SYLLABUS

(With effect from 2017-18)

ಪಠ್ಯಕ್ರಮ

(ಶೈಕ್ಷಣಿಕವರ್ಷ 2018–19)

V & VI Semester

Bachelor Degree
in

Electronics & Communication Engineering

Out Come Based Education with Choice Based Credit System

P.E.S. College of Engineering

Mandya - 571 401, Karnataka
(An Autonomous Institution Affiliated to VTU, Belagavi)
Grant -in- Aid Institution
(Government of Karnataka)
Accredited by NBA, New Delhi
Approved by AICTE, New Delhi.

ಪಿ.ಇ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ

ಮಂಡ್ಯ–571 401, ಕರ್ನಾಟಕ

(ವಿ.ಟಿ.ಯು, ಬೆಳಗಾವಿ ಅಡಿಯಲ್ಲಿನ ಸ್ವಾಯತ್ತ ಸಂಸ್ಥೆ)

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Preface

PES College of Engineering, Mandya, started in the year 1962, has become autonomous in the academic year 2008-09. Since, then it has been doing the academic and examination activities successfully. The college is running Eight undergraduate and Eight Postgraduate programs. It consists of Six M.Tech programs, which are affiliated to VTU. Other postgraduate programs are MBA and MCA.

India has recently become a Permanent Member by signing the Washington Accord. The accord was signed by the National Board of Accreditation (NBA) on behalf of India on 13th June 2014. It enables not only the mobility of our degree globally but also establishes equivalence to our degrees with that of the member nations such as Taiwan, Hong Kong, Ireland, Korea, Malaysia, New Zealand, Russia, Singapore, South Africa, Turkey, Australia, Canada and Japan. Among other signatories to the international agreement are the US and the UK. Implementation of Outcome Based Education (OBE) has been the core issue for enabling the equivalence and of Indian degrees and their mobility across the countries.

Our Higher Educational Institution has adopted the CBCS based semester structure with OBE scheme and grading system.

The credit based OBE semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching.

The OBE, emphasize setting clear standards for observable, measurable outcomes of programs in stages. There lies a shift in thinking, teaching and learning processes moving towards Students Centric from Teacher Centric education. OBE standards focus on mathematics, language, science, attitudes, social skills & moral values.

The key features which may be used to judge, if a system has implemented an outcome based education system is mainly Standard based assessments that determines whether students have achieved the stated standard. Assessments may take any form, so long as the process actually measure whether the student knows the required information or can perform the required task. Outcome based education is a commitment that all students of all groups will ultimately reach the same minimum standards. Outcome Based Education is a method or means which begins with the end in mind and constantly emphasizes continuous improvement.

Choice Based Credit System (CBCS) provides choice for students to select from the prescribed courses (core, Foundation, Foundation Elective, elective, open elective and minor or soft skill courses). The CBCS provides a 'cafeteria' type approach in which the students can Choose electives from a wide range of courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, adopt an interdisciplinary approach to learning which enables integration of concepts, theories, techniques, and, perspectives from two or more disciplines to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline. These greatly enhance the skill/employability of students.

In order to increase the Industry/Corporate readiness, many Soft Skills and Personality Development modules have been added to the existing curriculum of the academic year 2015-16. Industry Interactions have been made compulsory to enhance the field experience. In order to enhance creativity and innovation Mini Project and Industrial visit & Interaction are included in all undergraduate programs.

Dr. Umesh D R
Deputy Dean (Academic)
Associate Professor,
Dept. of CS &Engg

Dr. Nagarathna
Dean (Academic)
Professor
Dept. of CS &Engg

PES College of Engineering

VISION

PESCE shall be a leading institution imparting quality engineering and management education, developing creative and socially responsible professionals

MISSION

- Provide state of the art infrastructure, motivate the faculty to be proficient in their field of specialization and adopt best teaching -learning practices
- Impart engineering and managerial skills through competent and committed faculty using Outcome Based Educational curriculum
- Inculcate professional ethics, leadership qualities and entrepreneurial skills to meet the societal needs
- Promote research, product development and industry-institution interaction.

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

The department of Electronics and Communication Engineering was incepted in the year 1967 with an undergraduate program in Electronics and Communication Engineering. Initially program had an intake of 60 students and presently 150 students graduate every year. The long journey of 50 years has seen satisfactory contributions to the society, nation and world. The alumni of this department has strong global presence making their alma mater proud in every sector they represent.

Department has started its PG program in the year 2012 in the specialization of VLSI design and Embedded systems. Equipped with qualified and dedicated faculty department has focus on VLSI design, Embedded systems and Image processing. The quality of teaching and training has yielded high growth rate of placement at various organizations. Large number of candidates pursuing research programs (M.Sc/Ph D) is a true testimonial to the research potential of the department.

VISION

The department of E & C would Endeavour to create a pool of Engineers who would be extremely competent technically, ethically strong also fulfill their obligation in terms of social responsibility.

MISSION

- **M1:** Adopt the best pedagogical methods and provide the best facility, infrastructure and an ambience conducive to imbibe technical knowledge and practicing ethics.
- **M2:** Group and individual exercises to inculcate habit of analytical and strategic thinking to help the students to develop creative thinking and instil team skills

- **M3:** MoUs and Sponsored projects with industry and R & D organizations for collaborative learning
- **M4:** Enabling and encouraging students for continuing education and moulding them for life-long learning process

Programme Education Objectives (PEOs)

PEO1: Graduates to exhibit knowledge in mathematics, engineering fundamentals applied to Electronics and Communication Engineering for professional achievement in industry, research and academia

PEO2: Graduates to identify, analyse and apply engineering concepts for design of Electronics and Communication Engineering systems and demonstrate multidisciplinary expertise to handle societal needs and meet contemporary requirements

PEO3: Graduates to perform with leadership qualities, team spirit, management skills, attitude and ethics need for successful career, sustained learning and entrepreneurship.

Programme Specific Outcomes (PSOs)

Program Specific Outcomes of bachelor degree (B.E, E&C) program are defined as follows which are in line with the Program specific criteria (PSC) as defined by IEEE.

After the graduation, the student will have:

- An ability to **understand the basic concepts** in Electronics & Communication Engineering and to **apply them in the design and implementation** of Electronics and communication systems.
- An ability to **solve complex problems** in Electronics and Communication Engineering, using latest **hardware and software tools,** along with **analytical skills** to arrive at appropriate solutions.

SCHEME OF TEACHING AND EXAMINATION
V SEMESTER B.E. ELECTRONICS AND COMMUNICATION ENGINEERING

Sl. No.	Course Code	Course Title	Teaching Department	Hrs / Week			Credits	Examination Marks		
				L	T	P		CIE	SEE	Total
1	P18EC51	Innovation , Entrepreneurship and Management	ECE	4	-	-	4	50	50	100
2	P18EC52	Digital CMOS VLSI Design (CC-1)	ECE	4	-	-	4	50	50	100
3	P18EC53	Information Theory Coding and Cryptography (CC-2)	ECE	4	-	-	4	50	50	100
4	P18EC54	Optical Communication Systems and Networks (CC-3)	ECE	4	-	-	4	50	50	100
5	P18EC55X	**Professional Elective - I**	ECE	2	2	-	3	50	50	100
6	P18ECL56	Digital Signal Processing Laboratory	ECE	-	-	3	1.5	50	50	100
7	P18ECL57	Analog and Digital Communication Laboratory	ECE	-	-	3	1.5	50	50	100
8	P18ECL58	Skill Oriented Laboratory - I	ECE	-	-	2	1	50	50	100
9	P18EC59X	Technical Skills - I	ECE	-	2	-	1	50	50	100
10	P18HU510	Aptitude and Reasoning Development - Advance (ARDI)	HU	-	2	-	1	50	50	100
Total							**25**	**500**	**500**	**1000**

Professional Elective - I		
Sl. No.	**Course Code**	**Course Title**
1	P18EC551	Fundamentals of Object Oriented Language and Database Concepts
2	P18EC552	DSP Processor and Applications
3	P18EC553	ARM Processor
4	P18EC554	Adaptive Signal Processing
5	P18EC555	Cognitive Radio Networks

Technical Skills - I		
Sl. No.	**Course Code**	**Course Title**
1	P18EC591	Embedded System and IOT
2	P18EC592	System Verilog
3	P18EC593	Java and Web Technologies

SCHEME OF TEACHING AND EXAMINATION
VI SEMESTER B.E. ELECTRONICS AND COMMUNICATION ENGINEERING

Sl. No.	Course Code	Course Title	Teaching Department	Hrs / Week			Credits	Examination Marks		
				L	T	P		CIE	SEE	Total
1	P18EC61	Analog CMOS VLSI Design (CC-1)	ECE	4	-	-	4	50	50	100
2	P18EC62	Control Systems (CC-2)	ECE	4	-	-	4	50	50	100
3	P18EC63	Microwaves and Antennas (CC-3)	ECE	4	-	-	4	50	50	100
4	P18EC64X	**Professional Elective - II**	ECE	2	2	-	3	50	50	100
5	P18ECO65X	**Open Elective-I**	ECE	3	-	-	3	50	50	100
6	P18ECL66	Circuit Simulation Laboratory	ECE	-	-	3	1.5	50	50	100
7	P18ECL67	Analog and Digital VLSI Design Laboratory	ECE	-	-	3	1.5	50	50	100
8	P18ECL68	Skill Oriented Laboratory - II	ECE	-	-	2	1	50	50	100
9	P18HU69	Technical Skills - II	HU	2	-	-	1	50	50	100
Total							**23**	**450**	**450**	**900**

Professional Elective - II			**Open Elective –I**		
Sl. No.	**Course Code**	**Course Title**	**Sl. No.**	**Course Code**	**Course Title**
1	P18EC641	Multimedia Communication	1	P18ECO651	Electronics Waste Management
2	P18EC642	Radar and Navigational Systems	2	P18ECO652	Principles of Communication Systems
3	P18EC643	Introduction to Basics of Information Technology	3	P18ECO653	Ardiuno Controller with Applications
4	P18EC644	VLSI Testing and Verification	4	P18ECO654	Biometrics
5	P18EC645	Advance Digital Communication			

Course Title: **Innovation, Entrepreneurship and Management**			
Course Code: **P18EC51**	Semester: **V**	**L**-T-P-**H** : **4**-0-0-**4**	Credits: **4**
Contact Period : Lecture: **52 Hrs**. Exam: **3 Hrs**.		Weightage: CIE: **50%** SEE: **50%**	

A. Course Learning Objectives (CLOs)

This course aims to:

1. Categorize research, innovation and creativity.
2. Relate the role and importance of innovation in economic growth, skills of innovator, types of innovation and output forms of innovation.
3. Understand various ways to create and manage intellectual property and prepare innovation proposal.
4. Understand the entrepreneurial process and recognize the core role of creativity and innovation in managing the entrepreneurial process effectively.
5. Understand fundamental concepts and principles of management, including the basic roles, skill, and functions of management.
6. Summarize comprehensive Entrepreneurship Development process.
7. Understand the procedure of creating an Ownership and types.
8. Express the meaning of Professional Ethics, its importance and needs.

B. Course Content

UNIT- I

Introduction to Innovation and Innovator: Introduction, understanding Innovation, Creativity and Research, Role of Innovation in economic growth of country, companies and community, phases of innovation journey, Roles of Innovator.

Text 1: Chapter 1 to 5 **10 Hrs**

Self Learning Components: Prepare a Case study of An Innovator: How did he/she find the problem, thought about a solution and steps/situations came across during implementation.

UNIT - II

Innovator Skills and Innovation: Introduction to Innovative Skills, Types of Innovation, Introduction to patents and IP, preparing an innovation proposal Pitching an innovation proposal, Sustaining innovation.

Text 1: Chapter 6 to 13 **10 Hrs**

Self Learning Components: Prepare a case study of an entrepreneur around you.

UNIT - III

Entrepreneurship and Entrepreneurs:

Evolution of the concept of Entrepreneur, Characteristics of an Entrepreneur, Distinction between an Entrepreneur & a Manager, Functions of an Entrepreneur, Types of Entrepreneur. Concept of Entrepreneurship, Growth of Entrepreneurship in India, Role of Entrepreneurship in Economic Development.

Text 2: 1.1 to 1.10, 2.1 to 2.3 **11 Hrs**

Self Learning Components: Prepare a Case Study of an Entrepreneur / an Enterpriser or an Enterprise.

UNIT - IV

Management and Business Ownership: Fundamentals of Management: Meaning of Management, Management as Science, Art & Profession, Importance of Management, Scope of Management, Functions of Management, Management Process, Principles of Management.

Forms of Business Ownership: Sole Proprietorship, Partnership, Company, Cooperative, Selection of Appropriate Form of Ownership Structure.

Text 2: 24.1 to 24.9 & 18.1 to 18.5 **10 Hrs**

Self Learning Components: Being in different positions as an employee: Understanding Self, Self-Management& Understanding others for Effective Relationships and Communication (Ref Book: 6)

UNIT - V

Engineering and Professional Ethics: Making a Case: Introduction, Role Morality, What is a Profession?, Professional Ethics, The NSPE Board of Ethical Review, Engineering Ethics as Preventive Ethics

Honesty: Introduction, Ways of Misusing Truth, Why is Dishonesty Wrong?

International Engineering Professionalism: Introduction, Problems in International Professionalism, Problems in Interpreting and Applying the Codes, Striking a Balance, Guidelines for Interpreting the Codes: Human Rights, Avoiding Paternalism and Exploitation and Applying the Golden Rule, Bribery-Extortion-Grease Payments and Gifts.

Text 3: 1.1 to 1.6, 6.1 to 6.3 & 10.1 to 10.8 **11 Hrs**

Self Learning Components: Survey and Study the importance of Professional Ethics

Note: <u>No questions</u> from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)

TEXT BOOKS:

1. **"A Conversation with the Innovator in You",** Sudeendra Koushik and Pragya Dixit, Pearson Kindle Direct Publishing, Amazon, 2017.ISBN-10: 1520512716**,** ISBN-13: 978-152051271.
2. **"Entrepreneurial Development",** by Dr S S Khanka, S Chand & Company Ltd. ISBN-10: 8121918014; ISBN-13: 978-8121918015.
3. **"Engineering Ethics"** (2nd edition), Charles E. Harris, Michel S. Pritchard and Michel J. Rabins, Thomson Wadsworth Asia Pte Ltd, 2003. ISBN: 981-243-676-6.

REFERENCE BOOKS:

1. **"Debono, Edward: Six thinking Hats",** Penguin Books (2000).ISBN 10: 0140296662 / ISBN 13: 9780140296662.
2. **"Kelley, Tom: The Art of Innovation"** Profile Books Limited (2011). ISBN-0:0385499841; ISBN-13: 978-0385499842.
3. **"Principles and practice of Management"** – L. M. Prasad.ISBN-13: 9789351610502.
4. **"Entrepreneurship"** by Robert D Hisrich, Micheal P Peters, Dean A Shepherd- 6/e, TataMcGraw – Hill Companies.ISBN-10: 0078029198.

5. **"Management – Concepts and Cases"–** V. S. P. Rao & V. Hari Krishna Excel Books, 2/e, 2008.ISBN 10: 8174466681 / ISBN 13: 9788174466686**.**
6. **"Emotional Intelligence"** - Daniel Goleman, Bloomsbury Publishing, ISBN: 978 0 7475 2830 2.

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	Able to **Understand** the Functionalities and Requirements to Innovate.	**PO1 (L3), PO9 (L1), PO12 (L1)**
CO2	**Analyze** the Importance of Innovation and Entrepreneurship to build an Enterprise Resulting in Economic Growth.	**PO2 (L3), PO9 (L3), PO12 (L3)**
CO3	**Demonstrate** the Entrepreneurial and Management Process.	**PO3 (L3), PO7 (L4), PO9 (L4), PO12 (L4)**
CO4	**Understand** reliability of Innovation, Entrepreneurship and Management	**PO1 (L3), PO6 (L1), PO9 (L1), PO12 (L1)**
CO5	**Understand** Professional Ethics, **Analyze** its importance and need in current working environment.	**PO1 (L3), PO2 (L2), PO8 (L3), PO9 (L3), PO12 (L3)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	**3**								**1**			**1**	**3**	
#2		**3**							**1**			**1**		**3**
#3			**2**				**2**		**2**			**1**		
#4	**3**					**1**			**2**			**2**	**3**	
#5	**3**	**2**						**3**	**2**			**2**	**3**	**2**

Course Title : **Digital CMO VLSI Design (CC-1)**			
Course Code: **P18EC52**	Semester : **V**	**L**-T-P-**H** : **4**-0-0-**4**	Credits: **4**
Contact Period : Lecture : **52 Hrs,** Exam: **3 Hrs.**		Weightage : CIE: **50%**	SEE: **50%**

A. Course Learning Objectives (CLOs)

This course aims to:

1. Provide the basic knowledge of digital CMOS VLSI circuits and design.
2. Explain the basic electrical and physical properties of MOS transistor.
3. Discuss the dc characteristics of MOS inverter.
4. Describe the switching characteristics and delay of MOS inverter which determines the overall operating speed of digital systems.
5. Examine the static and dynamic characteristics of various combinational MOS logic circuits and sequential logic circuits.
6. Discuss the operation of dynamic logic circuits of reduced circuit delay and silicon area, compared to static logic circuits.
7. Provide the knowledge of I/O circuits, clock generation and distribution circuits which are essential in VLSI design chip.
8. Able to understand IC fabrication process of MOS Transistor.

B. Course Content

UNIT – I

Introduction: Historical Perspective, VLSI Design Flow,
MOS Transistor: The Metal Oxide Semiconductor(MOS) Structure, The MOS System under External Bias, Structure and Operation of MOS Transistor (MOSFET), MOSFET Current – Voltage Characteristics. MOSFET Scaling and Small geometry effects,
Text 1:**– 1.1, 1.5 &3.1 to 3.5.** **10 Hrs**
Self Learning Component: Design hierarchy, VLSI Design Styles

UNIT – II

MOSFET Capacitance: Introduction, Oxide related capacitance, Junction capacitance
MOS Inverters, Static Characteristics: Introduction, CMOS Inverter.
Switching Characteristics and Interconnect Effects: Introduction, Delay – Time Definitions, Estimation of Interconnect Parasitic, Calculation of Interconnect Delay, Switching Power Dissipation of CMOS Inverters
Text 1:–3.6, 5.1, 5.4 and 6.1, 6.2, 6.5, 6.6, 6.7. **10 Hrs**
Self Learning Component: Super buffer Design.

UNIT – III

Combinational MOS Logic Circuits : Introduction, MOS Logic Circuits with Depletion nMOS Loads, CMOS Logic Circuits, Complex Logic Circuits, CMOS Transmission Gates(Pass Gates)
Sequential MOS Logic Circuits: Introduction, Behavior of Bistable Elements, SR Latch Circuit
Text 1:– 7.1 to 7.5, 8.1 to 8.3 **11 Hrs**
Self Learning Component: Modeling of MOS Transistor using SPICE**:** Know about MODEL statement in SPICE. Plot O/P characteristics of N-MOS and P-MOS transistors and C-MOS inverter using, LEVEL-1 and LEVEL-2 model in SPICE and Scilab/Math lab.

UNIT – IV

Dynamic Logic Circuits: Introduction, Basic Principles of Pass Transistor Circuits, Voltage Bootstrapping, Synchronous Dynamic Circuit Techniques, Dynamic CMOS Circuit Techniques, High– Performance Dynamic CMOS Circuits

Text 1:– 9.1 to 9.6 **10 Hrs**

Self Learning Component: Design Margin, Supply Voltage, Temperature, Process Variation, Design Corners, Reliability, **Reliability** Terminology, Electro migration, Self-Heating, Hot Carriers, Overvoltage, Failure, Soft Errors,

UNIT – V

Fabrication of MOSFETS: Introduction, Fabrication Process flow, Fabrication of NMOS transistor, Device Isolation Techniques, Local oxidation of silicon, Multilevel interconnects and metallization.

BiCMOS Logic Circuits: Basic BiCMOS circuits, BiCMOS applications

Chip Input and Output (I/O) Circuits: Introduction, ESD Protection, Input Circuits, Output Circuits and L (di/dt) Noise, On– Chip Clock Generation and Distribution, Latch – Up and Its Prevention.

Text 1: – 2.1, 2.2. 12.4, 12.6. 13.1 to 13.6 **11 Hrs**

Self Learning Components: CMOS smart temperature sensors for RFID applications
Ref: https://ieeexplore.ieee.org/document/6644858
Study on Different Integrated circuits.(https://www.youtube.com/watch?v=QXBlQZYGO6Y).
CMOS VLSI Applications
(https://ieeexplore.ieee.org/document/1146652)

Note: No questions from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)

TEXT BOOK:

1. **"CMOS Digital Integrated Circuits Analysis and Design",** Sung – Mo Kang, Yusuf Leblebici, 3rd edition, McGraw Hill Education 2003, ISBN-13:978-0-07-053077-5, ISBN-10:0-07-053077-7.

