundations: Basics concepts in linear algebra, Variational calculus, singular value decomposition, principal component analysis, Bayesian theory.

Unit-II:

Image Representation and Preprocessing: Image representation, Classical filtering operations, thresholding techniques, edge detection techniques, corner and interest point detection, Binary morphological operations, Image Segmentation, Discrete wavelet transform.

Unit-III:

Feature Extraction: Texture Features and Descriptors, Color Features, Object Boundary and Shape Representations, Interest or Corner Point Detectors, HOG, SIFT, SURF, Visual Matching: Bag-of-words, VLAD, RANSAC, Hough transform, Pyramid Matching.

Unit-IV:

Classification: Types of classifier, Training and testing, accuracy measurement parameters, confusion matrix, Linear Regression, Linear discriminant functions, Minimum distance classifier, Euclidean and Mahalanobis distances, k-NN Classifier, Gaussian Classifier, Clustering, Dimension Reduction, PCA, LDA, ANNs for Pattern Classification.

Unit-V:

Applications of Computer vision: Medical Image Analysis, Segmentation Challenges in Medical Image, Automated Video Surveillance, foreground background separation, Object Recognition and tracking, Face Recognition, Facial Expression Recognition, Optical Character Recognition, Content-Based Image Retrieval, Video Data Processing.

Books and Materials

Text Books:

1. Bhuyan, M. K. *Computer Vision and Image Processing: Fundamentals and Applications.* CRC Press, Taylor & Francis Group, 2019.
2. Gonzalez, Rafael C., and Richard E. Woods. *Digital Image Processing.* 4th ed., PHI, 2018.

Reference Books:

1. Forsyth, D., and J. Ponce. *Computer Vision: A Modern Approach.* Prentice Hall, 2012.
2. Szeliski, Richard. *Computer Vision: Algorithms and Applications.* Springer, 2010.
3. Prince, Simon J. D. *Computer Vision: Models, Learning, and Inference.* Cambridge University Press, 2012.

B7407 – FPGA based System Design Laboratory

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
0	0	60	0	60	2	40	60	100

Course Description

Course Overview

This laboratory course focuses on the practical implementation of digital circuits and systems using Verilog Hardware Description Language (HDL) on FPGA platforms. Students will design and simulate fundamental building blocks such as adders, shifters, decoders, and floating-point units, as well as advanced digital modules like Booth multipliers, UART communication interfaces, and asynchronous FIFOs. The course emphasizes real-time applications through projects such as traffic light controllers, PWM generators, debouncing circuits, alarm clocks, and car parking systems. Through hands-on experience with industry-standard tools like AMD Vivado, students will develop skills in HDL coding, simulation, synthesis, and FPGA-based hardware prototyping, preparing them for real-world digital system design challenges.

Course Pre/Co-requisites

CMOS VLSI Design

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation, and Infrastructure
SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

B7407.1. Implement combinational and sequential circuits using Verilog HDL.
B7407.2. Apply simulation and verification techniques for validating digital designs.
B7407.3. Develop FSM-based designs for digital control systems.
B7407.4. Analyze the functionality and performance of digital communication and interface modules.
B7407.5. Integrate multiple digital modules to prototype system-level applications on FPGA platforms.

Course Syllabus

List of Experiments:

1. Hexadecimal digit to seven-segment LED decoder
2. Sign-magnitude adder
3. Barrel shifter
4. Simplified floating-point adder
5. Booth Multiplier Algorithm
6. Rising-edge detector
7. Verilog code for button debouncing on FPGA
8. PWM Generator
9. Traffic Light Controller
10. UART Transmitter and Receiver

11. Alarm clock
12. Car Parking System
13. RAM, ROM
14. Asynchronous FIFO

Laboratory Equipment/Software/Tools Required:

1. Computer Systems are installed with AMD Vivado Software

Books and Materials

Text Books:

1. Chu, Pong P. *FPGA Prototyping by Verilog Examples.* John Wiley & Sons, Inc., 2008.
2. Wolf, Wayne. *FPGA-Based System Design.* Prentice Hall PTR, Englewood Cliffs, New Jersey, 2004.

Reference Books:

1. Palnitkar, Samir. *Verilog HDL: A Guide to Digital Design and Synthesis.* 2nd ed., Prentice Hall, 2003.
2. Padmanabhan, T. R., and B. Bala Tripura Sundari. *Design through Verilog HDL.* Wiley-Interscience, 2004.
3. Trimberger, Stephen M. *Field-Programmable Gate Array Technology.* 1st ed., Springer International, 1997.

A7408 – Advanced Digital Signal Processing Laboratory

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
0	0	60	0	60	2	40	60	100

Course Description

Course Overview

The course describes how to solve simple problems in the areas of communications and signal processing in a MATLAB environment. The course provides practical experience of signal and image processing implementation in preparation for the project. The course will be composed of programming sessions and course assignments covering discrete time signal analysis, communications and image processing. Experiments cover fundamental concepts of digital signal processing like sampling and aliasing, quantization in A/D conversion and in internal arithmetic operations, digital filter design and implementation, signal generation, spectrum estimation and fast transforms, sampling-rate conversion and multi-rate processing. Application experiments address a selection of multi-media and digital communications problems.

Course Pre/Co-requisites

CMOS VLSI Design

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation, and Infrastructure
SDG 11 – Sustainable Cities and Communities

Course Outcomes

After the completion of the course, the student will be able to:

B7408.1. Analyze the properties of discrete-time systems to compute the linear convolution and correlations of discrete-time sequences

B7408.2. Evaluate the discrete Fourier transform (DFT) of a sequence to compute the linear convolution of two sequences.

B7408.3. Design and Implement the FIR and IIR digital filters for the given specifications.

B7408.4. Examine the Multirate Digital Signal Process Approaches.

B7408.5. Analyze the various power spectrum techniques to calculate the Power Spectral Density.

Course Syllabus

List of Experiments:

1. Calculation of auto correlation and cross correlation
2. Butterworth low pass and high pass filter design
3. Chebychev type I, II filter design
4. FIR filter design
5. Estimating the cost of filter
6. Decimation and interpolation using rationale factors
7. Wiener filter design
8. Linear prediction filter design

9. Adaptive filter design for noise cancellation
10. Estimation of power spectral density
11. Estimation of PSD using parametric method
12. Estimation of PSD using non-parametric method
13. Stability using Hurwitz Routh criteria

Laboratory Equipment/Software/Tools Required:

1. Computer Systems are installed with MATLAB Software

Books and Materials

Text Books:

1. Proakis, John G., and Dimitris G. Manolakis. *Digital Signal Processing: Principles, Algorithms, and Applications.* 4th ed., Prentice Hall, 2007.
2. Fliege, Norbert J. *Multirate Digital Signal Processing: Multirate Systems, Filter Banks, Wavelets.* 1st ed., John Wiley and Sons Ltd., 1999.

Reference Books:

1. Suter, Bruce W. *Multirate and Wavelet Signal Processing.* 1st ed., Academic Press, 1997.
2. Hayes, Monson H. *Statistical Digital Signal Processing and Modeling.* John Wiley & Sons Inc., 2002.

II M.Tech. I Semester

PROFESSIONAL ELECTIVE-V

B7467 – Design for Testability

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

VLSI design for testability is a technique that allows a chip to be tested. In VLSI, design for testability means adding extra logic during the design process to help with post-production testing. As part of architecture definition, logic design, verification, test pattern generation and more.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education

SDG 9 – Industry, Innovation, and Infrastructure

SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

B7467.1. Understand role of testing in VLSI designs and identify the errors

B7467.2. Analyze the test pattern generation for the Combinational and Sequential Circuits.

B7467.3. Analyze scan based testing by applying various methods.

B7467.4. Design and investigate self-checking circuits.

B7467.5. Design Testable digital circuits for various applications.

Course Syllabus

Unit-I:

Introduction to Testing: Testing Philosophy, Role of Testing, Digital and Analog VLSI Testing, VLSI Technology Trends affecting Testing, Types of Testing, Fault Modeling: Defects, Errors and Faults, Functional Versus Structural Testing, Levels of Fault Models, Single Stuck-at Fault

Unit-II:

Test Generation For Combinational and Sequential Circuits: Test generation for combinational logic circuits-Testable combinational logic circuit design-Test generation for sequential circuits-design of testable sequential circuits. Random testing, transition count testing, signature analysis

Unit-III:

Testability Measures: SCOAPC ontrollability and Observability, High Level Testability Measures, System level DFT approaches, Digital DFT and Scan Design:Ad-Hoc DFT Methods, Scan Design, Partial-Scan Design, Variations of Scan.

Unit-IV:

Self -Test and Test Algorithms: Introduction, design of totally self-checking checkers, Built-In Self-Test. Test pattern generation for BIST - Circular BIST - BISTArchitectures - Testable Memory Design-Test algorithms - Test generation for Embedded RAMs.

Unit-V:

Boundary Scan Standard: Motivation, System Configuration with Boundary Scan: TAP Controller and Port, Boundary Scan Test Instructions, Pin Constraints of the Standard, Boundary Scan Description Language: BDSL Description Components, Pin Descriptions.

Books and Materials

Text Books:

1. Bushnell, M. L., and V. D. Agrawal. *Essentials of Electronic Testing for Digital, Memory, and Mixed-Signal VLSI Circuits.* Kluwer Academic Publishers, 2000.
2. Abramovici, Miron, Melvin A. Breuer, and Arthur D. Friedman. *Digital Systems Testing and Testable Design.* Jaico Publishing House, 1990.

Reference Books:

1. Lala, P. K. *Digital Circuits Testing and Testability.* Academic Press, 1997.
2. Fujiwara, Hideo. *Logic Testing and Design for Testability.* MIT Press, 1985.
3. Crouch, Alan L. *Design Test for Digital ICs and Embedded Core Systems.* Prentice Hall International, 1999.

A7468 – Hardware Software Co-Design

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces the principles and methodologies of hardware and software co-design for embedded systems. It covers platform design space exploration, data flow modelling, custom architecture development, and hardware/software interface strategies. Students will engage with real-world case studies to understand co-design challenges in cryptographic and signal processing applications. The course emphasizes system-level thinking, enabling learners to create optimized, high-performance embedded solutions through effective hardware-software partitioning.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education

SDG 8 – Decent Work and Economic Growth

SDG 9 – Industry, Innovation, and Infrastructure

Course Outcomes

After the completion of the course, the student will be able to:

B7468.1. Integrate hardware and software co-design principles for embedded applications.