REFERENCE BOOKS:

1. **"Introduction to VLSI Circuits and Systems"**, John .P. Uyemura, John Wiley, 3rd edition 2002. ISBN: 978-81-265-0915-7
2. **"Principles of CMOS VLSI Design",** Neil. H. E. Weste, Kamran Eshraghian, 3rd edition, Pearson Education 2005, ISBN:978-81-317-6467-1.
3. **"Basic VLSI Design"**, Douglas A. Pucknell, Kamran Eshraghian, 3rd edition 2006, PHI, ISBN: 978-81-203-0986-9.
4. **"Digital Integrated Circuits: A Design Perspective"**, Jan Rabaey, Anantha Chandrakasan, B Nikolic, 2nd edition, Feb 2003, Prentice Hall of India. Pearson 2016, ISBN-13: 978-0130909961

ONLINE COURSES AND VIDEO LECTURES:

1. https://nptel.ac.in/courses/108/107/108107129/ (By **Sudeb Dasgupta** IIT Roorkee)

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	To **Apply** the basic knowledge of Physics and mathematics to understand the MOS and derive different current equations of MOS circuits and delays of CMOS inverter circuits	**PO1 (L3)**
CO2	To **Analyze** the CMOS inverter circuit and BiCMOS circuits.	**PO2 (L4)**
CO3	To **Design** combinational, sequential and Dynamic circuits based on CMOS inverters for the given specifications.	**PO3 (L5)**
CO4	To **Discuss** various issues related to clocking, I/O and protection in MOS and VLSI Fabrication Process	**PO1 (L4)**
CO5	Work in groups to model transistors and its circuits learning new tools	**PO5, PO9, PO12 (L4)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	**3**												**3**	
#2		**3**												**3**
#3			**2**											
#4	**2**												**2**	
#5					**2**				**1**			**1**		

Course Title: **Information Theory Coding and Cryptography (CC-2)**			
Course Code: **P18EC53**	Semester : **V**	**L-T**-P-**H** : **4-1**-0-**5**	Credits: **4**
Contact Period : Lecture: **52 Hrs.,** Exam: **3 Hrs.**		Weightage : CIE: **50%**	SEE: **50%**

A. Course Learning Objectives (CLOs)

This course aims to:

1. Provide the knowledge of probability, information theory and source coding theorem.
2. Analyze the efficient data compression methods and describe the most efficient compression method.
3. Develop the channel model and channel capacity theorem.
4. Describe the linear block codes, cyclic codes and BCH codes.
5. Discuss the encoding and decoding of convolution codes, concept of trellis coded modulation and concepts of cryptography.
6. Discuss the advanced data encryption standards.

B. Course Content

UNIT – I

Information Theory and Source Coding: Introduction to Information Theory, Uncertainty and Information, Average Mutual Information and Entropy, Information Measures for Continuous Random Variables, Relative Entropy, Source Coding Theorem, Huffman Coding, Shannon-Fano-Elias Coding, Arithmetic Coding, The Lempel-Ziv Algorithm, Run Length Encoding, Rate Distortion Function, Optimum Quantizer Design, Entropy Rate of a Stochastic Process, Introduction to Image Compression, The JPEG Standard for Lossless Compression, The JPEG Standard for Lossy Compression, Video Compression Standards

Text 1: 1.1-1.18 **10 Hrs**

Self Learning Component:

1. Understand the properties of codes and applications of information theory.
2. Study and compare the different lossy and lossless compression.

UNIT – II

Channel Capacity and Coding: Introduction, Channel Models, Channel Capacity, Channel Coding, Information Capacity Theorem, Parallel Gaussian Channels, The Shannon Limit, Channel Capacity for MIMO Systems, Capacity Region for Multiple Access Channels, Random Selection of Codes,

Error Control Coding (Channel Coding): Linear Block Codes for Error Correction, Introduction to Error Correcting Codes, basic definitions , Matrix Description of Linear Block, Equivalent Codes, Parity Check Matrix, Decoding of a Linear Block Code, Syndrome Decoding, Error Probability after Coding (Probability of Error Correction), Perfect Codes, Hamming Codes, Low Density Parity Check (LDPC) Codes, Optimal Linear Codes, Maximum Distance Separable (MDS) Codes, Bounds on Minimum Distance, Space Time Block Codes.

Text 1: 2.1-2.10 , 3.1-3.15 **11 Hrs**

Self Learning Component:

1. Identify the practical Applications of MIMO system.
2. Understand the uses of Linear and non Linear block codes.

UNIT – III

Cyclic Codes: Introduction to Cyclic Codes, Polynomials, he Division Algorithm for Polynomials, A Method for Generating Cyclic Codes, Matrix Description of Cyclic Codes, Quasi-Cyclic Codes and Shortened Cyclic Codes, Burst Error Correction, Fire Codes, Golay Codes, Cyclic Redundancy Check (CRC) Codes,

Bose–Chaudhuri Hocquenghem (BCH) Codes: Introduction to BCH Codes, Primitive Elements, Minimal Polynomials, Generator Polynomials in Terms of Minimal Polynomials, Some Examples of BCH Codes, Decoding of BCH Codes, Reed-Solomon Code, Implementation of Reed-Solomon Encoders and Decoders

Text 1: 4.1-4.10 , 5.1-5.8 **11 Hrs**

Self Learning Component:

1. Discuss the concept of Convolutional Codes.
2. What are AWGN Channel and identify the noises associated.

UNIT – IV

Coding for Secure Communications: Cryptography- Introduction to Cryptography, An Overview of Encryption Techniques, Operations used by Encryption Algorithms, Symmetric (Secret Key) Cryptography, Data Encryption Standard (DES), International Data Encryption Algorithm (IDEA), RC Ciphers, Asymmetric (Public-Key) Algorithms, The RSA Algorithm, Pretty Good Privacy (PGP), One-way Hashing , Other Techniques, Elliptic Curve Cryptography, Diffie hellman key agreement protocol, Secure Communication using Chaos Functions, Quantum Cryptography, Biometric Encryption, Cryptanalysis, Politics of Cryptography

Text 1: 9.1-9.19 **10 Hrs**

Self Learning Component:

1. Discuss the concept of Elliptic curve cryptography.
2. Apply the Cryptography concept in digital signature.

UNIT – V

Block Cipher and the Data Encryption Standard: Block Cipher Principles, The Data Encryption Standard, A Des Example, The Strength of Des, Differential and Linear Cryptanalysis, Block Cipher Design Principles,

Advance Encryption Standard: Finite Field Arithmetic, AES Structure, AES Transformation Functions, AES Key Expansion, An AES Example, AES Implementation,

Test 2: 3.1.-3.6, 5.1-5.6 **10 Hrs**

Self Learning Component:

1. Understand and apply the advance AES algorithm in image processing.
2. Compare the symmetric and Asymmetric algorithms.

Note: <u>No questions</u> from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)

TEXT BOOKS:

1. "**Information Theory, Coding and Cryptography**", Ranjan Bose, 3rd edition. Tata McGraw.ISBN : 978-0-07-0669017, 2016

2. **"Cryptography and Network Security Principles and Practice",** William Stallings 5th edition, SBN 10: 0-13-609704-9 ISBN 13: 978-0-13-609704-4, 2015

REFERENCE BOOKS:

1. **"Digital Communication Systems",** Simon Haykin, John Wiley, 4th edition. ISBN-13: 978-0130426727
2. **"Digital and Analog Communication Systems"**, K. Sam Shanmugam, John Wiley & Sons. Hill– 2008.

ONLINE COURSES AND VIDEO LECTURES:

1. NPTEL course on " Information Theory, coding and Cryptography by Dr Ranjan Bose, IIT Delhi, https://nptel.ac.in/courses/108/102/108102117/

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** knowledge of mathematics to understand concepts of Probability, Information theory, communication channel, source codes and cryptography.	**PO1 (L3)**
CO2	**Analyze** different source codes for its efficiency used with communication channels.	**PO2 (L4)**
CO3	**Design** coding schemes for a given specifications and evaluate for their error correcting capability.	**PO3 (L4)**
CO4	**Discuss** different lossy / lossless data compression schemes and analyze various decoding schemes for reconstruction of transmitted data.	**PO2 (L4)**
CO5	**Discuss** various cryptography algorithms for secured communication.	**PO2 (L4)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	**3**												**3**	
#2		**3**												**3**
#3			**2**											
#4		**2**												**2**
#5		**2**												**2**

Course Title: **Optical Communication Systems and Networks (CC-3)**			
Course Code: **P18EC54**	Semester : **V**	**L**-T-P-**H** : **4**-0-0-**4**	Credits: **4**
Contact Period : Lecture : **52 Hrs.,** Exam: **3 Hrs.**		Weightage **:** CIE: **50%**	SEE: **50%**

A. Course Learning Objectives (CLOs)

This course aims to:

1. Discuss the types, characteristics, constitution and application of optical fibers.
2. Describe the propagation of light waves through the fibers.
3. State the causes for the absorption mechanisms in fibers.
4. Explain the bending losses in fibers.
5. Discuss the construction and operation of optical sources.
6. List the different lensing schemes for coupling improvement.
7. Outline the physical principles of photodiodes.
8. Explain the digital link and analog link.
9. Discuss the WDM concepts and components.
10. Describe the optical amplifiers and optical networks.

B. Course Content

UNIT – I

Optical Fibers: Structures, Wave guiding, and Fabrication, Basic Optical Laws and Definitions, Optical Fiber Modes and Configurations, Fiber Fabrication, Attenuation, Signal Dispersion in Fibers.

Optical Sources: Light–Emitting Diodes (LEDs), Laser Diodes.

Text 1: 2.2, 2.3, 2.9, 3.1, 3.2, 3.2.1, 3.2.2, 3.2.5, 3.2.6, 3.2.8, 4.2, 4.3, 4.3.1-4.3.5 **10 Hrs**

Self Learning Components: Mode field diameter, Graded index fiber structure, Fiber materials, Photonic crystal fibers.

UNIT – II

Power Launching and Coupling: Source to fiber power launching, lensing schemes for coupling improvement, fiber to fiber joints, fiber splicing.

Photo Detectors: Physical principles of photodiodes, photo detector noise, detector response time.

Digital Links: Point to point links.

Text 1:5.1, 5.2, 5.3, 5.5, 6.1,6.2,6.3, 8.1 **10 Hrs**

Self Learning Components: LED coupling to single mode fibers, Optical fiber connectors, Structures for INGAAS APDS.

UNIT – III

Optical Receiver Operation: Fundamental receiver operation, eye diagrams, burst mode receivers, analog receivers.

Analog Links: Overview of analog links, carrier to noise ratio, multichannel transmission techniques, RF over fiber.

WDM Concepts and Components: Overview of WDM, passive optical couplers, isolators and circulators, fiber grating filters.

Text 1: 7.1, 7.3, 7.4, 7.5, 9.1 to 9.4, 10.1 to 10.4 **11 Hrs**

Self Learning Components: Receiver Sensitivity, The Quantum Limit, Radio over Fiber Links, Dielectric thin film filters.

UNIT – IV

Introduction to Optical Networks: Telecommunication network architecture, Services, Circuit switching and Packet switching, Optical networks, The optical layer, Transparency and All Optical networks, Optical packet switching, Transmission basics, Network Evolution.
Components: Optical Amplifiers.
Text 2: 1.1 to 1.8, 3.4 **10 Hrs**
Self Learning Components:
Case study: Study of Sterlite fiber optic cables deployed in India's longest natural gas pipeline.(https://www.stl.tech/brain-share/case-study/sterlite-fiber-optic-cables-deployed-in-india-s-longest-natural-gas-pipeline-5.html**)**

UNIT – V

Client Layers of the Optical Layer: SONET/SDH, Optical transport network.
WDM Network Elements: Optical line terminals, optical line amplifiers, Optical Add/Drop multiplexers, Optical Cross connects.
Control and Management: Network Management functions, Performance and fault management, Configuration management.
Text 2: 6.1, 6.2, 7.1 to 7.4, 8.1, 8.5, 8.5.1 to 8.5.4, 8.6 **11 Hrs**
Self Learning Components:
Case study: Study of STL fiber cables deployed in India's first 'Formula 1' race track.
(https://www.stl.tech/brain-share/case-study/sterlite-fiber-cables-deployed-in-india-s-first-formula-1-race-track.html)

Note: <u>No questions</u> from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)

TEXT BOOKS:

1. **"Optical Fiber Communications",** Gerd Keiser, McGraw Hill, 5th edition–2017, ISBN 13: 978-1-25-900687-6, ISBN 10: 1-25-900687-5.
2. **"Optical Networks",** Rajiv Ramaswami, Kumar N. Sivarajan, Galen H. Sasaki, Elsevier, 3rd edition. ISBN: 978-0-12-374092-2.

REFERENCE BOOKS:

1. **"Fiber Optic Communication",** Joseph C. Palais, Pearson Education, 5th edition-2005 ISBN-978-81-317-1791-2.
2. **"Fiber Optic Communication System",** Govind P Agarwal, Wiley, 3rd edition-2013 ISBN-978-81-265-1386-4.
3. **"Optical Fiber Communications",** John M. Senior, Pearson Education 3rd edition - 2013, ISBN- 978-81-317-3266-3

ONLINE COURSES AND VIDEO LECTURES:

1. https://nptel.ac.in/courses/115/107/115107095/ (By Dr. Vipul Rastogi,IIT Roorkee)
2. https://nptel.ac.in/courses/108/104/108104113/ (By Prof. Pradeep Kumar K, IIT Kanpur)

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** the knowledge of physics to explain basic optical laws, various optoelectronic devices and its structures.	**PO1 (L2)**
CO2	**Analyz**e the causes for different losses in an optical communication link.	**PO2 (L3)**
CO3	**Develop** a solution for optical communication systems for specified characteristics.	**PO2, PO3 (L3)**
CO4	**Examine** the methods to improve coupling efficiency and signal to noise ratio of the communication system.	**PO1, PO2 (L3)**
CO5	To **Enrich** the knowledge about optical communication systems and networks	**PO2 (L3)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	**3**												**3**	
#2		**2**												**2**
#3		**2**	**2**											**2**
#4	**2**	**3**											**2**	**3**
#5		**2**												**2**

Professional Elective - I			
Course Title: **Fundamentals of Object Oriented Language and Database Concepts**			
Course Code: **P18EC551**	Semester : **V**	**L**-T-P-**H** : **4**-0-0-**4**	Credits: **3**
Contact Period : Lecture : **52 Hrs,** Exam: **3 Hrs**		Weightage: CIE: **50**%	SEE: **50%**

A. Course Learning Objectives (CLOs)

This course aims to:

1. Explain the significance of object oriented concepts
2. Describe the concept of class, objects and methods in Java
3. Apply the concepts of inheritance and interfaces in Java
4. Illustrate usage of packages, string handling and exception handling in Java
5. State the importance of DBMS and explain how DBMS is better than traditional File Processing Systems.
6. Analyze the basic structure of Database and recognize the different views of the database.
7. Draw and Investigate Data Flow and Entity Relationship Diagrams.
8. Analyze and use Relational Data Model, while comparing with other data models.
9. Formulate data retrieval queries in SQL and the Relational Algebra and Calculus.

B. Course Content

UNIT – I

Fundamentals of Object Oriented Programming: Introduction, Object oriented paradigm, Basics concepts of object oriented programming, Benefits of object oriented programming, Applications of object oriented programming.

Java: History and features, Simple Java Program, Java Program Structure, Data types, Scope of variables, Operators overview

Decision Making and Branching: if, if else, else if ladder, nesting of if else statements, switch

Decision Making and Looping: do, while, for, Jumps in loops.

Text 1:1.1-1.5, 2.1, 2.2, 3.2, 3.5, 4.4, 4.5, 5.1-5.9, 6.2-6.7, 7.2-7.5. **10 Hrs**

Self Learning Components: How Java is different from C and C++, Java environment.

UNIT – II

Classes, Objects and Methods: Introduction, Defining a class, Fields declaration, Methods declaration, Creating objects, Accessing class members, Constructors, Method Overloading, Static members, Nesting of Methods, Inheritance, Overriding methods.

Arrays: Creating array, 1D array and 2D array.

Text 1:8.1-8.12, 9.2-9.3. **10 Hrs**

Self Learning Components: Understand the concept of Inheritance: Defining subclass, Subclass Constructor.

UNIT – III

Strings: String Arrays, String Methods

Interfaces: Introduction, Defining interfaces, Extending interfaces, implementing interfaces

Packages: Introduction, Java API packages, Using System packages, Naming conventions, creating packages, accessing a package, using a package, adding a class to a package.
Text 1: 9.5, 10.1-10.4, 11.1-11.8. **11 Hrs**
Self Learning Components: Discuss the Accessing interface variables, String buffer class.

UNIT – IV

Database and Database users: Introduction, An example, Characteristics of the database approach, Actors on the scene, Workers behind the scene.
Database system concepts and architecture: Database models, Schema and Instances, Three schema architecture and data independence, Database languages and interfaces.
Data Modeling using ER Model: Using High level conceptual data models for database design, Entity types, Entity sets, Attributes and keys, Relationship types, Relationship sets, Roles and structural constraints, Refining the ER design for the company database.
Text 2:1.1-1.5, 2.1-2.3, 7.1, 7.3, 7.4, 7.6. **11 Hrs**
Self Learning Components: Identify the Advantages of using DBMS approach.

UNIT – V

Basics SQL: SQL Data Definition and Data types, Specifying constraints in SQL, Basic Retrieval Queries in SQL, Insert, Delete and Update statements in SQL, More complex SQL retcrieval queries.
Relational Model and Relational Database Constraints: Relational Model concepts, Relational data model constraints and relational database schemas, Update operations, Transactions and dealing with constraint violations.
Text 2: 3.1-3.3, 4.1-4.4, 5.1. **10 Hrs**
Self Learning Components: Discuss the Additional features of SQL, Views in SQL.

Note: <u>No questions</u> from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)

TEXT BOOKS:

1. **"Programming With JAVA":** A Primer, E Balagurusamy, 6th edition Tata McGraw Hill. ISBN 13: 978-93-5316-233-7, ISBN 10:-93-5316-233-5
2. **"Fundamentals of Database Systems"** – Elmasri and Navathe, 6th edition, Addison-Wesley, 2011. ISBN 10: 0-136-08620-9 ISBN 13: 978-0-136-08620-8

REFERENCE BOOKS:

1. **"The Complete Reference JAVA, J2SE",** Herbert Schildt, 6th edition, TMH, 2010. ISBN: 0070598789.
2. **"C++ Primer",** Stanley B. Lippman, Josee Lajoie, Barbara E. Moo, 5th edition, Addison Wesley, 2012. ISBN-13: 978-0-321-71411-4, ISBN-10: 0-321-71411-3.
3. **"Database Management Systems"** Raghu Ramakrishnan and Johannes Gehrke – 3rd edition, McGraw-Hill Education(India) Edition 2014. ISBN 0-07-246563-8, ISBN -0-07-115110-9.

4. **"Data Base System Concepts"** – Silberschatz, Korth and Sudharshan, 5th edition, Mc-GrawHill, 2006 ISBN 0072958863, 9780072958867

ONLINE COURSES AND VIDEO LECTURES:

1. DBMS – SWAYAM - https://nptel.ac.in/courses/106/105/106105175/
2. Java Programming - https://nptel.ac.in/courses/106/105/106105191/

C. Course Outcomes

CO#	Course Outcome	Program Outcome Addressed (PO#) with BTL
CO1	**Apply** basic knowledge of programming in understanding concepts and syntax of Java Programming Language	**PO1 (L4), PO5 (L2)**
CO2	**Analyze** concepts and syntax of Java programming in developing Java program solutions to problems,	**PO2 (L3), PO5 (L2)**
CO3	**Implement** the various concepts of Java features in the development of Java Program.	**PO3 (L3), PO5 (L4)**
CO4	**Identify** the basic concepts and various data model used in database design ER modeling concepts and architecture use.	**PO1 (L1), PO5 (L1)**
CO5	Apply relational database theory to **Design** queries using SQL.	**PO3 (L3), PO5 (L3)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	**3**				**1**								**3**	
#2		**3**			**2**									**3**
#3			**3**		**3**									
#4	**3**				**1**								**3**	
#5			**3**		**2**									

Professional Elective - I			
Course Title : **DSP Processor and Applications**			
Course Code: **P18EC552**	Semester : **V**	**L**-T-P-**H** : **4**-0-0-**4**	Credits: **3**
Contact Period : Lecture: **52 Hrs,** Exam: **3 Hrs**		Weightage: CIE: **50%**	SEE:**50%**

A. Course Learning Objectives (CLOs)

This course aims to:

1. Provide the understanding of architecture, programming and interfacing of commercially available Digital Signal Processor.
2. Discuss the effective use of Digital Signal Processor in system implementation.
3. Adopt the MATLAB tools in DSP applications.
4. Provide the understanding of architecture features of TMS320C54XX.
5. Describe the programming of TMS320C54XX for several basic DSP algorithms.
6. Understand the interfacing procedure to use programmable Digital Signal Processor.
7. Discuss the applications of programmable DSP devices.