B7468.2. Assess data flow implementations through control and data flow graphs in hardware and software

B7468.3. Develop custom architectures using FSMD and evaluate microprogrammed control limitations

B7468.4. Examine hardware/software interface methods for efficient communication and synchronization

B7468.5. Design co-processor-based solutions using cryptographic and signal processing case studies

Course Syllabus

Unit-I:

Nature of Hardware and Software: Introduction to Hardware, Software and its co-design principles, Driving Factors in Co-Design and Exploration of Platform Design Space, Application Mapping and the Dualism of Hardware Design vs. Software Design, Concepts of Concurrency and Parallelism in Parallelism in Embedded Systems.

Unit-II:

Data Flow Implementation in Software and Hardware: Software Implementation of Data Flow, Converting queues and actors into software, Dynamic Scheduler, Hardware Implementation of Data Flow, single rate SDF graphs into hardware, Pipelining, Analysis of control flow and data flow, construction of control and data flow graph.

Unit-III:

Design Space of Custom Architectures: Finite state machines with datapath, FSMD design example, Limitations of Microprogrammed Architecture, Microprogrammed control, microinstruction encoding, Microprogrammed data path, microprogrammed machine, Embedded Core, RISC pipeline, Program organization, SoC interfaces for custom hardware, Design Principles in SoC Architecture

Unit-IV:

Hardware/ Software Interfaces: Principles of Hardware/software communication, synchronization schemes, communication constrained versus Computation constrained, Tight and Loose coupling, On-chip buses, Memory mapped interfaces, coprocessor interfaces, custom instruction interfaces.

Unit-V:

Case Studies: TriviumCripto coprocessor, Trivium stream cipher algorithm, Trivium for 8-bit platforms, AES coprocessor, CORDIC coprocessor algorithm and implementation.

Books and Materials

Text Books:

Staunstrup, J., and W. Wolf. *Hardware/Software Co-Design: Principles and Practice.* 2nd ed., Springer, 2009.

1. Schaumont, P. *A Practical Introduction to Hardware/Software Codesign.* Springer, 2010.

Reference Books:

1. Marwedel, P. *Embedded System Design: Modeling, Synthesis and Verification.* 2nd ed., Springer, 2010.
2. Harris, S., and D. Harris. *Digital Design and Computer Architecture: ARM Edition.* Morgan Kaufmann, 2015.

B7469 - Software Defined Radio

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course provides a comprehensive exploration of Software Defined Radio (SDR) as a pivotal technology in modern wireless communications. By abstracting radio functionalities into software, SDR offers unprecedented flexibility and reconfigurability. This course guides students from the foundational principles of SDR architecture to the practical design and implementation of communication systems. It emphasizes real-world applications, covering RF front-end design, advanced digital signal processing, and the software tools necessary for building and deploying SDR-based solutions.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation, and Infrastructure
SDG 11 – Sustainable Cities and Communities

Course Outcomes

After the completion of the course, the student will be able to:

B7469.1. Develop and test SDR-based analog and digital communication transceivers.

B7469.2. Implement key DSP algorithms for synchronization and baseband signal processing within an SDR framework.

B7469.3. Analyze performance trade-offs within SDR architectures, focusing on the RF front-end and digital subsystems.

B7469.4. Design an integrated SDR system for a target application, such as cognitive radio or wireless networking.

B7469.5. Justify the selection of hardware, software, and protocols for a given SDR application based on performance evaluation.

Course Syllabus

Unit-I:

Fundamentals of Software Defined Radio: Introduction to Software Defined Radio, SDR Architecture and Design Principles, Characteristics, Benefits, and Limitations of SDR, Major SDR Standards and Applications.

Unit-II:

RF and Digital Signal Processing for SDR: RF Front-End Topologies and Design, Dynamic Range, Noise, and Channel Capacity, Transmitter and Receiver Architectures, Analog-to-Digital and Digital-to-Analog Conversion, Multirate Signal Processing and Digital Filter Banks, Direct Digital Synthesis (DDS).

Unit-III:

SDR Implementation and Synchronization: SDR Processing Frameworks (GNU Radio, Python), Implementation of Analog and Digital Modulation, Timing, Carrier, and Frame Synchronization, Channel Estimation and Equalization, Signal Generation and Capture.

Unit-IV:

Advanced SDR Concepts and Cognitive Radio: Cognitive Radio Architecture and Spectrum Sensing, Dynamic Spectrum Access and Management, Smart Antennas, Beamforming, and MIMO for SDR, Advanced Channel Coding (Block, Convolutional, Turbo), SDR Security and Wireless Jamming

Unit-V:

Applications of SDR: Wireless Networking: PHY and MAC Layer Prototyping, Satellite Communications and VSAT Systems, Modern Radar Systems (Pulse, CW, MTI), Internet of Things (IoT) and Wireless Sensor Networks, Case Studies in 5G, Defence and Commercial Systems

Books and Materials

Text Books:

1. Collins, T. F., R. Getz, D. Pu, and A. M. Wyglinski. *Software-Defined Radio for Engineers.* Artech House, 2018.
2. Reed, J. H. *Software Radio: A Modern Approach to Radio Engineering.* Prentice Hall, 2002.

Reference Books:

1. Wyglinski, A. M., et al. *Digital Communication Systems Engineering with Software-Defined Radio.* Artech House, 2012.
2. Rouphael, T. J. *RF and Digital Signal Processing for Software-Defined Radio.* Elsevier, 2009.
   Proakis, J. G., and M. Salehi. *Digital Communications.* 5th ed., McGraw-Hill, 2008.
3. Mitola, J. *Software Radio Architecture: Object-Oriented Approaches to Wireless Systems Engineering.* John Wiley & Sons, 2000.

B7470 – Optimization Techniques

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course provides an in-depth comprehension of optimization techniques employed to address complex engineering challenges. It presents the principles of traditional optimization techniques and progresses to meta heuristic algorithms inspired by events in nature. Students will investigate Genetic Algorithms (GA), Swarm Intelligence methodologies such as Particle Swarm Optimization (PSO), Differential Evolution (DE), and Teaching-Learning Based Optimization (TLBO). Students will learn to model, analyze, and solve constrained and unconstrained, linear and non-linear optimization problems through theoretical principles and practical applications utilizing benchmark test functions and case studies.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education

SDG 9 – Industry, Innovation, and Infrastructure

SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

B7470.1. Formulate and classify real-world optimization problems and identify suitable optimization techniques.

B7470.2. Analyze classical optimization methods to both constrained and unconstrained problems.

B7470.3. Understand and implement Genetic Algorithms (GA) for solving benchmark and real-world optimization tasks.

B7470.4. Design and apply Swarm Intelligence techniques such as Particle Swarm Optimization (PSO) for complex problem solving.

B7470.5. Evaluate and employ Differential Evolution (DE) and Teaching-Learning Based Optimization (TLBO) algorithms for solving non-linear and multi-objective optimization problems.

Course Syllabus

Unit-I:

Introduction: Statement of an optimization problem, Classification of optimization problems, Overview of various optimization Techniques, Classical optimization techniques: Single variable optimization, Multivariable optimization, Unconstrained optimization and Constrained optimization.

Unit-II:

Genetic algorithm (GA): Fundamentals of Genetic algorithm, History, Basic concepts, working principle, Encoding, Design of Fitness function, Reproduction, Crossover, Mutation operator in GA, Applications of GA for standard Bench mark test functions Fundamentals.

Unit-III:

Swarm intelligence: Main inspiration source, Basic particle swarm optimization, Initialization techniques, Theoretical investigations and parameter selection, Design of PSO algorithm using computational statistics, Termination conditions, Application of PSO, Standard test function optimization, new modifications of PSO.

Unit-IV:

Differential Evolution: Classical differential evolution- An outline, Mutation, cross over, new modifications of DE.

Unit-V:

Teaching Learning Based Optimization (TLBO): Applications of TLBO for standard Bench mark test functions, Case studies Basic Steps in Differential Evolution algorithm. **Wavelet Mutation:** Basic Wavelet Theory, wavelet theory in mutation operation, Wavelet Mutation (WM) to improve further the optimization performance of Evolutionary Optimization Techniques through mutation.

Books and Materials

Text Books:

1. Rajasekharan, S., and G. A. Vijaya Lakshmi Pai. *Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications.* PHI Learning, 2011.
2. Deb, Kalyanmoy. *Optimization for Engineering Design: Algorithms and Examples.* 2nd ed., PHI Learning, 2013.

Reference Books:

1. Yang, Xin-She. *Nature-Inspired Optimization Algorithms.* Elsevier, 2014.
2. Daniels, Richard W. *An Introduction to Numerical Methods and Optimization Techniques.* Elsevier North Holland, 1978.
3. Eiben, A. E., and J. E. Smith. *Introduction to Evolutionary Computing.* Springer, 2010.

OPEN ELECTIVES

B7081 - Business Analytics

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course addresses the scope of business analytics, process and tools used to get competitive advantages of business analytics. It covers the forecasting techniques to predict the given data for various decision making. Apart from prediction it also establishes the relationship between the given data to formulate the strategies for business decisions..

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 8 – Decent Work and Economic Growth
SDG 9 – Industry, Innovation and Infrastructure

Course Outcomes

After the completion of the course, the student will be able to:

B7081.1 Describe the fundamentals and techniques of data analytics.

B7081.2 Evaluate data and apply critical thinking to make informed decisions using deep analytics.

B7081.3 Develop predictive models to support business decision-making.

B7081.4 Design prescriptive models to recommend optimal business solutions.

B7081.5 Interpret analytical results and present them as clear, actionable insights.

Course Syllabus

Unit-I:

Business analytics and Statistical Tools: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

Unit-II:

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Unit-III:

Organization Structures of Business Analytics:, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

Unit-IV:

Forecasting Techniques and Monte Carlo Simulation and Risk Analysis: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model,Overbooking Model, Cash Budget Model.

Unit-V:

Decision Analysis and recent trends: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

Books and Materials

Text Books:

1. Varshney, N., and Maheswari. *Business Analytics: Principles, Concepts, and Applications.* By Marc J. Schniederjans, Dara G. Schniederjans, and Christopher M. Starkey, 1st ed., Pearson FT Press, 2014.

Reference Books:

1. Evans, James R. *Business Analytics.* Global Edition, Pearson Higher Education & Professional Group, 2020.

B7082 - Waste to Energy

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

The course deals with the production of energy from different types of wastes through thermal, biological and chemical routes. This course provides insights into waste management options by reducing the waste destined for disposal and encouraging the use of waste as a resource for alternate energy production. This course is explores Biomass Pyrolysis, Biomass gasification, Biomass combustions and Bio energy systems.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 7 – Affordable and Clean Energy
SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

B7082.1. Classify different waste material produces from all sources.

B7082.2. Analyze Bio energy systems resources, process and application.

B7082.3. Apply emerging methods for Bio mass Pyrolysis, gasification and combustion to improve the efficiency.