B. Course Content

UNIT – I

Architectures for Programmable DSP Devices: Introduction, Basic Architectural Features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues, Features for External Interfacing.

Text 1: 4.1 to 4.10 **10 Hrs**

Self Learning Components:

1. Design and implement 8-bit Barrel Shifter using 2:1 Multiplexer in Verilog.
2. Explain pipelining and parallel processing with real life example. Also comment on time requirement in each process.

UNIT – II

Programmable Fixed Point Digital Signal Processors: Introduction, Commercial Digital Signal– processing Devices, Data Addressing Modes of TMS32OC54xx DSPs, Data Addressing Modes of TMS32OC54xx Processors, Memory Space of TMS32OC54xx Processors, Program Control, TMS32OC54xx Instructions and programming, On–chip Peripherals, Interrupts of TMS32OC54xx Processors, Pipeline Operation of TMS32OC54xx Processors.

Text 1:5.1 to 5.10 **10 Hrs**

Self Learning Components:

1. How DSP processor is different than conventional processor? Justify your answer with relevant example.
2. Study memory (internal and extended), peripherals and general purpose I/O pins characteristics of 54X processors.

UNIT – III

Implementation of Basic DSP Algorithms: Introduction, the Q– notation, FIR Filters, IIR Filters, Interpolation Filters, Decimation Filters, PID controller, Adaptive Filters, 2–D Signal Processing

Implementation of FFT Algorithms: Introduction, an FFT Algorithm for DFT Computation, Overflow and Scaling, Bit–Reversed Index Generation, an 8 Point FFT Implementation on the TMS32OC54xx, Computation of Signal Spectrum.

Text 1: 7.1 to 7.10 and 8.1 to 8.7 **11 Hrs**

Self Learning Components:

1. Design and Implement 3-bit Flash analog to digital converter using CMOS technology.
2. Design and implement 4 tap FIR filter using Verilog.

UNIT – IV

Interfacing Memory and Parallel I/O Peripherals to Programmable DSP Devices: Introduction, Memory Space Organization, External Bus Interfacing Signals, Memory Interface, Parallel I/O Interface, Programmed I/O, Interrupts and I/O, Direct Memory Access (DMA).

Interfacing and Applications of DSP Processor: Introduction, Synchronous Serial Interface, A Multichannel Buffered Serial Port (McBSP), McBSP Programming, A CODEC Interface Circuit, CODEC Programming, A CODEC–DSP Interface example.

Text 1: 9.1 to 9.8 and 10.1 to10.7 **11 Hrs**

Self Learning Components:

1. Study of Multi-channel Buffered Serial Port.
2. A study of CODEC interface circuit and CODEC programming.

UNIT – V

Programmable Floating Point Digital Signal Processors: Introduction, Features of TMS320C6713, TMS320C6713 Architecture, Linear and Circular addressing modes, Instruction set, TMS 320C6713 DSK Boards, TMS 320C6713 Programming.

Applications of DSP Devices : Introduction, A DSP system, DSP Based Bio– telemetry Receiver, A Speech Processing System, An Image Processing System, A Position control system for a hard disk drive, DSP based Power meter.

Text 2: 23.1 to 23.7.1, 23.8 **10 Hrs**

Self Learning Components:

1. Discuss why floating point processor better than fixed point processor.
2. Implement speech processing system using MATLAB.

Note: <u>No questions</u> from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)

TEXT BOOKS:

1. "**Digital Signal Processing**", Avatar Singh and S. Srinivasan, Thomson Learning, 1st edition 2004. ISBN 10: 0534391230 / ISBN 13: 9780534391232.

2. "**Modern Digital Signal Processing**", V. Udayashankara, Eastern Economy Edition, 2016. ISBN 10: 8120345673 / ISBN 13: 9788120345676.

REFERENCE BOOKS:

1. **"Digital Signal Processors Architectures, Implementations, and Applications"** Sen M Kuo, Woon-sengGan , Pearson Edition, 2005. ISBN-13: 978-0130352149, ISBN-10: 0130352144.
2. **"Digital Signal Processors- Architecture, Programming and Applications"** B Venkataramani, MBhaskar, McGraw Hill Education, 2015. ISBN-10: 9780070702561.

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO#) with BTL
CO1	**Distinguish** between the DSP Processor and general purpose processor	**PO1 (L2)**
CO2	**Analyze** the architecture features of Digital signal processor using basic digital circuit knowledge	**PO2 (L1)**
CO3	**Develop** programs for digital filters using DSP processor for various situations and demonstrate utility of DSP processor in various signal processing applications.	**PO4 (L4)**
CO4	**Apply** the logical and signal processing concepts to develop algorithms for DSP processor.	**PO1 (L3)**
CO5	**Design** the interface to connect specified memory and signal converters.	**PO3 (L5)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	**3**												**3**	
#2		**3**												**3**
#3				**3**										
#4	**3**												**3**	
#5			**3**											

Professional Elective-I			
Course Title : **ARM Processor**			
Course Code: **P18EC553**	Semester : **V**	**L**-T-P-**H** : **4**-0-0-**4**	Credits: **3**
Contact Period : Lecture : **52 Hrs,** Exam: **3 Hrs.**		Weightage : CIE: **50%** SEE: **50%**	

A. Course Learning Objectives (CLOs)

This course aims to:

1. Provide the knowledge of general architecture of ARM Cortex-M3 processor.
2. Thoroughly discuss the Instruction set of Cortex-M3 processor.
3. Understand Memory system, exceptions and interrupt control.
4. Provide the knowledge of fault interrupt behavior, Cortex-M3 and Exceptions Programming.
5. Provide the knowledge of Advanced Programming Features and System Behavior.

B. Course Content

UNIT – I

Introduction: What Is the ARM Cortex-M3 Processor?, **The Cortex-M3 Processor vs Cortex-M3-Based MCUs,** Background of ARM and ARM Architecture, Instruction Set Development, The Thumb-2 Instruction Set Architecture (ISA), Cortex-M3 Processor Applications.

Overview of the Cortex-M3: Fundamentals, Registers, Operation Modes, The Built-In Nested Vectored Interrupt Controller, The Memory Map, The Bus Interface, The Memory Protection Unit, The Instruction Set, Interrupts and Exceptions, Debugging Support, Characteristics Summary.

Cortex-M3 Basics: Registers, Special Registers, Operation Mode, Exceptions and Interrupts, Vector Tables, Stack Memory Operations, Reset Sequence.

Text 1: Chapter 1, 2, 3 **10 Hrs**

Self Learning Components:

1. Study the advanced Cortex processors.
2. Discuss the various applications of the ARM Cortex-M processors.

UNIT – II

Instruction Sets: Assembly Basics, Instruction List, Instruction Descriptions, LDR and ADR Pseudo Instructions, Assembler Language: Processing Data, Call and Unconditional Branch, Decisions and Conditional Branches, Combined Compare and Conditional Branch, Conditional Branches Using IT Instructions, Instruction Barrier and Memory Barrier Instructions, Saturation Operations Several Useful Instructions in the Cortex-M3.

Cortex-M3 Programming: Overview, The Interface Between Assembly and C, A Typical Development Flow, The First Step, Producing Outputs, Using Data Memory, Using Exclusive Access for Semaphores, Using Bit Band for Semaphores, Working with Bit Field Extract and Table Branch.

Text 1: Chapter 4, 10 **11 Hrs**

Self Learning Components:

1. Identify the applications of big endian and little endian processors.
2. Understand how the power management takes place

UNIT – III

Memory Systems: Memory System Features Overview, Memory Maps, Memory Access Attributes, Default Memory Access Permissions, Bit-Band Operations, Unaligned Transfers, Exclusive Accesses, Endian Mode,

Cortex-M3 Implementation Overview: The Pipeline, A Detailed Block Diagram, Bus Interfaces on the Cortex-M3, Other Interfaces on the Cortex-M3, The External Private Peripheral Bus, Typical Connections, Reset Signals.

Exceptions: Exception Types, Definitions of Priority, Vector Tables, Interrupt Inputs and Pending Behavior, Fault Exceptions, SVC and PendSV.

Text 1: Chapter 5, 6, 7 **11 Hrs**

Self Learning Components:

1. Understand the concept of advanced high-performance bus.
2. Indentify the difference between LDR and ADR.

UNIT – IV

The NVIC and Interrupt Control: NVIC Overview, the Basic Interrupt Configuration, Interrupt Enable and Clear Enable, Interrupt Pending and Clear Pending, Example Procedures in Setting Up an Interrupt, Software Interrupts, The SYSTICK Timer.

Interrupt Behavior: Interrupt/Exception Sequences, Exception Exits, Nested Interrupts, Tail-Chaining Interrupts, Late Arrivals, More on the Exception Return Value, Interrupt Latency, Faults Related to Interrupts.

The Memory Protection Unit: Overview, MPU Registers, Setting Up the MPU, Typical Setup.

Other Cortex-M3 Features: The SYSTICK Timer, Power Management, Multiprocessor Communication, Self-Reset Control.

Getting Started with Cortex-M3 Development: Choosing a Cortex-M3 Product, Differences between Cortex-M3 Revision 0 and Revision 1, Development Tools

Text 1: Chapter 8, 9, 13, 14, 17 **10 Hrs**

Self Learning Components:

1. List the development tools supporting cortex-M3
2. Understand the concept of software interrupts.

UNIT – V

Exceptions Programming: Using Interrupts, Exception/Interrupt Handlers, Software Interrupts, Example with Exception Handlers, Using SVC, SVC Example: Use for Output Functions, Using SVC with C.

Advanced Programming Features and System Behavior: Running a System with Two Separate Stacks, Double-Word Stack Alignment, Nonbase Thread Enable, Performance Consideration, Lockup Situations.

Debug Architecture: Debugging Features Overview, CoreSight Overview, Debug Modes, Debugging Events, Breakpoint in the Cortex-M3, Accessing Register Content in Debug, Other Core Debugging Features

Debugging Components: Introduction, Trace Components: Data Watchpoint and Trace, Trace Components: Instrumentation Trace Macrocell, Trace Components: Embedded Trace Macrocell, Trace Components: Trace Port Interface Unit, The Flash Patch and Breakpoint Unit, The AHB Access Port, ROM Table

Text 1: Chapter 11, 12, 15, 16 **10 Hrs**

Self Learning Components:

1. Design and Develop ARM processor based real-time car theft decline system.
2. Discuss how the event communication connection takes place in a two-processor system.

Note: No questions from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)

TEXT BOOK:

1. **"The Definitive Guide to the ARM Cortex-M3"** by Joseph Yiu, 2nd edition, Newnes, (Elsevier), ISBN: 978-0-7506-8534-4, 2007.

REFERENCE BOOKS:

1. "**ARM Assembly Language Fundamentals and Techniques**", William Hohl and Christoper Hinds, 2nd edition, ISBN 9781482229851, 2014, CRC (Taylor and Francis)
2. "**ARM System-On-Chip Architecture**" Steve Furber, 2nd edition, Pearson, ISBN: 9788131708408, 8131708403, 2015.

ONLINE COURSES AND VIDEO LECTURES:

1. NPTEL Course by Prof. Indranil Sengupta Dept. of Computer Science and Engineering IIT Kharagpur, https://nptel.ac.in/courses/106/105/106105193/

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** the knowledge of architecture and instruction set of ARM cortex-M3 to develop the program.	**PO1 (L2)**
CO2	**Analyse** the ARM processor based programs related to interrupts and exceptions.	**PO2 (L2)**
CO3	**Understand** different addressing modes and instructions	**PO3 (L1)**
CO4	**Apply** the knowledge gained for Programming ARM Cortex M3 for different applications.	**PO3 (L2)**
CO5	**Design and Develop** the embedded systems using the basic knowledge of cortex M3.	**PO3, PO5 (L5)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	3												3	
#2		2												2
#3			3											
#4			3											
#5			3		1									

Professional Elective-I			
Course Title: **Adaptive Signal Processing**			
Course Code: **P18EC554**	Semester: **V**	**L**-T-P-**H** : **4**-0-0-**4**	Credits: **3**
Contact Period: Lecture: **52 Hrs.** Exam: **3 Hrs.**		Weightage: CIE: **50%** SEE: **50%**	

A. Course Learning Objectives (CLOs)

This course aims to:

1. Provide general understanding of adaptive systems
2. Provide mathematical understanding of gradient analysis used with adaptive systems
3. Understand the filter design (Adaptive filters) related to adaptive signal processing
4. Provide understanding of LMS algorithm
5. Introduce different algorithms to implement adaptive signal processing
6. Provide exposure to different applications of adaptive signal processing

B. Course Content

UNIT – I

Introduction: Adaptive systems - definitions and characteristics - applications - properties-Open and closed Loop Adaptation- Application of Closed Loop adaptation, examples - adaptive linear combiner input signal and weight vectors – Desired Response and error-performance function-gradient and minimum mean square error, Example of a Performance Surface-Alternate Expression of the gradient, Decorrelation of Error and Input Components.

Properties of Quadratic Performance Surface: Normal Form of Input correlation Matrix, Eigen values and Eigenvectors of the input, correlation matrix, an Example of two weights, Geometrical significance of Eigenvectors and Eigen values, second example

Text 1: Chapter 1, Chapter 2 and Chapter 3 **10 Hrs**

Self Learning Components: Study and submit the report on

1. Application of adaptive filter-recording of a heart beat (an ECG) using Notch filter.

"Applications of a adaptive filtering to ECG analysis: noise cancellation and arrhythmia detection". IEEE transactions on biomedical Engineering.

UNIT – II

Searching the Performance Surface: Methods for searching the performance surface, basic Ideas of gradient search Methods, a simple gradient search algorithm and its solution, stability and rate of convergence, Learning curve, gradient search by Newton's method, Newton's method in multidimensional space, Gradient search by steepest Descent, Comparison of learning Curves.

Gradient Estimation and Its Effect on Application: Gradient Component Estimation by derivative measurement, Performance penalty, Derivative Measurement and Performance Penalties with multiple weights, Variance of gradient Estimate, effects on the weight vector solution, excess mean square error and time constants Mis-adjustments, compaitive performance of Newton's and Steepest-Descent Methods

Text 1: Chapter 4 and chapter 5 **11 Hrs**

Self Learning Components:
1. Understand the concepts of the wiener-hopf equation.
2. Analyse the applications of the steepest Descent Algorithm.

UNIT – III

Linear Adaptive Algorithm and Structures: LMS Algorithm-Derivation, Convergence of weight Vector, an example of Convergence, Learning Curve, Noise in Weight-Vector Solution, Mis-adjustments, Performance.

Z-Transform In Adaptive Signal Processing- z-Transform, right and left handed sequence, Transfer function, frequency response, impulse response and stability, inverse z-Transform, correlation functions and power spectra, performance Function, Example of Performance Surfaces.

Text 1: Chapter 6 and Chapter 7 **11 Hrs**

Self Learning Components:
1. Implement the Recursive linear system.
2. Understand and Implement the adaptive traversal filter

UNIT – IV

Other Adaptive Algorithms And Structures: LMS/Newton Algorithm, Properties of LMS/Newton Algorithm, The Sequential Regression Algorithm, Adaptive Recursive Filters, Random-Search Algorithms, Lattice structures, The Adaptive Lattice Predictor, Adaptive Filters with Orthogonal Signals.

Text 1: Chapter 8 **10 Hrs**

Self Learning Components:
1. Comparison of LMS algorithm with the steepest- descent algorithm.
2. List the Applications of LMS algorithm in signal processing.

UNIT – V

Applications of Adaptive Signal Processing: Adaptive Modelling and System Identification: General Description, Adaptive Modelling of a Multipath Communication channel, Adaptive Modelling in Geophysical Exploration, Adaptive Modelling in FIR Digital Filter Synthesis

Adaptive Interference Cancelling: Adaptive Interference cancellor as a Notch Filter, Adaptive Interference cancellor as a High Pass Filter, Cancelling Of 60-Hz Interference in ECG, Cancelling Maternal ECG in Fetal ECG.

Text 1:Chapter 9 , 12.5,12.6,12.9,2.11 **10 Hrs**

Self Learning Component:
1. Analyze the concept of system identification adaptive modeling.
2. Understand the concept of adaptive control systems.

Note: <u>No questions</u> from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)

TEXT BOOK:

1. **"Adaptive Signal Processing",** Bernard Widrow and Samuel Stearns, 2nd edition, Pearson Education, Second Impression-2009. ISBN: 978-81-317-0532-1.

REFERENCE BOOKS:

1. **"Adaptive Filter Theory",** Simon Haykin, 3rd edition., Prentice Hall International, 2002.ISBN: 013322760X
2. **"Adaptive Signal Processing in Wireless Communications",** Mohamed Ibnkahla(Edited), 1st edition., CRC Press, Taylor & Francis Group,2009. ISBN: 9781420046021.
3. **"Fundamentals of Adaptive Filtering",**Ali H. Sayed, Wiley, 1st edition., 2003. ISBN: 0-471-46126-1.
4. **"Adaptive Filters Theory and Applications",** Farhang-Boroujeny B.,1st edition., John Wiley and Sons ,1998. ISBN: 978-1-119-97954-8.

ONLINE COURSES AND VIDEO LECTURES:

1. https://nptel.ac.in/courses/117/105/117105075/ Lectured by Prof. M. Chakraborty IIT Kharagpur.

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** the basic Knowledge of Mathematics and Signal Processing to understand Adaptive Systems, Algorithms for adaptive systems and applications.	**PO1 (L3)**
CO2	**Analyze** Adaptive Systems for their operations and Performance	**PO2 (L4)**
CO3	**Analyze** and **Develop** algorithms for adaptive systems	**PO2-PO3 (L4, L5)**
CO4	**Apply** the concepts of Adaptive Signal Processing to **analyze and Develop** algorithms for adaptive filters	**PO1, PO3, (L4, L5)**
CO5	**Apply** the concepts of adaptive signal processing to real world applications	**PO1 (L2)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
#1	3												3	
#2		3												3
#3		3	2											3
#4	3		2										3	
#5	3												3	

Professional Elective-I			
Course Title : **Cognitive Radio Networks**			
Course Code: **P18EC555**	Semester : **V**	**L**-T-P-**H** : **4**-0-0-**4**	Credits: **3**
Contact Period: Lecture: **52 Hrs.** Exam: **3 Hrs.**		Weightage : CIE: **50%** SEE: **50%**	

A. Course Learning Objectives (CLOs)

This course aims to:

1. Describe the hardware and software sections of software-defined radio (SDR)
2. Describe the technologies required for cognitive radio and spectrum aware radio.
3. Discuss the fully functional cognitive radio and the intelligent cross-layer optimization of physical (PHY) and link (or medium access control, MAC) layers.
4. Provide the understanding of position and network awareness in cognitive radio.
5. Provide the understanding of the cognitive services for the radio.
6. Describe the radio environment map(REM) and different cognitive radio architectures.

B. Course Content

UNIT – I

The Software Defined Radio as a Platform for Cognitive Radio: Introduction, Hardware Architecture, Software Architecture, SDR Development and Design, Applications, Development, Cognitive Waveform Development.

Text 1: 3.1-3.7 **10 Hrs**

Self Learning Component: Study of

1. Comparison between cognitive Radio technologies.
2. The telecommunication policy and technology used in India

UNIT – II

Cognitive Radio- The Technologies Required: Introduction, Radio Flexibility and Capability, Aware, Adaptive, and CRs, Comparison of Radio Capabilities and Properties, Available Technologies for CRs.

Spectrum Awareness: Introduction, The Interference Avoidance Problem, Cognitive Radio Role, Spectral Footprint Minimization, Creating Spectrum Awareness, Channel Awareness and Multiple Signals in Space, Spectrally Aware Networking, Overlay and Underlay Techniques, Adaptive Spectrum Implications for Cognitive Radio Hardware.