B7082.4. Analyze different case studies for understanding success and failure of waste to energy technologies.

Course Syllabus

Unit-I:

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

Unit-II:

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Unit-III:

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers - Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Unit-IV:

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Unit-V:

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Books and Materials

Text Books:

1. Desai, Ashok V. *Non-Conventional Energy.* Wiley Eastern Ltd., 1990.
2. Khandelwal, K. C., and S. S. Mahdi. *Biogas Technology: A Practical Handbook.* Vols. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

Reference Books:

1. Challal, D. S. *Food, Feed and Fuel from Biomass.* IBH Publishing Co. Pvt. Ltd., 1991.
2. WereKo-Brobby, C. Y., and E. B. Hagan. *Biomass Conversion and Technology.* John Wiley & Sons, 1996.

B7083 - Operations Research

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

The courses in Operational Research offer a unique blend of traditional coursework, practical skills, and real-world problem-solving experience designed to position students for success in today's competitive world. This course covers Linear Programming, Non-Linear Programming Problem, Mathematical Models and problems.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

B7083.1. Gain knowledge in concepts and techniques of Operations Research.

B7083.2. Determine the optimal solution for Linear Programming problems.

B7083.3. Formulate and obtain the optimal solution for non- Linear Programming problems.

B7083.4. Solve to get optimal solution using queuing and inventory models.

B7083.5. Determine solution for non- Linear Programming problems using dynamic programming.

Course Syllabus

Unit-I:

Linear Programming Problem & Its Application I: Introduction, Formulation of LPP. Slack Variable, Surplus Variable and Artificial Variables. Standard Form and Matrix Form. Concept of Duality. Graphical Method. Simplex Method. Big - M method & Two - Phase Method. Problems of Degeneracy.

Unit-II:

Linear Programming Problem & Its Application II: Parametric Programming introduction . Types of Linear Variations. Graphical and Analytical Sensitivity Analysis.

Unit-III:

Non-Linear Programming Problem I: Introduction, Formulation and Graphical Method, Kuhn-Tucker Conditions, Quadratic Programming Problems by Wolfe's and Beale's Method.

Unit-IV:

Non-Linear Programming Problem II: Geometric programming introduction and analytical methods , Fractional programming introduction and analytical methods, Dynamic programming introduction and analytical methods.

Unit-V:

General Mathematical Models: Sequencing - n Jobs and m Machines, Inventory Control - introduction and its analytical methods. Single server queuing model.

Books and Materials

Text Books:

1. Desai, Ashok V. *Non-Conventional Energy.* Wiley Eastern Ltd., 1990.
2. Khandelwal, K. C., and S. S. Mahdi. *Biogas Technology: A Practical Handbook.* Vols. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

Reference Books:

1. Challal, D. S. *Food, Feed and Fuel from Biomass.* IBH Publishing Co. Pvt. Ltd., 1991.
2. WereKo-Brobby, C. Y., and E. B. Hagan. *Biomass Conversion and Technology.* John Wiley & Sons, 1996.

B7084 - Blockchain Technology

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces blockchain, a revolutionary technology that enables peer-to-peer transfer of digital assets without any intermediaries, and is predicted to be just as impactful as the Internet. A blockchain is a permanent, sequential list of transaction records distributed over a network. The course introduces consensus, proof of work, mining, in Bitcoin. The course introduces ethereum blockchain and smart contracts.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education

SDG 9 – Industry, Innovation and Infrastructure

SDG 16 – Peace, Justice and Strong Institutions

Course Outcomes

After the completion of the course, the student will be able to:

B7084.1. Identify and explain the fundamental concepts, architecture, and working principles of blockchain technology.

B7084.2. Demonstrate the process of cryptocurrency transactions using Bitcoin and analyze its underlying mechanisms.

B7084.3. Compare and choose suitable blockchain platforms such as Ethereum for ensuring data security and integrity.

B7084.4. Design and implement smart contracts based on given problem requirements using Ethereum or similar platforms.

B7084.5. Evaluate blockchain applications and deployment on Testnet environments for real-world use cases.

Course Syllabus

Unit-I:

Introduction to Cryptocurrencies: Cryptographic Hash Functions, Hash Pointers and Data Structures, Digital Signatures, Public Keys as Identities, A Simple Cryptocurrency. How Bitcoin Achieves Decentralization: Centralization vs. Decentralization, Distributed Consensus, Consensus without Identity: the Block Chain, Incentives and Proof of Work, Putting It All Together.

Unit-II:

Mechanics of Bitcoin: Bitcoin Transactions, Bitcoin Scripts, Applications of Bitcoin Scripts, Bitcoin Blocks, The Bitcoin Network, Limitations Improvements. Store Usage: How to Store and Use Bitcoins, Hot and Cold Storage, Splitting and Sharing Keys, Online Wallets and Exchanges, Payment Services, Transaction Fees, Currency Exchange Markets.

Unit-III:

Bitcoin Mining: The Task of Bitcoin Miners, Mining Hardware, Energy Consumption Ecology, Mining Pools, Mining Incentives and Strategies. Bitcoin and Anonymity: Anonymity Basics, How to de-anonymizeBitcoin, Mixing, Decentralized Mixing, Zerocoin and Zerocash, Tor and the Silk Road.

Unit-IV:

Ethereum: What is Ethereum, smart contracts, Solidity Ethereum Virturalmachine. Installing solidity ethereum wallet, basics of solidity by example, Layout of a solidity source file structure of smart contracts, General value types, ether units, Time units, Globally available variables and functions.

Unit-V:

Operators: Arithmetic, Logical Bitwise operators, Control structure (if-else, for, while, do-while), Scoping and declarations, Input parameters and output parameters, Function calls return types, Function Modifiers, Fallback functions, Abstract contract, Creating contracts via new operator, Inheriting smart contracts, Importing smart contracts compiling contracts, Events logging, exceptions, Examples of smart contract : crowd funding, voting ballot.

Books and Materials

Text Books:

1. Narayanan, A., Bonneau, J., Felten, E., Miller, A., Goldfeder, S.,Bitcoin and Cryptocurrency Technologies: a comprehensive introduction, Princeton University Press, 2016.
2. Dave Hoover, Kevin Solorio, and Randall Kanna., Hands–On Smart Contract Development with Solidity and Ethereum, O'Reilly Media, Inc., 2019.

Reference Books:

1. Andreas M. Antonopoulos, Mastering Bitcoin: Unlocking Digital Cryptocurrencies, 1st Edition, O'Reilly Media, Inc., 2019.

B7085 - Cyber Security

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course drawing upon a wealth of experience from academia, industry, and government service, Cyber Security details and dissects, in current organizational cyber security policy issues on a global scale—taking great care to educate students on the history and current approaches to the security of cyberspace. It includes thorough descriptions of Cyber Offences, Cyber Crime, tools and methods used in Cyber Crime. It also delves into organizational implementation issues, and equips students with descriptions of the positive and negative impact of specific policy choices.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 16 – Peace, Justice and Strong Institutions

Course Outcomes

After the completion of the course, the student will be able to:

B7085.1. Demonstrate the basics of cybercrime in computer, networked device or a network.

B7085.2. Identify various cyber offences in real time.

B7085.3. Identify the different attacks in cybercrime.

B7085.4. Use various methods and tools to control cybercrimes and cyber offences.

B7085.5. Examine how to protect organizations from intruders, attackers and cyber criminals.

Course Syllabus

Unit-I:

Introduction to Cybercrime: Introduction, Cybercrime, and Information Security, who are Cybercriminals, Classifications of Cybercrimes. The legal Perspectives and Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cybercrimes.

Unit-II:

Cyber Offenses: How Criminals Plan Them: Introduction, How Criminals plan the Attacks, Social Engineering, Cyber stalking, Cyber cafe and Cybercrimes. Botnets: The Fuel for Cybercrime, Attack Vector, and Cloud Computing.

Unit-III:

Cybercrime: Mobile and Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.

Unit-IV:

Tools and Methods: Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow.

Unit-V:

Cyber Security: Organizational Implications Introduction, Cost of Cybercrimes and IPR issues, Web threats for Organizations, Security and Privacy Implications. Social media marketing: Security Risks and Perils for Organizations, Social Computing and the associated challenges for Organizations.

Books and Materials

Text Books:

1. Godbole, Nina, and Sunil Belapure. *Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives.* 1st ed., Wiley India, 2011.

Reference Books:

1. Graham, James, Richard Howard, and Ryan Otson. *Cyber Security Essentials.* 1st ed., CRC Press, 2011.
2. Wu, Chwan-Hwa (John), and J. David Irwin. *Introduction to Cyber Security.* 1st ed., CRC Press/T&F Group, 2013.
3. Clarke, Richard A., and Robert Knake. *Cyberwar: The Next Threat to National Security & What to Do About It.* Ecco, 2010.

AUDIT COURSES

B7091 – Disaster Management

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
30	0	0	0	30	0	100	-	100

Course Description

Course Overview

The course has been framed with an intention to provide a general concept in the dimensions of disasters caused by nature beyond human control as well as the disasters and environmental hazards induced by human activities with emphasis on Natural disaster, Man-made disaster, vulnerability and risks of disasters, Disaster Management Mechanism, Capacity Building and disaster coping Strategies and Disaster management planning.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 11 – Sustainable Cities and Communities
SDG 13 – Climate Action

Course Outcomes

After the completion of the course, the student will be able to:

B7091.1. Identify concepts, hazards and vulnerabilities of different types of disasters.

B7091.2. Examine the components of disaster management mechanism.

B7091.3. Select suitable capacity building framework for disaster management.

B7091.4. Interpret various disaster coping strategies.

B7091.5. Develop Strategies for disaster management planning.

Course Syllabus

Unit-I:

Introduction: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude. *Disaster Prone Areas in India:* Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics.

Unit-II:

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

Unit-III:

Disaster Preparedness and Management: Preparedness: Monitoring of Phenomena Triggering A Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

Unit-IV:

Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

Unit-V:

Disaster Mitigation: Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

Books and Materials

Text Books:

1. Nishith, R., and A. K. Singh. *Disaster Management in India: Perspectives, Issues and Strategies.* New Royal Book Company.
2. Sahni, Pardeep, et al., editors. *Disaster Mitigation: Experiences and Reflections.* Prentice Hall of India, New Delhi.
3. Goel, S. L. *Disaster Administration and Management: Text and Case Studies.* Deep & Deep Publication Pvt. Ltd., New Delhi.

B7092 – Value Education

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
30	0	0	0	30	0	100	-	100

Course Description

Course Overview

The present education system does not prepare students well for dealing with life. Primarily, it prepares them for profession or jobs. It concentrates on providing "How to do" rather than "What to do" or "Why to do?". This course will be helpful for students to develop critical ability, commitment and courage in real life problems. Students will learn about happiness, character development, self control, honesty, time management.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 16 – Peace, Justice and Strong Institutions
SDG 10 – Reduced Inequalities

Course Outcomes

After the completion of the course, the student will be able to:

B7092.1. Identify the importance of value-based living for character development.