Text 1: 4.1-4.5, 5.1-5.9 **10 Hrs**

Self Learning Components:

Study and submit the report on:

1. Applications of Cognitive radio Authentication.

UNIT – III

Cognitive Techniques- Physical and Link Layers: Introduction, Optimizing PHY and Link Layers for Multiple-Objectives under Current Channel Conditions, Defining the Cognitive Radio, Developing Radio Controls (Knobs) and Performance Measures (Meters), MODM Theory and Its Application to Cognitive Radio, The Multi-objective GA for Cognitive Radios, Advanced GA Techniques.

Cognitive Techniques-Position Awareness: Introduction, Radio Geolocation and Time Services, Network Localization, Additional Geolocation Approaches, Network-Based Approaches, Boundary Decisions.

Text 1: 7.1-7.7, 8.1-8.6 **11 Hrs**

Self Learning Components: Study of

1. Comparison between Geolocation and Network based approaches.
2. The interfaces to other cognitive technologies.

UNIT – IV

Cognitive Techniques-Network Awareness: Introduction, Applications and their Requirements, Network Solutions to Requirements, Coping with the Complex Trade-Space, Cognition to the Rescue, the DARPA SAPIENT Program.

Cognitive Services for the User: Introduction, Speech and Language Processing, Concierge Services.

Text 1: 9.1-9.6, 10.1-10.3 **10 Hrs**

Self Learning Components: Study of

1. The PDF detection in Cognitive radio Networks
2. The Comparison between Speech and Language Processing

UNIT – V

Network Support the Radio Environment Map: Introduction, Internal and External Network Support, Introduction to the REM, REM Infrastructure Support to Cognitive Radios, Obtaining Awareness with the REM, Network Support Scenarios and Applications, Supporting Elements to the REM.

Cognitive Radio Architecture: Introduction, CRA I: Functions, Components, and Design Rules, CRA II: The Cognition Cycle, CRA III: The Inference Hierarchy.

Text 1: 11.1-11.7, 14.1-14.4 **11 Hrs**

Self Learning Components: Study of

1. The Building the CRA on SDR architectures.
2. Cognitive electronics

3. **Note: <u>No questions</u> from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)**

TEXT BOOK:

1. "**Cognitive Radio Technology**" Bruce A. Fette (Editor), 1st edition, Elsevier(Newnes), 2006. ISBN:13:978-0-12-374535-4.

REFERENCE BOOKS:

1. "**Software Defined Radio for 3G**", Paul Burns- Artech house, 2002. ISBN: 1-58053-347-7.
2. "**RF and DSP for SDR**", Tony J. Rouphael-Elsevier(Newnes) 2008. ISBN: 9780080941738, 9780750682107.
3. "**Digital Synthesizers and Transmitters for Software Radio**", Joukovankka-Spinger 2005. ISBN:10 1-4020-3194-7.
4. "**RF and Baseband Techniques for Software Defined Radio**", P.Kenington-Artech house, 2005. ISBN: 1-58053-793-6.

ONLINE COURSES AND VIDEO LECTURES:

1. Lecture by Prof. Aditya K Jagannatham IIT Kanpur. https://www.youtube.com/watch?v=SljXFf0vgvw/

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** knowledge of electronics and software in understanding Hardware and software architecture of SDR	**PO1 (L2)**
CO2	**Apply** the concepts of MODM theory and others to Cognitive radio.	**PO1 (L3)**
CO3	**Analyze** the functions of different components of Software defined radio in cognitive radio network	**PO2 (L4)**
CO4	**Design** the cognitive radio network using the concepts of physical and link layers as well as position and network awareness	**PO3 (L5)**
CO5	**Examine** the applicability of cognitive radio network to cognitive services such as speech and language processing, concierge services.	**PO4 (L4)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	**3**												**3**	
#2	**3**												**3**	
#3		**3**												**3**

#4			**3**											
#5				**2**										

Laboratory			
Course Title : **Digital Signal Processing Laboratory**			
Course Code: **P18ECL56**	Semester : **V**	L-T-**P-H** : 0-0-**3**-**3**	Credits:**1.5**
Contact Period : Lab: **36 Hrs,** Exam: **3 Hrs.**		Weightage: CIE: **50%** SEE: **50%**	

A. Course Learning Objectives (CLOs)

This course aims to:

1. Provide the basic knowledge of how to use MATLAB, Simulink, CC studio and TMS32054xx for DSP concepts.
2. Illustrate and Verify fundamental DSP concepts using MATLAB.
3. Understand the usage of recorded real life signals in signal processing.
4. Understanding and dealing with various parameters of noise.
5. Programming of DSP processors.
6. Using of DSP processor for real time signal processing applications.

B. Course Content

1. EXPERIMENTS USING MATLAB/SCILAB/OCTAVE/WAB

1 Computation of the N point DFT of a given sequence and to plot magnitude and phase spectrum.
2 Linear convolution and circular convolution of the two given sequences without using function and using DFT and IDFT.
3 Autocorrelation, Cross correlation of the given sequence and verification of its properties.
4 Plot the spectrum of voice, ECG, EMG and Music.
5 Adding noise of specific mean variance and distribution and add to voice signal and separate using a filter.
6 Solve a given difference equation/system of linear equations using Simulink.
7 Design Filters(FIR and IIR) to meet the given specifications using Simulink.

2. EXPERIMENTS USING DIGITAL SIGNAL PROCESSOR (TMS320C54XX) AND CODE COMPOSER STUDIO (CCS)

(Note: Experiments no. 1, 2 & 3 may be performed on CCS)

1 Linear and Circular convolution of the two given sequences.
2 Computation of the N Point DFT of a given sequence.
3 Realize the FIR filters to meet given specifications. The input can be a signal from function generator / speech signal.
4 Audio applications such as to plot time and frequency (Spectrum) display of Microphone output plus a cosine using DSP. Read a wav file and match with their respective spectrograms.
5 Noise: Add noise above 3 kHz and then remove; Interference suppression using 400 Hz tone.

Open Ended Experiments

1. Interface ECG/EEG signal generator and analyse using DSP processor

2. Analyse the impulse response and step response of a system using MATLAB/SIMULINK
3. Analyse the operation of Basic Communication model using Simulink.

REFERENCE BOOKS:

1. **"Digital Signal Processing using MATLAB",** Sanjit K Mitra, TMH, 2001
2. **"Digital Signal Processing using MATLAB**", J.G. Proakis & Ingle, MGH, 2000
3. **"Digital Signal Processors",** B.Venkataramani and Bhaskar, TMH,2002
4. **"Digital Signal Processing"** Tarun Kumar Rawat, Oxford Univ Press India, 2015 ISBN: 0198081936, 9780198081937

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Analyze** and **apply** the fundamental DSP concepts using MATLAB	**PO1 (L3), PO2 (L3), PO5 (L4)**
CO2	**Analyze** the recorded real life signals.	**PO2 (L3)**
CO3	**Analyse** various parameters of noise.	**PO2 (L3)**
CO4	**Implement** the filters by Interfacing external signal (Biomedical, speech etc) to DSP processor using CCS studio and conduct the experiment **in group**	**PO3 (L3), PO5 (L4), PO9 (L2)**
CO5	**Conduct** experiments to **verify** DSP concepts and applications of DSP using **Hardware DSP board**	**PO3 (L3), PO5 (L4)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	**2**	**2**			**2**								**2**	**2**
#2		**3**												**3**
#3		**3**												**3**
#4			**2**		**2**				**2**					
#5			**2**		**2**									

Laboratory			
Course Title : **Analog and Digital Communication Laboratory**			
Course Code: **P18ECL57**	Semester : **V**	L-T-**P-H** : 0-0-**3-3**	Credits: **1.5**
Contact Period: Lab: **36 Hrs.,** Exam: **3 Hrs.**		Weightage: CIE: **50%** SEE: **50%**	

A. Course Learning Objectives (CLOs)

This course aims to:

1. Provide the basic practical knowledge of Analog and Digital Fiber Optic links, laser, diode characterization and attenuation.
2. Demonstrate the measurement of various parameters of Optical fiber losses, Numerical Aperture and WDM MUX- DEMUX.
3. Demonstrate the generation and detection of analog signals using various modulation techniques such as AM, FM, PAM, PPM.
4. Provide the basic practical knowledge of digital modulation & demodulation.
5. Know the working of DPSK, DPCM, ADPCM, QAM Generation and its detection.
6. Design and Analyze the frequency response of Second order active filters using op-Amp and Astable multi-vibrators.

B. Course Content

All the following experiments have to be performed using discrete components and modules.

1. Analog and Digital Fibre optic links. Attenuation, Bending loss and Numerical aperture measurement of optical fibre.
2. Characterization of WDM MUX and DEMUX.
3. Time Division Multiplexing of signals (Using PAM Kit).
4. Amplitude Modulation and Detection in time domain and its observation in frequency domain (Use Spectrum Analyser).
5. Frequency Modulation using IC8038/2206 in time domain and in frequency domain.
6. Pulse Position Modulation using IC555 timer
7. Demonstration of ASK, FSK and PSK modulation and Demodulation.
8. Demonstration of DPSK and QAM modulation and Demodulation.
9. Demonstration of DPCM and Adaptive DPCM Modulation – Demodulation and Observation of Quantization Noise.
10. Simulation of QPSK transmitter and receiver taking into account the phase and the frequency offset (Using WICOMM–T Kit).
11. Design an A-stable Multi-vibrator using IC555 Timer.
12. Design Second order active filters for different cut-off frequencies using op-Amp: LPF, HPF and BPF.

Open Ended Experiments:

1. Analyse and Understand the Hysteresis Curve generated using Schmitt Trigger Op-amp Circuit.
2. Determine the Bit Error Rate (BER) and Analyse the Eye Pattern generated in a Digital Transmission using Light Runner.
3. Design a circuit for Mono-Stable multi-vibrator for a given pulse using MatLab Simulink.
4. Understand the Modulation and Demodulation of Minimum Shift Keying Modulation schemes.
5. Differentiate Delta and Adaptive Delta Modulation techniques.

REFERENCE BOOKS:

1. **"Introduction to Fiber Optic",** A. Ghatak and K. Thygarajan, Cambridge University Press, Cambridge, UK 1988.
2. **"Fiber Optical Communication System",** 3rd edition Govind P. Agrawal, John wiley Sons Inc. 2002.
3. **"Optical Fiber Communication Principles and Systems",** S. Kar, A. Selvarajan and T Sreenivas Tata McGraw Hill Publishing Company Ltd., New Delfi, 2002.
4. **"An Introduction to Analog and Digital Communication System",** Simon Hykin and John Wiley 2004.
5. **"Advanced Digital Communication Laboratory Manual",** Preetha Sharan, R Bhargava Rama Gowda, CBS Publishers & Distributors Pvt. Ltd., First Edition, 2013.

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Understand** data transmission in an Optical Analog and Digital Link and **Determine** attenuation, losses and Numerical Aperture of an **optical link.**	**PO1, PO2, PO9 (L2)**
CO2	**Analyze** by **applying** basic knowledge of communication theory the working of TDM, ADM, WDM- MUX and WDM-DEMUX.	**PO1, PO2, PO9 (L3)**
CO3	**Analyze** the operation of different Analog and Digital modulation schemes.	**PO2, PO4, PO9, P12 (L3)**
CO4	Design and **Analyze** Second Order Active filters and Multi-vibrator.	**PO2, PO3, PO9 (L4)**
CO5	**Apply** knowledge gained with experiments to **extend design** and **conduction** of new experiments	**PO1 (L4), PO3 (L3), PO12 (L3)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
#1	2	2							3				2	2
#2	2	2							3				2	2
#3		2		2					3			1		2
#4		2	2						3					2
#5	3		2									1	3	

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Skill Laboratory - Core			
Course Title : **Skill Oriented Laboratory –I**			
Course Code: **P18ECL58**	Semester : **V**	L-T-**P-H** : 0-0-**2-2**	Credits: **1**
Contact Period: Lab: **26 Hrs.,** Exam: **2 Hrs.**		Weightage: CIE: **50%** SEE: **50%**	

Track -1: Embedded Systems and Applications Laboratory

A. Course Learning Objectives (CLO'S)

This course aims to:

1. Understand the basics of programming in C and Embedded C.
2. Understand different properties and capabilities of programming for micro controller implementations.
3. Understand the working and interfaces of an Arduino Micro controller.
4. Understand interface of perform multiple real-time experiments.
5. Understand the overall operation of Automations using controllers.

B. Course Content

1) Introduction to C Programming:

a) Write a c program function to calculate the sum of two integers where the two integers will be provided by the user.

b) Write a c program function to calculate the circumference of a circle if the radius of the circle is passed to it.

2) Pointer, Database Management:

a) Write a C program to return the bigger number between 2 integers using conditional/ternary operator.

b) Write a C program function to print a half pyramid using *.

3) Understanding the Basics of Arduino Board:

a) Connect and understand the interface of an Arduino with PC or Arduino IDE.

b) Verify enabling/disabling of I/O pins on an Arduino Board, Use LEDs to check the status of any Pin.

4) Programming Basics in Arduino:

a) Write a c program function to take your name as input using fgets stdin and print the name as output on an Arduino IDE.

b) Write a C program to set the 0th to 3rd bits of an integer, show the same through the LEDs on an Arduino.

5) Sensors and their Integration with Arduino:

a) Develop a controller system, which can take inputs through various sensors (Gas Sensor, Fire Sensor, IR Sensors & Ultrasonic Sensors) and provide outputs through LED or Buzzers.

6) **Learning to Control a Motor:**
   a) Develop a controller system to control the rotation of a Motor (Simple DC Motors, Stepper Motors).
   b) Interface the Motor Controller or Motor Drivers and Control the operation of a motor.
7) **Establishing Wired/Wireless Communication using Peripherals:**
   a) Develop a controller system to sense a specific data and send the sensed data to the PC through communication module.
8) **Interfacing Different Display or Output Peripherals with Arduino.**
   a) Write a program and develop a controller system, to display environmental temperature.
   b) Develop a controller system to interface 7-Segment Display or QLED to display the A Message.
9) **GSM and Long Range Communication:**
   a) Develop a controller system, to communicate and alert the registered mobile number using GSM module interface.
   b) Develop a controller system to communicate to the host through the use of LoRA gateway.
10) **Learning RFID with Arduino:**
   a) Develop a controller system, which can identify the registered RFID Tags and result in some specific action.
11) **Effectiveness of Arduino for Automation.**
   a) Design a controller system for Home Automation.

REFERENCE BOOKS:

1. **"Arduino Projects for Dummies",** Brook Craft, Jhon Wiley & Sons, 2013. ISBN: 978-1-118-55151-6 (eBook)**.**
2. **"Controlling Motors with Arduino/Genuino",** David Leithauser, Create Space independent publishing platform, 1st edition 2018, ISBN: 978-1721143870.
3. **"Arduino Cookbook",** Michael Margolis, Oreilly Publication, 2nd edition, ISBN: 978-1449313876.

Track -2: System Verilog Laboratory

A. Course Learning Objectives (CLO'S)

This course aims to:

1. Understand the basics of programming in System Verilog.
2. Learn System Verilog Constraint Random Verification to verify VLSI designs, usage of System Verilog communication features like Semaphores, events and mail boxes.
3. Understand and use the System Verilog RTL design and synthesis features.
4. Understand the methods of robust verification.
5. Develop a stimulus generator to create constrained random test stimulus.

B. Course Content

1. Develop a System Verilog code to create and maintain a queue/stack with corresponding operations also simulate it as per stated requirements.
2. Using the array data type in System Verilog develop a code for ALU as per given specifications and simulate it.
3. Using the Class facility of the System Verilog develop a code to simulate and test the operation of a given combinational logic function.
4. Develop a System Verilog code to illustrate the concept of Polymorphism.
5. Using function facilities of System Verilog develop a code for given arithmetic/logical operation and verify its operation through its test bench simulation.
6. Using task facility of System Verilog develop a code to synthesize given logical functionality, verify its operation through test bench and also comment on synthesizability with respect to return type.
7. Using class data types in System Verilog develop a code for control register with given specifications and simulate its operation.
8. Develop a System Verilog code to illustrate the concept of threads and fork.
9. Develop a System Verilog code to illustrate the concept of semaphore.
10. Develop a System Verilog code to test the functionality of a given sequential logic circuit.
11. Develop a System Verilog code to generate a random test vectors and test given functionality.
12. Using System Verilog data types and facilities design and develop synthesizable code for binary search tree.

REFERENCE BOOKS:

1. **"SystemVerilog for Verification: A Guide to Learning the Testbench Language Features",** Chris Spear, Springer-Verlag New York, Inc, 3rd edition, 2012, ISBN 978-1-4614-0714-0.

2. **"Hardware Verification with System Verilog (An Object Oriented Framework)"**, Mike Mintz and Robert Ekehndal, Springer, USA, 2007, ISBN 0-387-71738-2.

Track -3: Java and Web Technologies Laboratory

A. Course Learning Objectives (CLO'S)

This course aims to:

1) To understand object oriented concepts in Java
2) To execute basic SQL queries
3) To develop an ability to design and implement websites with client side scripts, and server side scripting.

B. Course Content

1. **Java programs covering object oriented concepts Abstraction, Encapsulation:**
   a) Write a Java program to print the result of the following operations.
   b) Write a Java program to display any specific character pattern.
2. Write a Java program to get a number from the user and print whether it is positive or negative.
3. **Classes and Objects:**
   a) Write a program called **Check Pass Fail** which prints "PASS" if the int variable "mark" is more than or equal to 50; or prints "FAIL" otherwise. The program shall always print "DONE" before exiting.
4. Write a program called **Print Number In Word** which prints "ONE", "TWO",... , "NINE", "OTHER" if the int variable "number" is 1, 2,... , 9, or other, respectively. Use
   i) a "nested-if" statement;
   ii) a "switch-case-default" statement.
5. **Inheritance, Polymorphism:**
   a) Write a class called Square, as a subclass of Rectangle. Convince yourself that Square can be modeled as a subclass of Rectangle. Square has no instance variable, but inherits the instance variables width and length from its superclass Rectangle.
6. **Interface and Packages:**
   a) Write a program for discount system of a beauty salon, which provides services and sells beauty products. It offers 3 types of memberships: Premium, Gold and Silver. Premium, gold and silver members receive a discount of 20%, 15%, and 10%, respectively, for all services provided (or for similar applications).
7. Write a program for a price calculating system, which provides different pricing depending on the quantity of products purchased: Less than 100 Nos, up-to 500 Nos & more than 500 Nos to give a discount of 10%, 15% and 20% respectively.
8. **Programs on HTML5:**
   a) Write a java program to develop a single page website (for profile management).

9. Write a java program to develop a website page (an online book store can be chosen as an example) on HTML5.

REFERENCE BOOKS:

1. **"Java: The Complete Reference",** Schildt Herbert, McGraw Hill Education, 7th edition, ISBN: 9780070636774, 9780070636774**.**
2. **"HTML & CSS: The Complete Reference",** Powell Thomas, Tata McGraw-Hill Education India, 7th edition, ISBN: 9780070701946, 9780070701946.

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	Ability to **understand and verify** basic concepts of embedded theory, Java programming and System Verilog programming with experimentation	**PO1(L1), PO2 (L2)**
CO2	Ability to **analyse and discriminate** intricacies of embedded theory, Java programming and System Verilog programming	**PO1(L2), PO2(L4), PO3 (L2)**
CO3	Ability to **use modern tools** and get tuned to industrial requirements	**PO5 (L2)**
CO4	Will be able to **develop** small projects through knowledge gained out of practical session	**PO2(L4), PO3 (L3)**
CO5	Will learn **professional ethics**, project management capabilities and working in a team	**PO8(L2), PO9 (L3)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11		PO 12	PS O1	PS O2
#1	**2**	**1**												**2**	**1**
#2	**2**	**2**	**1**											**2**	**2**
#3					**3**										
#4		**2**	**3**												**2**
#5								**2**	**2**						

Technical Skill – I			
Course Title : **Embedded System and IOT**			
Course Code: **P18EC591**	Semester : **V**	L-**T**-P-**H** : 0-**2**-**0**-**2**	Credits: **1**
Contact Period: Lab: **26 Hrs.,** Exam: **2 Hrs.**		Weightage: CIE: **50%** SEE: **50%**	

A. Course Learning Objectives (CLO'S)

This course aims to:

1. Understand the basics of programming in C and Embedded C.
2. Understand different properties and capabilities of programming for micro controller implementations.
3. Understand the specifications and working of Arduino microcontroller.
4. Understand different peripherals interface for multiple real-time experiments.
5. Understand the overall operation of Automations using controllers.
6. Understand different basic programming for IOT applications.
7. Understand the interface of different sensors and signaling peripherals to Arduino & raspberry pi.

B. Course Content

UNIT- I

1. **Introduction to C Programming:**
   Basics of C-Programming & Embedded C,
2. **Pointer, Database Management:**
   Use of Pointers, Arrays and Database Management for building different applications using embedded C.
3. **Understanding the Basics of Arduino Board:**
   Introduction to Arduino Hardware, Understanding different I/O pins, Architecture of Arduino, Arduino IDE.
4. **Programming Basics in Arduino:**
   Programming Requirements, Use of Conditions, Loops, Timers & Interrupts in Arduino Programming, Pointers, Declaration of I/O pins in Programming
5. **Sensors and their Integration with Arduino:**
   Introduction to Gas Sensor, Fire Sensor, IR Sensors & Ultrasonic Sensors, Understanding their operations with respect to Arduino.
6. **Learning to Control a Motor:**
   Types of Motor: Simple DC Motors, Stepper Motors (Servo Motors, Precession Motors), Motor Drivers and their Applications.

7. **Establishing Wired/Wireless Communication using Peripherals:**
   Connection with PC/Laptop, Bluetooth, Wifi & Zigbee Interfaces for Communication.
8. **Interfacing different Display or Output peripherals with Arduino.**
   7-Segment Display, LED, LCD & QLED for Arduino.
9. **GSM and Long Range Communication:**
   Introduction to GSM & LoRA, AT Commands, Interfacing GSM module with Arduino.
10. **Learning RFID with Arduino:**
    Introduction to RFID, Active & Passive RFID, RFID frequencies and protocols.
11. **Effectiveness of Arduino for Automation.**
    Introduction Simple Automation, How to Design & Develop Automation using Arduino, Introduction to Home and Industry Automation.

REFERENCE BOOKS:

1. **"Arduino Projects for Dummies",** Brook Craft, Jhon Wiley & Sons, 2013. ISBN: 978-1-118-55151-6 (eBook) **.**
2. **"Controlling Motors with Arduino/Genuino",** David Leithauser, CreateSpace independent publishing platform, 1st edition, ISBN: 978-1721143870, 2018.
3. **"Arduino Cookbook",** Michael Margolis, Oreilly Publication, 2nd edition, ISBN: 978-1449313876.
4. **"21 Internet Of Things (IOT) Experiments",** Yashavant Kanetkar/ Shrirang Korde, BPB Publications (Paperback), 1st edition ISBN: 9789386551832**,** 2018.

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Understand** the concepts of Programming in C and Embedded C.	**PO1, PO3 (L1)**
CO2	**Analyze** the implementations of Embedded Processors (Arduino) with different peripherals.	**PO1, PO2, PO3 (L2)**
CO3	**Illustrate** the Embedded Systems (Arduino Microcontrollers) for simple automations.	**PO1, PO3 (L2)**
CO4	Explore and **understand modern tools** both hardware and software used with Embedded Technology and IOT.	**PO1, PO2, PO5 (L3)**
CO5	**Develop** the capability to learn on your own individually and in group to explore advanced technologies in Embedded system and IOT.	**PO9, PO12 (L4)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	2		1										2	
#2	3	1	2										3	1
#3	3		2										3	
#4	2	2			3								2	2
#5									1			1		

Technical Skill – I			
Course Title : **System Verilog**			
Course Code: **P18EC592**	Semester : **V**	L-**T**-P-**H** : 0-**2**-**0**-**2**	Credits: **1**
Contact Period: Lab: **26 Hrs.,** Exam: **2 Hrs.**		Weightage: CIE: **50%** SEE: **50%**	

A. Course Learning Objectives (CLO'S)

This course aims to:

1. Develop an understanding of the System Verilog language constructs.
2. Introduce the facilities and features of System Verilog for unified Design, testing and verification.
3. Introduce the programming approach for testing and verification.
4. Provide framework of System Verilog for functional coverage.

B. Course Content

Module 1-Part -1: Data Types

Built-in Data Types, Fixed-Size Arrays, Dynamic Arrays, Queues, Associative Arrays, Linked Lists, Array Methods, Choosing a Storage Type.
Text 1: 2.1-2.7.

Module 1-Part -2: Data Types

Creating New Types with typedef, Creating User-Defined Structures, Enumerated Types, Constants, Strings, Expression Width.
Text 1: 2.8-2.16.

Module 2: Procedural Statements and Routines

Introduction, Procedural Statements, Tasks, Functions, and Void Functions, Task and Function Overview,
Routine Arguments, Returning from a Routine, Local Data Storage, Time Values.
Text 1:3.1-3.7.

Module 3: Basic OOPs - Part-1

Your First Class, Where to Define a Class, Creating New Objects, Object De allocation, Using Objects, Class methods, Defining methods outside of the class.
Text 1: 5.3-5.10.

Module 4: Basic OOPs - Part-2
Static Variables vs. Global Variables, Scoping Rules, Using One Class Inside Another, Understanding Dynamic Objects, Copying Objects, Public vs. Private Straying Off Course, Building a Testbench.
Text 1: 5.11-5.18.

Module 5: Randomization and Constraints - Part-1
Introduction, What to Randomize, Randomization in SystemVerilog, Constraint Details, Solution Probabilities, Controlling Multiple Constraint Blocks, Valid Constraints, In-line Constraints.
Text 1: 6.1-6.8.

Module 6: Randomization and Constraints - Part-2
The pre_randomize and post_randomize Functions, Random Number Functions, Constraints Tips and Techniques, Common Randomization Problems.
Text 1: 6.9-6.12.

Module 7: Randomization and Constraints - Part-3
Iterative and Array Constraints, Atomic Stimulus Generation vs. Scenario Generation, Random Control, Random Number Generators, Random Device Configuration.
Text 1: 6.13-6.17.

Module 8: Threads and Inter Process Communication
Working with Threads, Disabling Threads, Interprocess Communication, Events, Semaphores, Mailboxes, Building a Testbench with Threads and IPC.
Text 1: 7.1-7.7.

Module 9: Functional Coverage - Part-1
Gathering Coverage Data, Coverage Types, Functional Coverage Strategies, Simple functional Coverage examples, Anatomy of a cover group, triggering a cover group.
Text 1: 9.1-9.6.

Module 10: Functional Coverage - Part-2
Data Sampling, Cross coverage, Generic cover groups, Coverage Options, Analyzing Coverage Data, Measuring Coverage Statistics during simulation.
Text 1: 9.7-9.12.

TEXT BOOK:

1. **"System Verilog for Verification: A Guide to Learning the Testbench Language Features",** Chris Spear, Springer-Verlag New York, Inc, 3rd edition, ISBN 978-1-4614-0714-0, 2012.

REFERENCE BOOK:

1. **"Hardware Verification with System Verilog (An Object Oriented Framework)",** Mike Mintz and Robert Ekehndal, Springer, USA, ISBN 0-387-71738-2, 2007.

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Understand** the System Verilog language constructs.	**PO1, PO2, PO3 (L1)**
CO2	**Understand** the System Verilog OOPs facilities and framework for the verification.	**PO2, PO3 (L1)**
CO3	**Develop** programs by applying the System Verilog facilities and framework.	**PO1, PO3, PO4 (L4)**
CO4	Explore and **understand modern software tools** to perform different operations in System Verilog.	**PO1, PO2, PO5 (L3)**
CO5	**Develop** the capability to learn on your own individually and in group to explore advanced technologies in system Verilog.	**PO9, PO12 (L4)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	**1**	**2**	**1**										**1**	**2**
#2		**3**	**1**											**3**
#3	**1**		**2**	**1**									**1**	
#4	**2**	**2**			**2**								**2**	**2**
#5									**2**			**2**		

Technical Skill – I			
Course Title : **Java and Web Technologies**			
Course Code: **P18EC593**	Semester : **V**	L-**T**-P-**H** : 0-**2**-**0**-**2**	Credits: **1**
Contact Period: Lab: **26 Hrs.,** Exam: **2 Hrs.**		Weightage: CIE: **50%** SEE: **50%**	

A. Course Learning Objectives (CLO'S)

This course aims to:

1. To understand object oriented concepts in Java
2. To execute basic SQL queries
3. To develop an ability to design and implement websites with client side scripting, and server side scripting.

B. Course Content

Week 1 and 2: Java programs covering object oriented concepts Abstraction, Encapsulation, Classes and Objects

Week 3 and 4: Java programs covering Inheritance, Polymorphism, Interface and Packages

Week 5 and 6: Programs on HTML5 and CSS

Week 7: Executing basic SQL queries: Insert, Delete, Search, Update

Week 8 and 9: Programs on Java Script

Week 10, 11 and 12: PHP programs

(Week 5 onwards a simple web application like an online book store can be chosen as an example to write programs on HTML5, CSS, Java Script, PHP. MySQL can be used as database management system).

REFERENCE BOOKS:

1. **"Java: The Complete Reference",** Schildt Herbert, McGraw Hill Education, 7th edition ISBN: 9780070636774, 9780070636774**.**
2. **"HTML & CSS: The Complete Reference",** Powell Thomas, Tata McGraw-Hill Education India, 5th edition, ISBN: 9780070701946, 9780070701946.
3. **"PHP: The Complete Reference",** Steven Holzner, Mcgrawhill HED, 1st edition, ISBN: 9780070223622, 0070223629.

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Implement** object oriented concepts in Java.	**PO1,PO3 (L2)**
CO2	**Design and Implement** websites with client side scripting using Java script.	**PO1,PO2,PO3,PO5 (L3)**
CO3	**Understand** the **modern software tools** like HTML5, CSS for advanced web developments.	**PO1,PO3,PO5, PO12 (L1)**
CO4	**Design and Implement** websites and connect to database with server side scripting using PHP.	**PO1, PO2, PO5 (L3)**
CO5	**Develop** the capability to learn on your own individually and in group to explore advanced technologies in SQL, HTML5, CSS & PHP.	**PO9, PO12 (L4)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	**1**		**1**										**1**	
#2	**2**	**1**	**2**		**2**								**2**	**1**
#3	**1**		**2**		**1**							**2**	**1**	
#4	**2**	**2**			**2**								**2**	**2**
#5									**2**			**2**		

Course Title: **Aptitude and Reasoning Development - Advanced (ARDA)**			
Course Code: **P18HU510**	Semester: **V**	L-**T**-P-**H** : 0-**2**-0-**2**	Credits: **1**
Contact Period : Lecture: **32 Hrs**. Exam: **3 Hrs**.		Weightage: CIE: **50%**	SEE: **50%**

Prerequisites: Vocabulary builder, Concept of Percentage.

A. Course Learning Objectives (CLO'S)

This course aims to:

1. Describe the importance of reading with comprehension.
2. Explain seven dimensions approach to better reading skills.
3. Explain the purpose, plan and the ways to identify specific details in a paragraph for better comprehension.
4. Formulate easier ways to solve problems of averages.
5. Explain the Application of the technique of alligation while solving weighted average and mixture problems.
6. Describe the concepts of profit, loss, discount, Marked price.
7. Explain the application of percentage in our daily life.
8. Discover different ways to identify the progressions and to compare between AP< GP and HP.
9. Explain the basic concepts in calculating simple interest and compound interest.
10. Differentiate between simple interest and compound interest and describes the importance of compound interest and its behavior.

B. Course Content

UNIT- I

Reading Comprehension: Introduction: Read more and more, The process of writing and its relevance to the process of writing, how reading skills are important for aspects other than the reading comprehension questions, the daily reading scheme.

Seven Dimension Approach to Better Reading Skills: Developing the ability of understanding vocabulary in context, Ability to identify and understand main ideas, Ability to predict and identify supporting details, Understanding the use of transition and idea organization patterns, Inferences, Identifying purpose and tone, Recognizing and evaluating arguments and their common structures.

Theory of Reading Comprehension: Solving RC passages is an exact science, tackling RC on the basis of evaluation of support, All passages have a topic, purpose and a plan, Other things to pick up while reading the passage– The tonality and other software related the author's viewpoint in the passage, specific details and their use in the passage, Types of questions asked in reading comprehension passage.

8 Hrs

UNIT - II

Averages and Alligations Mixtures: Average: relevance of average, meaning of average, properties of average, deviation method, concept of weighted average. **Alligation Method:** situation where allegation technique, general representation of alligations, the straight line approach, application of weighted average and alligation method in problems involving mixtures. Application of alligation on situation other than mixtures problems.

6 Hrs

UNIT - III

Permutation and Combination: Understanding the difference between the permutation and combination, Rules of Counting-rule of addition, rule of multiplication, factorial function, Concept of step arrangement, Permutation of things when some of them are identical, Concept of 2^n, Arrangement in a circle.

6 Hrs

UNIT - IV

Progression: Arithmetic Progression: sum of given number of terms in an A.P., arithmetic mean, to insert a given number of arithmetic means between two given quantities, nth term of an A.P., finding common difference of an A.P. given 2 terms of an A.P., types of A.P.s– increasing A.P.s and decreasing A.P. s

Geometric: to find, the geometric mean between two given quantities, to insert a given number of geometric means between two given quantities, sum of a number of terms in a G.P. Types of G.P.s— increasing G. P. s type one and two , decreasing G. P. s type one and two.

Harmonic Progression: to find the harmonic mean between two given quantities, theorems related with progressions, solved examples sample company questions.

4 Hrs

UNIT - V

Coding Decoding: Letter Coding, Number Coding, symbol coding

Crypt arithmetic: Basic concepts, addition**,** subtraction, multiplication of coded alphabets, Types of cryptarithm.

Data Interpretation: Approach to interpretation - simple arithmetic, rules for comparing fractions, Calculating (approximation) fractions, short cut ways to find the percentages, Classification of data– Tables, Bar graph, line graph, Cumulative bar graph, Pie graph, Combination of graphs. Combination of table and graphs.

8 Hrs

REFERENCE BOOKS:

1. **"The Trachtenberg Speed System of Basic Mathematics",** published by Rupa publications. ISBN: 9780285629165, 9780285629165,
2. **"CAT Mathematics"** by Abhijith Guha. Published by PHI learning private limited. 1st edition, ISBN-10: 8120350278, ISBN-13: 978-8120350274, 2014.
3. **"Quantitative Aptitude"** by Dr. R. S Agarwal, published by S.Chand private limited. ISBN: 9788121924986, 9788121924986 , 2018
4. **"Verbal Reasoning"** by Dr. R. S Agarwal , published by S. Chand private limited. ISBN: 9789352535323, 9789352535323
5. **"Quantitative Aptitude for CAT"** by Arun Sharma, published by McGraw Hill publication, ISBN: 9789353160180, 9789353160180

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** the approach of seven dimension to better reading skills.	**PO8 (L2)**
CO2	**Solve** the questions under reading comprehension confidently with higher accuracy than random reading	**PO7, PO8 (L4)**
CO3	**Apply** the technique of alligation for effective problem solving.	**PO3(L2)**
CO4	**Interpret** the requirement of different methods of calculating average and apply the right method at right scenario.	**PO1, PO8 (L4)**
CO5	Effectively **solve** problems of profit and loss and problems related to discount, simple interest and compound interest..	**PO1,PO8 (L5)**
CO6	**Formulate** the equations for summation and other functions for all the kinds of progressions– AP, GP and HP.	**PO1 (L1)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1								**2**						
#2							**2**	**2**						
#3			**3**											
#4	**2**							**2**					**2**	
#5	**3**							**2**					**3**	
#6	**2**												**2**	

Course Title : **Analog CMOS VLSI Design (CC-1)**			
Course Code: **P18EC61**	**Semester : VI**	**L**-T-P-**H** : **4**-0-0-**4**	Credits: **4**
Contact Period : Lecture : **52 Hrs,** Exam: **3 Hrs.**		Weightage : CIE: **50%** SEE: **50%**	

A. Course Learning Objectives (CLOs)

This course aims to:

1. Describe the basic MOS device physics and models.
2. Describe method of the small signal and large signal analysis of amplifiers.
3. Understanding the working of single stage MOS amplifiers with analysis.
4. Describe the operation of different types of Current mirrors and their applications.
5. Analysis and Design of the Operational amplifiers.
6. Analyse and design of CMOS oscillators with mathematical model of VCOs.

B. Course Content

UNIT – I

Single– Stage Amplifiers: MOS Device Models**,** Basic Concepts, Common–Source Stage, Source Follower, Common–Gate Stage, Cascode Stage. **Differential Amplifiers:** Single– Ended and Differential Operation, Basic Differential Pair, Common–Mode Response.

Text 1: 2.4, 3.1 to 3.5 and 4.1 to 4.3 **11 Hrs**

Self Learning Component: Design and simulate a single stage/differential amplifier for given requirements across different technologies, note the limitations and benefits.

UNIT – II

Differential Amplifiers: Differential Pair with MOS Loads, Gilbert Cell. **Passive and Active Current Mirrors:** Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors.

Text 1: 4.4 to 4.5 and 5.1 to 5.3 **11 Hrs**

Self Learning Component: Explore and analyze the Wilson Current mirror.

UNIT – III

Frequency Response of Amplifiers: General Considerations: Miller Effect, Association of Poles with Nodes, Common source stage, Source Followers, Common-Gate Stage, Cascode Stage and Differential Pair.

Text 1: 6.1-6.6 **11 Hrs**

Self Learning Component: Study and understand the procedure of calculating Network functions along with the analysis of its Poles and Zeros (Ref: Ch.10 of Network Analysis, 3rd edn, M.E. Van Valkenburg, PHI.)

UNIT – IV

Operational Amplifiers: General considerations, One stage op-amp, Two stage op-amp, Gain Boosting, Comparison, Common Mode feedback, Input Range limitations, Slew rate, Power supply rejection, Noise in Op-amps.

Text 1: 9.1 to 9.9 **10 Hrs**

Self Learning Component: Read and explore the design of Fully differential OPAMP System of Cirrus Logic International (Patent No: US20180062583A1).

UNIT – V

Noise: Statistical characteristics of noise, Types of Noise, Representation of Noise in Circuits, Noise in single stage amplifiers: Common Source stage. **Oscillators:** General Considerations, Ring Oscillators, LC Oscillators, Voltage–Controlled Oscillators, Mathematical Model of VCOs.
Text 1:14.1 to 14.5 **10 Hrs**
Self Learning Component: Read and explore the Qualcomm VCO design.

Note: No questions from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)

TEXT BOOK:

1. **Design of Analog CMOS Integrated Circuits",** Behzad Razavi, Tata McGraw Hill, Indian Edition, 2008, ISBN: 0-07-238032-2.

REFERENCES BOOK:

1. **"CMOS Analog Circuit Design"**, Phillip E. Allen, Douglas R. Holberg, Oxford University Press, 3rd edition 2011, ISBN: 9780199765072.
2. **"CMOS Circuit Design, Layout and Simulation"**, R. Jacob Baker, Harry W. Li, David E. Boyce, Prentice Hall of India, 1st edition 2005, ISBN-13:978-0780334168 ISBN-10: 0780334167.

ONLINE COURSES AND VIDEO LECTURES:

1. https://nptel.ac.in/courses/117/101/117101105/ (By Prof. A N Chandorkar, IIT, Bombay)
2. https://nptel.ac.in/courses/108/106/108106105/ (By Prof. Aniruddhan S, IIT, Madras) SWAYAM:
3. https://swayam.gov.in/nd1_noc20_ee13/preview (By Prof. Hardik Jeetendra Pandya, IISC, Bengaluru)

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	To **Apply** the knowledge of circuit elements and circuit analysis to understand the MOS devices and analog CMOS circuits	**PO1 (L2)**
CO2	To **Analyze** different Analog CMOS VLSI circuits(Amplifiers, Op-amps, Oscillators)	**PO2 (L4)**
CO3	To **Design** the analog CMOS circuits for the given Specifications.	**PO3 (L4)**
CO4	To **Develop** analog CMOS circuits for Different applications.	**PO3 (L5)**
CO5	To **Simulate** the analog CMOS circuits using modern tools.	**PO5, PO9 (L5)**

D.Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	**3**												**3**	
#2		**3**												**3**
#3			**2**											
#4			**2**											
#5					**3**				**2**					

Course Title : **Control Systems (CC-2)**			
Course Code: **P18EC62**	Semester : **VI**	**L**-T-P-**H** : **4**-0-0-**4**	Credits: **4**
Contact Period : Lecture : **52 Hrs,** Exam: **3 Hrs.**		Weightage : CIE: **50%** SEE: **50%**	

A. Course learning Objectives (CLOs)

This course aims to:

1. Determine the mathematical transfer function models of electrical system, mechanical system and analogous system.
2. Determine the transfer function from the block diagrams and signal flow graph techniques of different system.
3. Analyze the performance of different systems by determining the time Response specifications.
4. Analyze the stability of different systems by analytical and graphical means.(By sketching plots)
5. Discuss the concepts of state models for different electrical systems.