B7092.2. Emerge as responsible citizens with clear conviction to practice values and ethics in life.

B7092.3. Interpret their role in nation building for a better tomorrow.

B7092.4. Develop a sense of commitment and decision-making capability.

B7092.5. Demonstrate ethical reasoning and leadership in personal and professional life.

Course Syllabus

Unit-I:

Values and Self - Development: Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgments.

Unit-II:

Importance of Cultivation of Values: Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truth fullness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature Discipline.

Unit-III:

Personality and Behavior Development: Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness.

Unit-IV:

Achieving Happiness: Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature.

Unit-V:

Character and Competence: Holy Books vs Blind faith. Self-Management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, and Studying effectively.

Books and Materials

Text Books:

1. Chakroborty, S. K. *Values and Ethics for Organizations: Theory and Practice.* Oxford University Press, New Delhi.
2. Aspin, David N., and Judith D. Chapman. *Values Education and Lifelong Learning: Principles, Policies, Programmes.* Springer, 2007.

B7093 – Constitution of India

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
30	0	0	0	30	0	100	-	100

Course Description

Course Overview

This course enables the students to understand the constitution of India as the Supreme law of India. The student will also gain knowledge about the parliament of India and how it functions. This course will survey the basic structure and operative dimensions of the Indian constitution. It will explore various aspects of the Indian political and legal system from a historical perspective highlighting the various events that led to the making of the Indian constitution.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 16 – Peace, Justice and Strong Institutions
SDG 10 – Reduced Inequalities

Course Outcomes

After the completion of the course, the student will be able to:

B7093.1. Identify the important components of Indian Constitution.

B7093.2. Explore the basics of Constitutional right in various domains .

B7093.3. Illustrate the evolution of Indian Constitution.

B7093.4. Analyze the Administrative process in India from grass-root level.

B7093.5. Relate the basic concepts of democracy, liberty, equality, secular and justice.

Course Syllabus

Unit-I:

History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working), **Philosophy of the Indian Constitution:** Preamble, Salient Features.

Unit-II:

Contours of Constitutional Rights & Duties: Fundamental Rights Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

Unit-III:

Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualification, Powers and Functions.

Unit-IV:

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI:

Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

Unit-V:

Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Books and Materials

Text Books:

1. The Constitution of India, 1950. Government Publication.
2. Busi, S. N., and B. R. Ambedkar. *Framing of the Indian Constitution.* 1st ed., 2015.

Reference Books:

1. Jain, M. P. *Indian Constitution Law.* 7th ed., Lexis Nexis, 2014.
2. Basu, D. D. *Introduction to the Constitution of India.* Lexis Nexis, 2015.

B7094 - Stress Management by Yoga

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
30	0	0	0	30	0	100	-	100

Course Description

Course Overview

Stress has been determined to be a key factor of illness and disease. Prolonged stress in any person can lead to negative thinking, depression and worse. The course is based on managing stress by practice of yogic principles that are proven to be highly effective and easy to learn. In this course the students will learn about different types of yoga practices, Meditation, Yoga asanas, Pranayama for stress, anger and fear management.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 3 – Good Health and Well-being
SDG 4 – Quality Education
SDG 8 – Decent Work and Economic Growth

Course Outcomes

After the completion of the course, the student will be able to:

B7094.1. Make use of yoga for stress management in educational environments.

B7094.2. Improve emotional intelligence to better deal with stress.

B7094.3. Develop flexibility through participation in yoga.

B7094.4. Learn methods of performing asanas, pranayama, mudras and bandhas.

B7094.5. Practice meditation for holistic living.

Course Syllabus

Unit-I:

Meaning and Definition of Stress: Eutress, Distress, Anticipatory Anxiety, Intense Anxiety and Depression. Necessity of Stress Management, Concept of Stress according to Yoga.

Unit-II:

Introduction to Yoga: Definition and Meaning of Yoga, Historical Perceptive on yoga – yoga before the time of Patanjali (Indus valley civilization, Vedas, Brahmnas, Upanishads, Epics, Puranas).

Unit-III:

Schools of Yoga: Eight Limbs of Yoga: Yama, Niyama, Asana, Pranayama, Pratyahara, Dharana, Dhyana & Samathi. General principles of practicing Asana, Pranay- ama, Meditation, Kriyas Bandhas and Mudra.

Unit-IV:

Essentials of yoga practices: Prayer, Disciplines in Yogic Practices, Place & Timing, Diet & Schedule for Yoga Practitioner. Obstacles in the Path of Yoga Practice, Sequence for yogic practices, Different between yogic & non yogic system of exercise. Do's and donts during Yoga.

Unit-V:

Personality development by yoga: Yoga and development of Social qualities of personality, Co-operation, Simplicity, Tolerance, Social adjustments, Yoga and personal efficiency. Improvement of personal efficiency through yoga.

Books and Materials

Text Books:

1. Andrews, Wasmer Linda. *Stress Control for Peace of Mind.* Barnes & Noble Publisher, 2005.
2. Nagendra, H. R., and R. Nagarathana. *Yoga Practices for Anxiety & Depression.* Bangalore: Swami Sukhabodhanandha Yoga Prakashana, 2004.