B. Course Content

UNIT – I

Fundamental Concepts of Control Systems: Basic definitions of control systems, Classification, Open loop and closed loop systems,

Modeling of Systems: Differential equations of physical systems, Determinations of transfer function models for Electrical, Mechanical and Analogous systems.

Block Diagrams and Signal Flow Graphs: Transfer functions, Block diagram algebra, Signal Flow graphs (State variable formulation excluded).

Text 1: 1.1, 2.1, 2.2, 2.4, 2.5, 2.6, 2.7. **10 Hrs**

Self Learning Component:

1. Develop the Block diagram for field and armature controlled D.C. Servomotors.
2. Develop the system equations and TF model for a seated human body with applied force.

UNIT – II

Time Domain (Transient and Steady State Response) Analysis of Feedback Control Systems: Standard test signals, Unit step response of First and second order systems.

Time Response Specifications: Transient response specifications of second order systems, steady state errors and static error constants.

Text 1: 2.4, 2.5, 2.6, 2.7, 5.1, 5.2, 5.3, 5.4, 5.5 **10 Hrs**

Self Learning Component:

1. Determine the transient response specifications of second order RLC systems for R=1000 ohms, L=1 Henry and C=2μF.

UNIT – III

Stability Analysis: Concepts of stability, asymptotic stability, necessary conditions for stability, Routh-Hurwitz stability criterion, Routh's tabulation, special cases when Routh's tabulation terminates prematurely.

Root Locus Techniques: The root locus concepts, summary of general rules for constructing Root Loci, Stability analysis.

Text 1: 6.1, 6.2, 6.4, 6.5, 6.6, 7.1, 7.2, 7.3 **10 Hrs**

Self Learning Component:

1. Write the MATLAB program to draw the Root Locus diagrams of open loop transfer function of different systems. **(Refer Text 2)**

UNIT – IV

Frequency-Response Analysis: Introduction, advantages and limitations of frequency domain methods, correlation between time response and frequency response, frequency response specifications- resonant peak, resonant frequency and bandwidth.
Graphical Analysis of Frequency –Response: (i) Bode Plots

Gain margin, Phase Margin and discuss the stability, Relative stability analysis. **(**ii) Polar plots

Gain margin and Phase Margin and discuss the stability. (iii) Nyquist plots

Pole-zero configurations, concept of encirclement, analytical function and singularities, mapping theorem, Nyquist stability criteria, and determination of stability from the Nyquist plot.

Text 1: 8.1, 8.2, 8.4, 8.5, 8.6, 9.1, 9.2, 9.3, 9.4. **12 Hrs**

Self Learning Component:

1. Write the MATLAB program to draw the Bode diagrams of open loop transfer function of different systems. **(Refer Text 2)**

UNIT –V

Introduction to State variable analysis: Concepts of state, state variable and state models for electrical systems, Controllability and observability, Derivation of transfer functions from the state model, Solution of state equations.

Text 1: 12.1, 12.2, 12.3, 12.6, 12.7 **10 Hrs**

Self Learning Component:

1. Obtain the time response for different state models

Note: <u>No questions</u> from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)

TEXT BOOKS:

1. **"Control Systems Engineering",** I. J. Nagarath and M. Gopal, New Age International (P) Limited, Publishers, 4th edition – 2005, ISBN 10:8122420087; ISBN 13: 9788122420081.

2. **"Modern Control Engineering",** K. Ogata, Pearson Education Asia/ PHI, 4th edition, 2002. ISBN 0-13-043245-8.

REFERENCE BOOKS:

1. **"Automatic Control Systems",** Benjamin C. Kuo, John Wiley India Pvt. Ltd., 8th edition, 2008, ISBN 978-81-203-4010-7
2. **"Feedback Control System Analysis and Synthesis",** J. J. D'Azzo and C. H. Houpis McGraw Hill, International student Edition, ISBN 10: 0070161755 / ISBN 13: 9780070161757.
3. **"Control System Engineering",** Norman S. Nise, 5th edition, ISV,WileyIndia, 2012.

ONLINE COURSES AND VIDEO LECTURES:

1. NPTEL course on "Introduction to System and Control" by Prof Ramakrishna Pasumarthy, IIT Madras https://nptel.ac.in/courses/108/106/108106098/

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** mathematical knowledge to determine the Transfer function of a system	**PO1(L3)**
CO2	**Analyze** the stability of a system using different techniques	**PO2(L4)**
CO3	**Analyze** the response of the system in time and frequency domain and state variable techniques	**PO2(L4)**
CO4	**Develop** the mathematical models using different techniques of state variables	**PO2(L4)**
CO5	**Design** Using MATLAB software for the linear control system problems.	**PO4, PO9(L5)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	3												3	
#2		3												3
#3		3												3
#4		3												3
#5				1					1					

Course Title: **Microwaves and Antennas (CC-3)**			
Course Code: **P18EC63**	Semester : **VI**	**L**-T-P-**H** : **4**-0-0-**4**	Credits: **4**
Contact Period : Lecture : **52 Hrs.,** Exam: **3 Hrs.**		Weightage: CIE: **50%**	SEE: **50%**

A. Course Learning Objectives (CLOs)

This course aims to:

1. Provide the basic knowledge of Microwave transmission lines and planar transmission lines.
2. Discuss the working of Microwave waveguides, microwave IC's, active and passive Devices.
3. Solve the numerical Problems on Microwave transmission lines and devices.
4. Provide the understanding of concepts of types of antenna and parameters of antenna.
5. Discuss the field due to dipole antenna and array of antenna.
6. Describe the structure and working of helical, log-periodic and microstrip antennas.
7. Solve the numerical Problems on antenna parameters and arrays.
8. Design the helical, log-periodic and microstrip antennas.

B. Course Content

UNIT – I

Microwave Transmission Lines: Introduction, transmission lines equations, characteristic and input impedances, reflection and transmission coefficients, standing waves, mismatch losses in transmission lines, rectangular waveguides, TE and TM wave solutions, dominant and degenerate modes, planar transmission lines, strip lines.

Microwave Integrated Circuit Manufacturing: Introduction, types of MICs and their technology, hybrid technology, thick-film manufacture, thin-film manufacture.

Text 1: 3.1- 3.6, 3.10, 3.10.1, 3.11 - 3.11.4, 4.1, 4.2, 4.3, 4.3.1, 4.3.2. 11 Hrs

Self Learning Components:

1. Microstrip lines.
2. Smith Chart.

UNIT – II

Microwave Passive Devices: Attenuators, phase shifters - precision phase shifter, MIC phase shifter, reciprocal and non reciprocal phase shifter, waveguide tees, E-plane tee, H-plane tee, hybrid or magic tee, Directional couplers- waveguide directional coupler and Bethe-hole coupler (excluding all other types of couplers)

Microwave Solid State Devices: Transferred electron devices (TED) - Gunn diodes, gunn diode oscillator, avalanche transit time devices (ATTD), IMPATT diodes, DC operating principles, mechanism of oscillations, IMPATT diode power amplifier, TRAPATT diodes, BARITT diodes, tunnel diodes.

Text 1: 6.4.14, 6.4.15, 6.4.16, 6.4.18, 10.3-10.5 10 Hrs

Self Learning Components:

Applications of microwaves:

1. Industrial application of microwaves- Microwave ovens, Industrial control and measurements- thickness measurements, moisture content measurements.
2. Medical applications- microwave diathermy.

UNIT – III

Introduction: Types of Antennas – Wire, Aperture, Micro-strip, Array, Reflector and Lens antennas, Radiation Mechanism – Single wire, Two-Wires and Dipole.

Fundamental Parameters of Antennas: Introduction, Radiation Pattern – Isotropic, Directional, and Omnidirectional Patterns, Principal Patterns, Radiation Pattern Lobes, Field Regions, Radian and Steradian, Radiation Power Density, Radiation Intensity, Directivity, Gain, Antenna Efficiency, Half-Power Beamwidth, Beam Efficiency, Bandwidth, Radiation Efficiency.

Text 2: 1.1, 1.2, 1.3 – (1.3.1, 1.3.2, 1.3.3),2.1 to 2.5, 2.7 to 2.11, 2.14 **11 Hrs**

Self-Learning Components:

1. Linear, Circular and Elliptical Polarization
2. Friis Transmission Equation and Radar Range Equation.

UNIT – IV

Dipole Antennas: Introduction, Infinitesimal Dipole – Radiated Fields, Power density and Radiation resistance, Radian Distance and Sphere, Intermediate and Far – field region, Directivity.

Antenna Arrays: Introduction, Two- Element Array**,** N-Element Linear Array **–** Uniform Amplitude and Spacing, Directivity.

Text 2: 4.1, 4.2, 6.1, 6.2, 6.3 - 6.3.1 to 6.3.3, 6.4 -6.4.1, 6.4.2. **10 Hrs**

Self-Learning Components:

1. Planar Array: Array Factor, Beamwidth, Directivity
2. Hansen- Woodyard End-Fire array

UNIT – V

Broadband Antennas: Helical Antenna- Design Concepts, Frequency independent Antennas – Introduction, Theory, Log –periodic Antennas –Design concepts.

Microstrip Antennas: Introduction- Basic Characteristics, Feeding Methods, Rectangular Patch Transmission line model – Design Concepts.

Text 2:10.3 - 10.3.1, 11.1, 11.2, 11.4, 14.1, 14.2 – 14.2.1 **10 Hrs**

Self Learning Components:

1. Yagi-Uda Antenna – Design Concepts
2. Circular Patch – Design Concepts.

Note: <u>No questions</u> from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)

TEXT BOOKS:

1. **"Microwave Engineering",** Annapurna Das, Sisir K Das, 2nd edition-2009, T.M.H, ISBN (13): 978-0-07-066738-9. ISBN (10): 0-07-066738-1.
2. **"Antenna Theory Analysis and Design",** C. A. Balanis, 2nd edition – 2001, John Wiley,ISBN:9971-51-233-5.

REFERENCE BOOKS:

1. **"Microwave Engineering",** David M Pozar, 2nd edition – 2004,John Wiley, ISBN: 9780470631553.
2. **"Foundations for Microwave Engineering",** Robert E Collin, 2nd edition – 2009,John Wiley & Sons Inc (Sea) Pte Ltd, ISBN: 9788126515288.
3. **"Microwave Devices and Circuits",** Samuel Y Liao, 3rd edition – 2004, ISBN:9780135846810.
4. **"Antennas for all Applications",** John D Kraus, Ronald J Marheka, Ahmad s Khan, 3rd edition- 2006, T.M.H, ISBN:9780070601857.

ONLINE COURSES AND VIDEO LECTURES:

1. **NPTEL course: "Antennas",** by Prof. Girish Kumar, IIT Bombay. https://nptel.ac.in/noc/courses/noc17/SEM1/noc17-ee03/

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** the knowledge of mathematics and EM fields to understand the parameters, field due to antennas, properties of microwave devices and transmission lines	**PO1 (L3)**
CO2	**Analyse** the working and performance of microwave transmission lines, microwave IC's and antennas **Applying** basic concepts of Microwave theory	**PO1,PO2 (L4)**
CO3	**Examine** the working and performance of microwave sources, microwave transmission line and different types of antennas.	**PO2 (L4)**
CO4	**Analyse** the working and performance of microwave devices and antenna arrays.	**PO2 (L4)**
CO5	**Design** of helical, log-periodic and microstrip antennas.	**PO3 (L4)**

D. Course Articulation Matrix

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	**3**												**3**	
#2	**3**	**3**											**3**	**3**
#3		**3**												**3**
#4		**3**												**3**

#5			**2**											

Professional Elective-II			
Course Title : **Multimedia Communication**			
Course Code: **P18EC641**	Semester : **VI**	**L**-T -P-**H** : **4**-0-0-**4**	Credits: **3**
Contact Period: Lecture: **52 Hrs.** Exam: **3Hrs.**		Weightage : CIE: **50%** SEE: **50%**	

A. Course Learning Objectives (CLOs)

This course aims to:

1. Explain the types of multimedia network and its applications.
2. Describe the digitization principles of text and images.
3. Provide the understanding of digitization techniques of audio and video.
4. Discuss the compression techniques of different media types.
5. Describe the standards related to multimedia communication.
6. Discuss the applications of Cloud Computing for Multimedia Services.

B. Course Content

UNIT-I

Multimedia Communications: Introduction, Multimedia information representation, Multimedia networks: Telephone, data, Broadcast television, ISD and Broadband multiservice digital networks, Multimedia applications: Interpersonal communication, Interactive application over the internet, Entertainment applications, Application and networking terminology: Media types, Communication modes, Network types, Network QoS and Application QoS.

Text 1: 1.1 to 1.5 **10 Hrs**

Self Learning Component:

1. Multimedia Electronic mail structure,
2. Transmission of a constant bit rate stream over packet-switched networks.
3. Multipoint conferencing.

UNIT – II

Multimedia Information Representation: Introduction, Digitization principles: Analog signals, Encoder design, and Decoder design, Text: Unformatted text, Formatted text, Hypertext, Images: Graphics, Digitized documents, Digitized pictures, Audio: PCM speech, Video: Broadcast television, Digital video.

Text 1: 2.1 to 2.6 **10 Hrs**

Self Learning Component:

1. Digital cameras and scanners,
2. CD-quality audio and Synthesized audio,
3. HDTV formats, PC video and video content.

UNIT – III

Text and Image Compression: Introduction, Compression principles: Source encoders and destination decoders, Lossless and lossy compression, Entropy encoding, Source encoding, Text compression: Static Huffman coding, Dynamic Huffman coding, Arithmetic coding, Image compression: GIF, TIFF, JPEG.

Audio and Video Compression: Introduction, Audio compression: Differential pulse code modulation, Adaptive differential PCM, Adaptive predictive coding, Linear predictive coding, MPEG audio coders, Dolby audio coders, Video compression: H.261, MPEG, MPEG- 1, MPEG-2 and MPEG- 4.

Text 1: 3.1 to 3.4 and 4.1 to 4.3 **11 Hrs**

Self Learning Component:

1. Text: Lempel-Ziv coding and Lemplel-Ziv-welsh coding.
2. Image: Digitized documents, Digitized pictures
3. Audio: code-excited LPC and perceptual coding
4. Video: H.263.

UNIT – IV

Standards for Multimedia Communications: Introduction, Standards relating to interpersonal communications: Circuit-mode networks, Packet-switched networks, Electronic mail, Standards relating to interactive applications over the internet: Information browsing, Electronic commerce, Intermediate systems, Standards for entertainment applications: Movie/video-on-demand.

Text 1: 5.1, 5.3 to 5.5 **11 Hrs**

Self Learning Component:

1. TCP/IP reference model,
2. Java and JavaScript

UNIT – V

Multimedia Information sharing and Retrieval: Representative Social Media Services, User-Generated Media content Sharing, Media Propagation in Online Social Networks.

Cloud Computing for Multimedia Services: Cloud Computing Overview, Multimedia cloud Computing, Cloud-Assisted Media Sharing, Computation Offloading for Multimedia Services, Interactive Cloud Gaming.

Text 2: 18.1 to 18.3 and 19.1-19.5. **10 Hrs**

Self Learning Component:

1. Enhancing UGC video sharing,
2. Video Streaming and Inline Storage
3. Cloud-Assisted Motion Estimation.

Case Studies:

1. Investigate effective factors on multimedia advertising: A case study of online Advertising.
2. Analysis, Design, and Implementation of a Web-page for a particular area support, Integrating Hypertext, Images, videos and Multimedia-Based Case Studies and software.

Note: <u>No questions</u> from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)

TEXT BOOK:

1. "**Multimedia Communications, Applications, Networks, Protocols and Standards**", Fred Halsall, Fifth Impression, Pearson, 2011.ISBN: 978-81-317-0994-8.
2. **"Fundamentals of Multimedia",** Ze-Nian Li, Mark S and Drew Jiangchuan Liu, Second edition, Springer, 2014. ISBN: 978-3-319-05289-2; ISBN: 978-3-319-05290-2 (eBook)

REFERENCE BOOKS:

1. "**Multimedia: Computing, Communications and Applications**", Ralf Steinmetz and KlaraNabrsted, Pearson Education, 2004ISBN: 9788177584417.
2. "**Multimedia Communication Systems**", K.R Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, Pearson Education, 2004, ISBN: 013031398X.

ONLINE COURSES AND VIDEO LECTURES:

1. **NPTEL video lecturing on "Multimedia Processing (Web)"**, Co-ordinated by IIT Kharagpur. Link - https://nptel.ac.in/courses/117/105/117105083/#

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Compare** different networks in Multimedia Communication and its applications.	**PO1 (L2)**
CO2	**Apply** the basic knowledge of digital data processing and representation to **Analyze** Multimedia information.	**PO1, PO2 (L3)**
CO3	**Analyse** various compression techniques for different media types and **design** algorithms	**PO2, PO3 (L3)**
CO4	**Inspect** the various standards used in multimedia applications.	**PO1 (L2)**
CO5	**Analyse** cloud sharing and retrieval of multimedia information.	**PO2 (L2)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	3												3	
#2	3	2											3	2

#3		**3**	**1**											**3**
#4	**2**												**2**	
#5		**2**												**2**

Professional Elective-II			
Course Title : **Radar and Navigational Systems**			
Course Code: **P18EC642**	Semester : **VI**	**L**-T -P-**H** : **4**-0-0-**4**	Credits: **3**
Contact Period: Lecture: **52 Hrs.** Exam: **3Hrs.**		Weightage : CIE: **50%**	SEE: **50%**

A. Course Learning Objectives (CLOs)

This course aims to:

1. Describe the basic Radar operation, detection of echo signal and radar applications.
2. Discuss different radar range equations and calculate the effect of various external / internal factors on radar accuracies.
3. Explain the idea behind MTI and radar tracking systems.
4. Examine the different technologies for Detection of targets.
5. Explain different Clutters that affects the detection of radar signals.
6. Discuss the different radar transmitters and receivers.
7. Explain different navigational aids.

B. Course Content

UNIT – I

An Introduction to Radar: Basic Radar, Simple form of the Radar equation, Radar block diagram, Radar frequencies, Applications of radar. **The Radar Equation:** Introduction, Detection of signals in noise, Receiver noise and signal to noise ratio, Probabilities of detection and false alarm, Radar cross section of targets.

Text 1: 1.1 to 1.5, 2.1 to 2.3, 2.5, 2.7. **11 Hrs**

Self Learning Components:

1. Applications of modern radar systems.
2. Household Radar Can See Through Walls and Knows How You're Feeling:- https://spectrum.ieee.org/telecom/wireless/household-radar-can-see-through-walls-and-knows-how-youre-feeling.
3. MIT Lincoln Laboratory- Introduction to Radar Systems – Lecture 1 – Introduction; Part 1 https://www.youtube.com/watch?v=Hw5IaS6-Fzw

UNIT – II

MTI and Pulse Doppler Radar: Introduction, Delay line cancellers, Digital MTI processing, Moving target detection. **Tracking Radar:** Tracking with Radar, Monopulse tracking, Conical scan and sequential lobing.

Text 1: 3.1, 3.2, 3.5 to 3.7,4.1 to 4.3. **10 Hrs**

Self Learning Components:

1. Limitations to tracking accuracy

UNIT – III

Detection of Signals in Noise: Introduction, Matched filter receiver, Detection criteria, Detectors, Automatic detection. **Radar Clutter:** Introduction to Radar clutter, surface clutter radar equation, land clutter, sea clutter, weather clutter.

Text 1: 5.1 to 5.5, 7.1 to 7.4, 7.6. **10 Hrs**

Self Learning Components:

1. Detection of targets in clutter

UNIT – IV

Radar Transmitter: Introduction, linear beam power tubes, solid state RF power sources, cross field amplifiers. **Radar Receiver:** Radar noise figures, Super-heterodyne receiver, Duplexers and receiver protectors, Radar displays.

Text 1: 10.1 to 10.3, 10.5, 11.1 to 11.5. **10 Hrs**

Self Learning Components:

1. Other RF Power Sources

UNIT – V

Navigation: Hyperbolic Navigation: Introduction, LORAN-A, LORAN-C, DECCA, OMEGA, DECTRA, DERLAC.

Satellite Navigation: Introduction, Doppler Navigation, GPS, Principle of operation of GPS, GPS Segments, GPS Navigation Message, GPS Data Subframe, Source of Errors in GPS. Modern Navigational Method.

Text 2: 14.1 to 14.10, 15.1, 17.3. **11 Hrs**

Self Learning Components:

1. Differential Global Positioning System (DGPS)

Note: <u>No questions</u> from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)

TEXT BOOKS:

1. "**Introduction to Radar Systems**", Merill. I. Skolnik, 3rd Edition. Tata McGraw Hill, 2001. ISBN-13: 978-0-07-044533-8.
2. "**Radar Systems and Radio aids to Navigation**", Dr. A. K Sen, Dr. A .B Bhattacharya. Khanna Publishers. ISBN ***:*** 978-81-7409-08-9.

REFERENCE BOOKS:

1. "**Elements of Electronic Navigation**", N.S.Nagaraj, 2nd Edition, Tata McGRAW Hill
2. **Radar and Electronic Navigation**, <u>Gerrit Jacobus Sonnenberg</u>, Newnes-Butterworths; 5th edition (1978), ISBN-10: 0408002727, ISBN-13: 978-0408002721
3. **Radar Engineering**, G S N Raju, I. K. International Pvt Ltd, 2008,ISBN 8190694219, 9788190694216

ONLINE COURSES AND VIDEO LECTURES:

1. NPTEL Courseon Principles and Techniques of Modern Radar Systems by Dr. Amitabha Bhattacharya, IIT Kharagpur Link:-https://nptel.ac.in/courses/108/105/108105154/

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** the basics of electromagnetic field theory and mathematics concepts to understand the working of different radars, Tracking systems and Factors affecting radar system.	**PO1 (L3)**
CO2	**Analysis** of Radar Equations, different types of Radar systems and Tracking systems.	**PO1, PO2 (L3)**
CO3	**Analyze** the effect of various external / internal factors on Radar and its trans-reception.	**PO1, PO2 (L2)**
CO4	**Analysis** of radar applications for different target detections.	**PO1, PO2 (L4)**
CO5	**Analyz**e the concept of Navigation and Positioning Aids.	**PO1, PO2 (L3)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	3												3	
#2	2	3											2	3
#3	2	3											2	3
#4	1	3											1	3
#5	1	3											1	3

Professional Elective-II			
Course Title : **Introduction to Basics of Information Technology**			
Course Code: **P18EC643**	Semester : **VI**	**L**-T-P-**H** : **4**-0-0-**4**	Credits: **3**
Contact Period : Lecture : **52 Hrs,** Exam: **3 Hrs.**		Weightage : CIE: **50%**	SEE: **50%**

A. Course Learning Objectives (CLOs)

This course aims to:

1. Understand the principles of multifunctional computer arithmetic and logical operations.
2. Provide an overview of the Operating Systems topics.
3. Examine the issues of mutual exclusion and deadlock.
4. Impart a thorough understanding of linear data structures such as stacks, queues and their applications.
5. Impart a thorough understanding of non-linear data structures such as trees, graphs and their applications along with various sorting, searching and hashing techniques.

B. Course Content

UNIT – I

Arithmetic: Numbers, Arithmetic Operations and Characters, Addition and Subtraction of Signed Numbers, Design of Fast Adders, Multiplication of Positive Numbers, Signed Operand Multiplication, Fast Multiplication, Integer Division, Floating-point Numbers and Operations.

Text 1: Ch 2: 2.1, Ch 6: 6.1 to 6.7 **11 Hrs**

Self Learning Components:

1. Simulating Fast adders by using any simulator

UNIT – II

Operating System Overview: Operating System Objectives and Functions, The Evolution of Operating Systems, Major Achievements, Developments Leading to Modern Operating Systems, Virtual Machines, OS Design Considerations for Multiprocessor and Multicore.

Process Description and Control: What Is a Process? Process States, Process Description, Process Control, Execution of the Operating System.

Text 2: 2.1-2.6, 3.1-3.5 **10 Hrs**

Self Learning Components:

1. Discuss the objectives and functions of operating system.
2. Understand the Android software Architecture.

UNIT – III

Concurrency: Mutual Exclusion and Synchronization - Principles of Concurrency, Mutual Exclusion: Hardware Support, Semaphores, Monitors, Message Passing, Readers/Writers Problem.

Concurrency: Deadlock and Starvation - Principles of Deadlock, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, An Integrated Deadlock Strategy, Dining Philosophers Problem.

Memory Management: Memory Management Requirements, Memory Partitioning, Paging Segmentation

Text 2: 5.2 - 5.7, 6.1 - 6.6, 7.1-7.4 **10 Hrs**

Self Learning Components:

1. Understand the importance of concurrency in a single-processor multiprogramming system.
2. Discuss Fixed partitioning and Dynamic partitioning memory partition.
3. Learn how Data Structures used in Online Ticket Booking, Music Player, Web Browser & in Google Maphttps://www.youtube.com/watch?v=d_XvFOkQz5k

UNIT – IV

Basic Concepts: Pseudocode, The Abstract Data Type, Model for an Abstract Data Type, ADT Implementations.

Stacks: Basic Stack Operations, Stack Linked List, C Language Implementations, Stack ADT.

Queues: Queue Operations, Queue Linked List Design, Queuing Theory.

Text 3: Chapter 1(1.1 - 1.4), Chapter 3 (3.1 – 3.4), Chapter 4 (4.1 - 4.2, 4.4) **10 Hrs**

Self Learning Components:

1. Discuss stack ADT implementation.
2. List the applications of Queuing theory in data structures.
3. NPTEL- Data Structures and Algorithms- https://www.youtube.com/watch?v=zWg7U0OEAoE&list=PLBF3763AF2E1C572F

UNIT – V

Introduction to Trees: Basic Tree Concepts, Binary Trees, General Trees.

Binary Search Trees: Basic Concepts, BST Operations.

Sorting: Sort Concepts, Selection Sorts, Insertion Sorts.

Searching: List Searches: Search Implementations.

Text 3: Chapter 6 (6.1 – 6.3), Chapter 7 (7.1 – 7.3), Chapter 12 (12.1 – 12.3), Chapter 13 (13.1 – 13.2) **11 Hrs**

Self Learning Components:

1. Understand the applications of Binary Search Tree.
2. Understand Bubble / Exchange Sort Algorithms.

Note: <u>No questions</u> from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)

TEXT BOOKS:

1. "**Computer Organization**" by Carl Hamacher, ZvonkoVranesic, SafwatZaky, 5th edition, Tata McGraw Hill, 2002. ISBN 10: 1259005275 / ISBN 13: 9781259005275.

2. "**Operating Systems"** by William Stallings, 7e, Pearson India. ISBN-10: 9332518807.
3. "**Data Structures – A Pseudocode Approach with C**", Gilberg and Forouzan, 2nd edition, Cengage Learning.,2004. ISBN-13: 978-0-534-39080-8, 10:m0-534-39080-3.

REFERENCE BOOKS:

1. "**Computer Organization & Architecture**" by William Stallings, 9th edition, Pearson, 2015. ISBN-13: 978-0-13-607373-4. ISBN-10: 0-13-607373-5.
2. "**Operating Systems**" by Silberschatz and Galvin, 9th edition, Wiley. ISBN-10: 8126554274.
3. "**Operating Systems**" by Godbole, 3rd edition, McGraw Hill India. ISBN 10: 0070702039 / ISBN 13: 9780070702035.
4. "**Data Structures using C and C++**", 2nd edition, Langsam, Augenstein, Tenenbaum, PHI.

ONLINE COURSES AND VIDEO LECTURES:

1. NPTEL- Computer Organization and Architecture A Pedagogical Aspect- by Prof. Arnabsarkar et.al IIT Guwahatihttps://www.youtube.com/watch?v=msqxkEKFg8I&list=PLgHucKw979AvcnTpPNZMZyORdL5HvTr9m
2. Operating System Fundamentals by Prof. Santanu Chattopadhyay, IIT Kharagpurhttps://nptel.ac.in/courses/106/105/106105214/
3. Programming, Data structures and Algorithms by Dr. N S. Narayanaswamy et.al, IIT Madrashttps://nptel.ac.in/courses/106/106/106106133/

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	Will be able to formulate computer arithmetic and understand the performance requirements of systems	**PO1, (L1), (L2)**
CO2	Will understand the functions and objectives of operating system	**PO1 (L2)**
CO3	Will be able to identify the problems related to task synchronization and deadlock	**PO2 (L2)**
CO4	Will use appropriate data structures like arrays, linked list, stacks and queues to solve real world problems efficiently.	**PO2, PO3, (L3)**
CO5	Will be able to represent and manipulate data using nonlinear data structures like trees to design algorithms for various applications.	**PO2 (L2)**

Professional Elective-II

Course Title : **VLSI Testing and Verification**			
Course Code: **P18EC644**	Semester : **VI**	**L**-T-P-**H** : **4**-0-0-**4**	Credits: **3**
Contact Period : Lecture : **52 Hr,** Exam: **3 Hr**		Weightage: CIE: **50%**	SEE: **50%**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	3												3	
#2	3												3	
#3		2												2
#4		3	1											3
#5		3												3

A. Course Learning Objectives (CLOs)

This course aims to:

1. Provide the basic knowledge of VLSI Testing and Verification.
2. Provide the understanding of Test Generation for Combinational Logic Circuits.
3. Design a Testable Combinational Logic Circuits and Sequential Circuits.
4. Explain the concept of Verification Tools and Verification languages.
5. Outline the concepts of waveform generation and test benches.

B. Course Content

UNIT - I

Faults in Digital Circuits: Failures and Faults, Modeling of Faults: Stuck at Faults, Bridging Faults, Breaks and transistor Stuck –On/Open Faults in CMOS, Delay Faults.

Test Generation for Combinational Logic Circuits: Fault Diagnosis of Digital Circuits, Test Generation Techniques for Combinational Circuits.

Text 1:1.1, 1.2, 2.1, 2.2.1, 2.2.2, 2.2.3, 2.2.4 **10 Hrs**

Self Learning Components: Temporary Faults, FAN, Delay Fault detection.

UNIT - II

Testable Combinational Logic Circuit Design: The Reed-Muller Expansion Technique, Three-Level OR-AND-OR Design, Automatic Synthesis of Testable Logic, Synthesis of Random Pattern Testable Combinational Circuits, Testable PLA Design.

Test Generation for Sequential Circuits: Testing of Sequential Circuits as Iterative Combinational Circuits, State Table Verification, Test Generation Based on Circuit Structure,

Text1:3.1,3.2,3.3,3.5,3.7,4.1,4.2, 4.3. **11 Hrs**

Self Learning Components: Testable design of Multilevel Combinational circuits, Path delay faults testable combinational Logic Design, Functional Fault Models.

UNIT- III

Design of Testable Sequential Circuits: Controllability and Observability, Ad Hoc Design Rules for Improving Testability, The Scan-Path Technique for Testable Sequential Circuit Design, Level-Sensitive Scan Design, Boundary Scan.
Built-In Self Test: Test Pattern Generation for BIST, Output Response Analysis, BIST Architectures.
Text 1: 5.1, 5.2, 5.4, 5.5, 5.10, 6.1, 6.2, 6.4 . 11 Hrs
Self Learning Components: Design of Diagnosable Sequential Circuits, Random Access Scan Technique, Cross Talk, Circular BIST.

UNIT - IV

What is verification: What is testbench, Importance of verification, Reconvergence model, Human factor, What is being verified.
Verification Tools: Linting tools, Simulators, Waveform viewers, Code coverage, Verification languages, Issue Tracking, Metrics.
Text 2: Chapter-1, Chapter-2 10 Hrs
Self Learning Components: Functional verification approaches, Third party models, Revision Control.

UNIT- V

Stimulus and Response: Simple Stimulus: Generating a simple waveform, Generating a Complex waveform, Generating Synchronised Waveforms, Aligning Waveforms in Delta-Time, Generating Synchronous Data Waveforms, Encapsulating Waveform Generation, Abstracting Waveform Generation, Verifying the output: Visual Inspection of Response,Producing Simulation Results, Minimizing Sampling, Visual Inspection of Waveforms. Self checking Testbenches: Input and Output Vectors, Golden Vectors, Run-Time Result Verification ,Complex Stimulus, Complex response.
Text 2: Chapter -5 10 Hrs
Self Learning Components: Predicting the output: Data Formatters, Packet Processors, Complex Transformations.
Case Study:

- VLSI Testing (http://www.ee.ncu.edu.tw/~jfli/vlsi21/lecture/ch06.pdf)
- https://nptel.ac.in/courses/106/103/106103116/

Note: No questions from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)

TEXT BOOKS:

1. **"Digital Circuit Testing and Testability"**, Parag. K. Lala, Academic Press, ISBN 0-12-434330-9.
2. **"Writing Test Benches: Functional Verification of HDL Models"**, JanickBergeron,2nd edition Kluwer Academic Publishers,2003, ISBN 1-4020-7401-8.

REFERENCE BOOKS:

1. **"Digital Systems and Testable Design"**, M. Abramovici, M.A. Breuer and A.D. Friedman, Jaico Publishing House, 2002, ISBN 0-7803-1062-4.
2. **"Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits"**, M.L. Bushnell and V.D. Agrawal, Kluwar Academic Publishers, ISBN 978-0-306-470470-0.

ONLINE COURSES AND VIDEO LECTURES:

1. NPTEL Course on Design Verification and test of Digital VLSI circuits, by DrSanthosh Biswas and DrJitendra Kumar Deka, IIT Guhathi, https://nptel.ac.in/courses/106/103/106103116/

C.Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** the knowledge of Digital and Analog VLSI circuits to understand the concepts of VLSI Circuit testing.	**PO1 (L2)**
CO2	**Analyze** the various concepts of test generation for combinational, sequential logic circuits and BIST.	**PO2 (L2)**
CO3	**Design** the testable combinational, sequential logic circuits and BIST for the given specifications.	**PO3 (L3)**
CO4	**Discuss** the verification tools and verification languages.	**PO2 (L3)**
CO5	**Analyze** the role of Stimulus and Response in verification	**PO2 (L2)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	**3**												**3**	
#2		**3**												**3**
#3			**3**											
#4		**2**												**2**
#5		**3**												**3**

Professional Elective-II			
Course Title : **Advance Digital Communication**			
Course Code: **P18EC645**	Semester : **VI**	**L**-T-P-**H** : **4**-0-0-**4**	Credits: **3**
Contact Period: Lecture: **52 Hrs.** Exam: **3 Hrs.**		Weightage : CIE: **50**% SEE: **50%**	

A. Course Learning Objectives (CLOs)

This course aims to:

1. Discuss optimum receiver performance of a channel with ISI and AWGN.
2. Explain the model of discrete time channel with ISI & the model of discrete time channel by equalizer.
3. Discuss Multichannel and Multicarrier modulation schemes in communication system.
4. To study Spread spectrum signals for digital communication.
5. Discuss multiplexing and modeling of MIMO channels.

B. Course Content

UNIT-I

Communication Through Band Limited Channels: Characterization of Band-Limited Channels, Optimum receiver for channel with ISI and AWGN: Optimum Maximum-Likelihood Receiver, A discrete-Time Model for a Channel with ISI, Maximum-Likelihood Sequence Estimation (MLSE) for the White Noise, and Performance of MLSE for channels with ISI.

Linear Equalization: Peak Distortion Criterion, Mean-square-error (MSE) Criterion, Performance characteristics of the MSE Equalizer. Decision Feedback Equalization: Coefficient Optimization, Performance Characteristics of DFE. Reduced Complexity ML- Detectors.

Text 1: 9.1, 9.3, 9.4 – (9.4.1 to 9.4.3), 9.5 – (9.5.1 to 9.5.2), 9.6. 11 Hrs

Self Learning Component:

1. Design of Band-Limited signals for with and without ISI.
2. Turbo Equalization

UNIT – II

Adaptive Equalization: The zero-Forcing Algorithm, The LMS Algorithm, Convergence Properties of the LMS Algorithm**,** Adaptive Fractionally Spaced Equalizer-Tap leakage Algorithm, An Adaptive Channel Estimator for ML Sequence Detection. Adaptive Decision

Feedback Equalizer. Recursive Least-Squares Algorithms for Adaptive Equalization: Recursive Least Squares, Linear Prediction and the Lattice Filter.

Text 1: 10.1 – (10.1.1, 10.1.2, 10.1.3, 10.1.6, 10.1.7), 10.2, 10.4. **10 Hrs**

Self Learning Component:

1. Blind equalization Based on the Maximum-Likelihood Criterion.
2. Stochastic Gradient Algorithms.

UNIT – III

Multichannel Systems: Multichannel Digital Communications in AWGN Channels: Binary Signals, M-ary Orthogonal Signals.

Multicarrier Systems: Signal-Carrier versus Multicarrier Modulation, Capacity of a Non ideal Linear Filter Channel, Orthogonal Frequency Division Multiplexing (OFDM), Modulation and Demodulation in an OFDM System, Spectrum Characteristics of Multicarrier Signals, Bit and Power Allocation in Multicarrier Modulation, Peak-to-Average Ratio in Multicarrier Modulation.

Text 1: 11.1, 11.2 – (11.2.1 to 11.2.8). **10 Hrs**

Self Learning Component:

1. An FFT Algorithm Implementation of an OFDM System.
2. Channel coding considerations in multicarrier modulation.

UNIT – IV

Spread Spectrum Signals for Digital Communication: Model of spread spectrum digital communication system, Direct sequence spread spectrum signals: Some applications of DS spread spectrum signals**,** generation of PN sequences**,** Frequency hopped spread spectrum signals: Performance of FHSS Signals in an AWGN Channel, Performance of FHSS Signals partial- Band Interference, CDMA System Based on FHSS Signals, Other Types of SS Signals, Synchronization of SS systems.

Text 1: 12.1, 12.2 – (12.2.2, 12.2.5), 12.3, 12.4, 12.5 **11 Hrs**

Self Learning Component:

1. Effect of Pulsed Interference on DS SS Systems.
2. Excision of Narrowband Interference in DS SS Systems

UNIT – V

MIMO Spatial Multiplexing and Channel Modeling: Multiplexing capability of deterministic MIMO channels: Capacity via Singular Value Decomposition, Rank and Condition Number, Physical modeling of MIMO channels: Line-of-Sight SIMO channel, Line-of-Sight MISO channel , Modeling of MIMO fading channels: Basic Approach, MIMO Multipath Channel, Angular Domain Representation of signals, Angular Domain Representation of MIMO Channels.

Text 2: 7.1, 7.2 – (7.2.1 & 7.2.2), 7.3 - (7.3.1 to 7.3.4) **10 Hrs**

Self Learning Component:

1**.** Statistical Modeling in the Angular Domain.
2. Degrees of Freedom and Diversity.

Note: <u>No questions</u> from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)

TEXT BOOKS:

1. '**Digital Communications',** John G. Proakis, Masoud Salehi, 5th edition,Pearson Education, 2014, ISBN:978-93-392-0479-2.
2. **'Fundamentals of Wireless Communication',** David Tse, Pramod Viswanath, 1st edition,Cambridge University Press, 2005, ISBN: 0521845270.

REFERENCE BOOKS:

1. **"Digital Communications - Fundamentals and Applications",**Bernard Sklar, 2nd edition, PearsonEducation (Asia) Pvt. Ltd, 2014, ISBN: 1292026065, 9781292026060.
2. **"Digital Communication**", Simon Haykin, Reprint, Wiley, 2013, ISBN: 0471647357,9780471647355.

ONLINE COURSES AND VIDEO LECTURES:

1. NPTEL Course on Fundamentals of MIMO Wireless Communication by Prof. SuvraSekhar Das, IIT Kharagpur Link:-https://nptel.ac.in/courses/117/105/117105132/
2. NPTEL course on Principles of Modern CDMA/ MIMO/ OFDM Wireless Communications by Prof. Aditya K. Jagannatham, IIT Kanpur Link:- https://nptel.ac.in/courses/117/104/117104115/

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Discuss** the concepts of optimum receiver for Band limiting channels with ISI and AWGN.	**PO1 (L2)**
CO2	**Analyse** and demonstrate the model of discrete time channel with ISI & the model of discrete time channel by equalizer.	**PO2 (L3)**
CO3	**Analysis** and **Understanding** of various digital communication systems.	**PO1 (L3)**
CO4	**Evaluate** the performance of various digital communication systems.	**PO2 (L3)**
CO5	**Articulate** different modeling schemes for MIMO channels.	**PO2 (L3)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	3												3	
#2		2												2

#3	**3**												**3**	
#4		**3**												**3**
#5		**2**												**2**

Open Elective - I			
Course Title: **E-Waste Management**			
Course Code:**P18ECO651**	Semester : **VI**	**L**-T-P-**H** : **4**-0-0-**4**	Credits: **3**
Contact Period : Lecture : **52 Hrs.,** Exam: **3 Hrs.**		Weightage : CIE: **50%** SEE: **50%**	

A. Course Learning Objectives (CLOs)

This course aims to:

1. Discuss the Global e-waste growth in India.
2. Explain the Hazardous substances in waste electrical and electronic equipment-toxicity and release.
3. Understand the importance of e-waste recycling in India.
4. Outline the study of international and national legal framework on e-waste.
5. Describe the Technologies for recovery of resources from electronic waste

B. Course Content

UNIT-I

Global E-Waste Growth: Introduction, Global and local WEEE/ e-waste definition, Global WEEE/ e-waste growth and trade route/ migration, Global and local business/ financial model and trade economics, WEEE/ e-waste growth in India, Gaps in the existing system, The Hazardous Wastes Rules 2003, The municipal solid waste (Management and Handling) Rules, 2000.