Reference Books:

1. Iyengar, B. K. S. *The Art of Yoga.* New Delhi: Harper Collins Publishers, 2003.

B7095 - Pedagogy Studies

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
30	0	0	0	30	0	100	-	100

Course Description

Course Overview

Pedagogy is the relationship between learning techniques and culture. It requires meaningful classroom interactions between educators and learners. The objective of this course is to help students build on prior learning and develop skills and attitudes. Furthermore it can improve the quality of your teaching and the way students learn, helping them gain a deeper grasp of fundamental material.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 8 – Decent Work and Economic Growth
SDG 9 – Industry, Innovation and Infrastructure

Course Outcomes

After the completion of the course, the student will be able to:

B7095.1. Develop a positive attitude towards life and the teaching profession.

B7095.2. Critically analyze classroom teaching, learning processes, and student behavior.

B7095.3. Compare teaching and learning practices in educational institutes over the past decade.

B7095.4. Summarize the aspects of an effective teaching process.

B7095.5. Apply innovative strategies to enhance teaching and learning outcomes.

Course Syllabus

Unit-I:

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology. Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching.

Unit-II:

Thematic Overview: Pedagogical practices in formal and informal classrooms in developing countries, Curriculum development, Teacher education.

Unit-III:

Evidence on the Effectiveness of Pedagogical Practices : Quality assessment of included studies, How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?. Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

Unit-IV:

Professional Development: Alignment with classroom practices and followup support. Peer support, Support from the head teacher and the community. Curriculum and assessment. Barriers to learning: limited resources and large class sizes.

Unit-V:

Research Gaps and Future Directions: Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment. Dissemination and research impact.

Books and Materials

Text Books:

1. Ackers, J., and F. Hardman. "Classroom Interaction in Kenyan Primary Schools." *Compare*, vol. 31, no. 2, 2001, pp. 245-261.
2. Agrawal, M. "Curricular Reform in Schools: The Importance of Evaluation." *Journal of Curriculum Studies*, vol. 36, no. 3, 2004, pp. 361-379.
3. Akyeampong, K. *Teacher Training in Ghana—Does It Count?* Multi-site Teacher Education Research Project (MUSTER) Country Report 1, London: DFID, 2003.

Reference Books:

1. Akyeampong, K., K. Lussier, J. Pryor, and J. Westbrook. "Improving Teaching and Learning of Basic Maths and Reading in Africa: Does Teacher Preparation Count?" *International Journal of Educational Development*, vol. 33, no. 3, 2013, pp. 272–282.
2. Alexander, R. J. *Culture and Pedagogy: International Comparisons in Primary Education.* Oxford and Boston: Blackwell, 2001.
3. Chavan, M. *Read India: A Mass Scale, Rapid, 'Learning to Read' Campaign.* 2003.

B7096 - English for Research Paper Writing

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
30	0	0	0	30	0	100	-	100

Course Description

Course Overview

This course equips students with essential academic writing skills, including sentence and paragraph structuring, clarity, conciseness, and avoidance of ambiguity. Students will learn to structure research papers effectively, covering abstracts, introductions, literature reviews, methods, results, discussions, and conclusions. Emphasis is placed on ethical writing practices, paraphrasing, and avoiding plagiarism. By the end of the course, students will be able to produce clear, coherent, and professionally written research papers suitable for publication.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 8 – Decent Work and Economic Growth
SDG 9 – Industry, Innovation and Infrastructure

Course Outcomes

After the completion of the course, the student will be able to:

B7096.1. Develop effective planning and preparation skills for academic writing, including sentence structuring and paragraph development.

B7096.2. Apply techniques to clarify meaning, avoid ambiguity, and maintain conciseness and coherence in writing.

B7096.3. Demonstrate the ability to structure research papers, including abstracts, introductions, literature review, methods, results, discussion, and conclusions.

B7096.4. Utilize skills for proper paraphrasing, citation, avoiding plagiarism, and critically analyzing findings in research writing.

B7096.5. Employ advanced writing skills for finalizing papers, including crafting titles, abstracts, and ensuring first-time submission quality.

Course Syllabus

Unit-I:

Planning and Preparation: Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

Unit-II:

Clarifying and Writing Techniques: Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

Unit-III:

Paper Structure: Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Unit-IV:

Writing Key Sections of a Research Paper: Skills needed when writing a Title, Abstract, Introduction, and Review of the Literature.

Unit-V:

Writing and Finalizing Research Papers: Skills needed when writing the Methods, Results, Discussion, Conclusions, useful phrases, and ensuring the paper is as good as possible for first-time submission.

Books and Materials

Text Books:

1. Goldbort, R. *Writing for Science.* Yale University Press, 2006. Available on Google Books.
2. Day, R. *How to Write and Publish a Scientific Paper.* Cambridge University Press, 2006.

Reference Books:

1. Highman, N. *Handbook of Writing for the Mathematical Sciences.* SIAM, 1998.
2. Wallwork, Adrian. *English for Writing Research Papers.* Springer, New York, Dordrecht, Heidelberg, London, 2011.

Vision

To be a pioneer institute and leader in engineering education to address societal needs through education and practice.

Mission

To adopt innovative student centric learning methods.
To enhance professional and entrepreneurial skills through industry institute interaction.
To train the students to meet dynamic needs of the society.
To promote research and continuing education.

Quality Policy

We at Vardhaman College of Engineering, endeavor to uphold excellence in all spheres by adopting the best practices in effort and effect.

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