Dark Shadows of Digitization on Indian Horizon: Growth of electrical and electronics industry in india, Growth of e-waste, E-waste domestic waste generation, India major import destination, The recycling industry, Informal waste trade chain, occupational hazards related to e-waste recycling, Awareness among citizens, Existing legal framework, Way ahead.

E-Waste Generation, Mitigation, and a Case Study, Delhi: Introduction, Generation and migration of e-waste, Way forward, Extended producer responsibility.

Text 1: Chapter 1, 2 and 3. **11 Hrs**

Self Learning Component:

1. Growth of e-waste trade in Delhi and its impact on the environment and health: a case study

UNIT-II

Whither E-Waste in India – the Indo-German-Swiss Initiative: Introduction, Scope of the initiative, Approach of the initiative, Activities of the Indo-German-Swiss E-waste Initiative, The future.

Hazardous Substances in Waste Electrical and Electronic Equipment-Toxicity and Release: Introduction, Characteristics of pollutants, Laboratory analysis of typical pollutants in electronic scrap, Pollutants in waste electrical and electronic equipment, other typical heavy metals and pollutants in waste electrical and electronic equipment, Typical pathways for the release of pollutants from WEEE.

Text 1: Chapter 4 and 5 **10 Hrs**

Self Learning Component:

1. Hazardous wastes (Management and Handling) Rules,2003

UNIT- III

Occupational and Environmental Health Perspectives of E-Waste Recycling in India: a Review: Introduction, Estimated release of toxic substances from e-waste, Recycling of e-waste and human health issues, Adverse health outcomes, Occupational and environmental health: cross-cutting issues, Way forward.

E-waste Legislation in the European Union and the Basel Convention: Introduction, The WEEE and RoHS directives, Categories of EEE, Exemptions from scope, When does a product become waste?, Obligations of the producer, The RoHS Directive, Implementation, Electronic waste under the Basel Convention,

Text 1: Chapter 6 and 7 **10 Hrs**

Self Learning Component:

1. Environmentally Sound e-waste treatment technologies

UNIT –IV

Regulating E-Waste: a Review of the International and National Legal Framework on E-Waste: Introduction, International law and other national laws relating to e-waste**,** an overview of Indian environmental jurisprudence.

Extended Producer Responsibility: a Key Tool for International Rules and Regulations on E-Waste: Extended producer responsibility-salient features, Waste Electrical and Electronics Equipment Directive, Restriction on Hazardous Substance Directive.

Optimal Planning for Computer Waste: Introduction, Objective of the proposed model formulation, Model formulation, proposed framework of waste management.

Text 1: Chapter 8, 9 and 10 **11 Hrs**

Self Learning Component:

1. Procedures for setting-up and management of integrated e-waste facility

UNIT –V

Recycling of E-Scrap in a Global Environment-Opportunities and Challenges: Introduction, Recovery of metals from e-scrap at Umicore, Recycling chain for electronic scrap, State-of-the-art metal recovery from e-scrap, metallurgical process, Emission control at Umicore's Hoboken plant, Optimization of waste electrical and electronic equipment recycling chain, opportunities for India.

Technologies for Recovery of Resources from Electronic Waste: Introduction, Resource recovery potential of e-waste, Steps in recycling and recovery of materials.
Classification of E-Waste: Composition of e-waste, Components of e-waste, Possible hazardous substances present in e-waste, E-Waste scenario, Basis for defining e-waste, Proposed definition of e-waste, Reduction of the Hazardous Substances (RoHS) in the Electronic and Electrical Equipments, Extended Producer Responsibility(EPR).
Text 1: Chapter 11, 12 and Chapter 4 in Annexure (4.0 to 4.7). 10 Hrs
Self Learning Component:
1. E-waste recycling/treatment technologies in India

Note: <u>No questions</u> from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)

TEXT BOOK:

1. **"E-waste: Implications, Regulations, and Management in India and Current Global Best Practices"** Edited by Rakesh Johri, TERI Publishing, ISBN: 978-81-7993-153-0**.**

REFERENCE BOOKS:

1. **"E-Waste: Management, Types and Challenges (Computer Science, Technology and Applications: Environmental Remediation Technologies, Regulations and Safety)",** YinchuanLi, BanciLian Wang, Nova Science Publishers, 2012, ISBN: 1619422174.
2. **"Electronic Waste Management",** edited by Ronald E. Hester, Roy M. Harrison, RSC Publishing, ISBN: 9780854041121

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Discuss** the Global e-waste growth in India	**PO1 (L2)**
CO2	**Explain** the Hazardous substances in waste electrical and electronic equipment-toxicity and release	**PO2 (L2)**
CO3	**Analyze** to understand the importance of e-waste recycling in India	**PO2 (L2)**
CO4	**Outline** the study of international and national legal framework on e-waste	**PO3 (L5)**
CO5	**Describ**e the Technologies for recovery of resources from	**PO3 (L4)**

	electronic waste through case study	

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	3												3	
#2		2												2
#3		2												2
#4			2											
#5			2											

Open Elective - I			
Course Title: **Principles of Communication Systems**			
Course Code:**P18ECO652**	Semester : **VI**	**L**-T-P-**H** : **4**-0-0-**4**	Credits: **3**
Contact Period : Lecture : **52 Hrs.,** Exam: **3 Hrs.**		Weightage : CIE: **50%**	SEE: **50%**

A. Course Learning Objectives (CLOs)

This course aims to:

1. Provide the basic knowledge on Electronic Communication Systems.
2. Describe the concept of Amplitude Modulation and Frequency modulation.
3. Outline the concept of Digital Communication Systems.
4. Explain the concept and importance of Satellite communication.
5. Discuss Foundamentals of Networking andLocal Area Network
6. Discuss the importance and applications of Cell phone and wireless technologies

B. Course Content

UNIT – I

Introduction to Electronic Communication: The significance of human communication, Communication Systems, Types of Electronic Communication, Modulation and Multiplexing, The Electromagnetic Spectrum, Bandwidth, A survey of Communication Applications.

Amplitude Modulation Fundamentals: AM Concepts, Modulation Index and Percentage of Modulation, Sidebands and the Frequency Domain, AM Power, Single Sideband Modulation, Amplitude Demodulators

Text 1:1.1-1.7, 3.1-3.5, 4.3 **11 Hrs**

Self Learning Component:

1.SSB Circuits

UNIT – II

Fundamental of Frequency Modulation: Basic Principles of Frequency Modulation, Principles of Phase Modulation, Modulation index and side bands, Frequency modulation Versus

Amplitude Modulation.

Digital Communication Techniques: Digital transmission of data, Parallel and Serial Transmission, Pulse Modulation, Basic Principles of Signal Reproduction, Super heterodyne receivers.

Text 1: 5.1-5.3, 5.5, 7.1,7.2, 7.4,9.1,9.2 **10 Hrs**

Self Learning Component:

1. Study of Digital communication technologies in TV broad casting

UNIT – III

Multiplexing and Demultiplexing: Multiplexing Principles, Frequency division Multiplexing,Time-Division Multiplexing, Pulse-code Modulation, Duplexing

Fandamentals of Networking and Local Area Networks: Network Foundamentals**,**LAN hardware.

Text 1: 10.1-10.5, 12.1-12.2 **10 Hrs**

Self Learning Component:

1. Advanced Ethernet.

UNIT – IV

Satellite Communication: Satellite Orbits, Satellite communication systems, Satellite Subsystems, Ground Stations, Satellite Applications, Global Navigation System

Text 1:17.1-17.6, **10 Hrs**

Self Learning Component:

1. Make a study of advances made by India in Satellite communication

UNIT – V

Cell Phone Technologies: Cellular Telephone Systems, A Cellular Industry Overview, 2G and 3G Digital Cell Phone Systems, Long Term Evolution and 4G Cellular Systems, Base Stations and small cells.

Wireless Technologies: Wireless LAN, PANs and Bluetooth, Zigbee and Mesh wireless Networks

Text 1: 20.1-20.5, 21.1 – 21.3 **11 Hrs**

Self Learning Component:

1. WiMAX and Wireless Metropolitan-Area Networks
2. Case study: To improve the quality of service in communication(Ref: Zayan EL Khaled and Hamid Mcheick, Case studies of communications systems during harsh environments: A review of approaches, weaknesses, and limitations to improve quality of service, International Journal of Distributed Sensor Networks 2019, Vol. 15(2))

Note: <u>No questions</u> from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)

TEXT BOOK:

1. **"Principles of Electronics Communication System",** Louis E FrenzelJr, 4th edition. ISBN 978-0-07-337385-0, Mcgraw Hill Publication

REFERENCE BOOKS:

1. **"Digital Communication",** P. Ramakrishna Rao, TATA McGraw Hill,2011, ISBN:9780070707764.
2. **"Wireless and Mobile Communication"** by Sanjeev Kumar, New age International Publishers- 2010 Edition,ISBN(10):81-224-2354-X, ISBN(13):978-81-224-2354-9
3. **"Mobile Cellular Telecommunication",** Lee W.C.Y, McGraw Hill, 2002, ISBN: 9780071436861, 0071436863
4. **"Satellite Communications",** Dennis Roddy, 4th Edition, Special Indian Edition 2009, 11th reprint 2013 McGraw–Hill, ISBN13:978-0-07-007785-0, ISBN 10:0-07-007785-1

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Explain** the basics of Electronic Communication System.	**PO1 (L2)**
CO2	**Analyse** at block level the use of various Digital Communication Techniques and Satellite Communication	**PO2 L2)**
CO3	**Describe** the concept of Networking and Local Area Networks	**PO3 (L4)**
CO4	**Explain** the importance and working of Cell phone, multiplexing and de multiplexing in electronic communication systems	**PO1 (L5)**
CO5	**Understand** the use and working of wireless technologies	**PO1 (L2)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	**3**												**3**	
#2		**2**												**2**

#3			**2**											
#4	**3**												**3**	
#5	**3**												**3**	

Open Elective - I			
Course Title: **Ardiuno Controller with Applications**			
Course Code: **P18ECO653**	Semester : **VI**	**L**-T-P-**H** : **4**-0-0-**4**	Credits: **3**
Contact Period : Lecture : **52 Hrs.,** Exam: **3 Hrs.**		Weightage : CIE: **50%**	SEE: **50%**

A. Course Learning Objectives (CLOs)

This course aims to:

1. Provide the basic knowledge on AVR Controller.
2. Discuss the AVR Architecture and information needed to write program.
3. Able to write the program using C.
4. Provide the basic knowledge on Arduino Controller.
5. Discuss about the applications of Communication Interfaces using Arduino.
6. Discuss the concept of Wireless applications using Arduino

B. Course Content

UNIT – I

The AVR microcontroller: history and features, microcontrollers and embedded processors, overview of the AVR family.

AVR architecture and assembly language programming: The general purpose registers in the AVR, the AVR data memory using instructions with the data memory, AVR status register, AVR data format and directives introduction to AVR assembly programming, assembling an AVR program the program counter and Program ROM space in the AVR. RISC architecture in the AVR, viewing registers and memory with AVR STUDIO IDE.

Text 1: Chapter 2 and chapter 3 **11 Hrs**

Self Learning Component:
1. Understand the Branch Instructions and Looping in AVR.
2. Analyze the working principle of STACK in AVR.

UNIT – II

AVR I/0 Port Programming : I/0 port programming in AVR, I/0 bit manipulation programming.
Arithmetic, Logic Instructions and Programs: arithmetic instructions, signed number concepts and arithmetic operations, logic and compare instructions, rotate and shift instructions and data serialization, BCD and ASCII conversion
Text 1:Chapter 4 and Chapter 5 **10 Hrs**
Self Learning Component:
1. Understand the concept of Call Instructions in AVR.
2. AVR Time Delay and Instruction Pipeline.

UNIT – III

AVR Programming in C: Data types and time delays in C, Programming in C logic operations in C**,** Data conversion programs in C**,** Data serialization in C**,** Memory allocation in C.
LCD and Keyboard Interfacing in C: LCD interfacing , Keyboard interfacing (Excluding Interfacing in Assembly level language)
Text 1: Chapter 7 and Chapter 12 **10 Hrs**

Self Learning Component:
1. Develop a C program to monitor the status of SW and perform the following operations (Assume switch connected to pin PA7).
(i) If SW=0; Stepper Motor moves clockwise.
(ii)If SW=1; Stepper Motor moves counter clockwise.

UNIT – IV

Getting Started and Understanding the Arduino Landscape: Exploring the Arduino Ecosystem, Arduino Functionality, The Microcontroller Programming Interfaces, Input/Output: GPIO, ADCs, and Communication Busses Power Arduino Boards, Creating Your First Program Downloading and Installing the Arduino IDE. Running the IDE and Connecting to the Arduino Breaking Down Your First Program
Communication Interfaces :
The I2C Bus: History of the I2C Bus, I2C Hardware Design, Communication Scheme and ID Numbers, Hardware Requirements and Pull-Up Resistors, Communicating with an I2C, Temperature Probe Setting Up the Hardware, Referencing the Datasheet, Writing the Software. Combining Shift Registers, Serial Communication, and I2C Communications, Building the Hardware for a Temperature Monitoring System Modifying the Embedded Program
Writing the Processing Sketch
The SPI Bus and Third-Party Libraries:
Overview of the SPI Bus, SPI Hardware and Communication Design, Hardware Configuration Communication Scheme. Comparing SPI to I2C and UART
Text 2: Chapter 1, Chapter 10 and Chapter 11 **10 Hrs**
Self Learning Component:
1. Analyze the concept of AVR communication with an SPI Accelerometer.

2**.** Understand and analyze the Creation of Audiovisual Instrument Using a 3-Axis Accelerometer.

UNIT – V

Going Wireless:

Wi-Fi and the Cloud: The Web, the Arduino, and You, Networking Lingo: The Internet vs. the World Wide Web vs. the Cloud, IP Address, Network Address Translation, MAC Address, HTML, HTTP and HTTPS, GET/POST, DHCP, DNS, Clients and Servers. Your Wi-Fi–Enabled Arduino. Controlling Your Arduino from the Web: Setting Up the I/O Control Hardware, Preparing the Arduino IDE for Use with the Feather Board, Ensuring the Wi-Fi Library is Matched to the Wi-Fi Module's Firmware, Checking the WINC1500's Firmware Version, Updating the WINC1500's Firmware. Writing an Arduino Server Sketch: Connecting to the Network and Retrieving an IP Address via DHCP, Writing the Code for a Bare-Minimum Web Server. Controlling Your Arduino from Inside and Outside Your Local Network: Controlling your Arduino over the Local Network, Using Port Forwarding to Control Your Arduino from Anywhere. Interfacing with Web APIs: Using a Weather API, Creating an Account with the API Service Provider, Understanding How APIs Are Structured, JSON-Formatted Data and Your Arduino, Fetching and Parsing Weather Data, Getting the Local Temperature from the Web on Your Arduino. Completing the Live Temperature Display: Wiring up the LED Readout Display, Driving the Display with Temperature Data.

Text 2: Chapter 17 **11 Hrs**

Self Learning Component:

1. Understand the Bluetooth Connectivity: Bluetooth Standards and Versions
2. Understand the working principle of:
   - Communication between your Arduino and your Phone.
   - Reading a Sensor over BTLE and adding Support for Third-Party Boards to the Arduino IDE.

Note: <u>No questions</u> from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)

TEXT BOOKS:

1. **"The AVR Microcontroller and Embedded Systems using assembly and C"**, Muhammad Ali Mazidi, Sarmad Naimi, and Sepehr Nalml**,** Copyright@2011, Pearson Education, Inc., publishing as Prentice Hall**,** ISBN-13: 978-0-13-800331-9 and ISBN-10: 0-13-800331-9.
2. **"Exploring Arduino: Tools and Techniques for Engineering Wizardry",** Jeremy Blum**,** 2nd edition, John Wiley & Sons, Inc. ISBN: 978-1-119-40537-5, ISBN: 978-1-119-40535-1, ISBN: 978-1-119-40530-6.

REFERENCE BOOKS:

1. **"Arduino Cookbook",** Michael Margolis, ISBN: 978-0-596-80247-9, O Reilly media.inc
2. **"Arduino Programming in 24 Hours",** Richard Blum, Sams Teach Yourself, ISBN-13:

978-0-672-33712-3.

3. **"Arduino Essentials",** Francis Perea, PACKT Publishing, ISBN 978-1-78439-856-9.

ONLINE COURSES AND VIDEO LECTURES:

1. https://www.youtube.com/watch?v=NkZdosZH6Wo.
2. https://www.youtube.com/watch?v=UfWqhw1qN_M.
3. https://www.youtube.com/watch?v=4f11oOk5cl8.

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** knowledge of microcontroller and embedded systems to **understand** the concepts of AVR Microcontroller.	**PO1 (L2)**
CO2	**Apply** the concepts of microcontroller to **analyze** instruction sets and other features in AVR Microcontroller.	**PO1 (L2)**
CO3	To **Analyze** with logical skills to write programs in C for the various interfacing problems for Arduino.	**PO2 (L2)**
CO4	**Design** and **Develop** the Arduino programming interface for the given hardware and communication specification.	**PO3 (L3)**
CO5	**Design** and **Develop** the Arduino programming interface for wireless communication systems.	**PO3 (L3)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	1												1	
#2	2												2	
#3		2												2
#4			2											
#5			2											

Open Elective- I			
Course Title: **Biometrics**			
Course Code: **P18ECO654**	Semester: **VI**	**L**-T-P-**H** : **4**-0-0-**4**	Credits: **3**
Contact Period: Lecture: **52Hrs**, Exam: **3 Hrs**.		Weightage: CIE: **50%** SEE: **50%**	

A. Course Learning Objectives (CLOs)

This course aims to:

1. Provide the basic knowledge on biometrics and its modality.
2. Analyze the handwritten character recognition and its experimental results.
3. Describe the concept of face biometrics.
4. Outline the concept of retina and iris biometrics.
5. Illustrate the concept of vein and fingerprint biometrics.
6. Interpret biometric hand gesture recognition for Indian sign language.
7. Discover the privacy issues and concerns related to biometrics.
8. Discuss biometric cryptography and multimodal biometrics.
9. Explain the importance of watermarking techniques in biometrics.
10. Summarize the scope and future of biometrics and its standards.

B. Course Content

UNIT – I

Introduction: What is Biometrics? History of biometrics**,** Types of biometric traits**,** General architecture of biometric system, Basic working of biometric matching (Templates)**,** Biometric system error and performance measures, Design of biometric systems**,** Applications of biometrics, Benefits of biometrics versus Traditional authentication methods.
Text1: 1.1-1.9 10Hrs
Handwritten Character Recognition: Introduction**,** Character recognition**,** System overview**,** Feature extraction for character recognition**,** Neural network for handwritten Character recognition, Multilayer neural network for handwritten character recognition**,** Experimental results.
Text 1:2.1-2.9 **11 Hrs**
Self Learning Component:
1**.** Devanagari numeral recognition
2. Isolated handwritten devanagari character recognition using fourier descriptor and hidden**.**

UNIT – II

Face Biometrics: Introduction**,** Background of face recognition**,** Design of face recognition system**,** Neural network for face recognition**,** Face detection in video sequences**,** Challenges in face biometrics**,** Face recognition methods**,** Advantages and disadvantages.
Text1: 3.1-3.8
Retina and Iris Biometrics: Introduction**,** Performance of biometrics**,** Design of retina biometrics, Design of iris recognition system**,** Iris segmentation method**,** Determination of iris region**,** Experimental results of iris localization**,** Applications of iris biometrics**,** Advantages and disadvantages.
Text 1: 4.1-4.9 **10 Hrs**

Self Learning Component:
1**.** Applications of iris biometrics

UNIT – III

Vein and Fingerprint Biometrics: Introduction**,** Biometrics using vein pattern of palm**,** Fingerprint biometrics, Fingerprint recognition system, Minutiae extraction**,** Fingerprint indexing**,** Experimental results**,** Advantages and disadvantages.
Biometric Hand Gesture Recognition for Indian Sign Language: Introduction**,** Basics of hand geometry**,** Sign language, Indian sign language (ISL), SIFT algorithm, A practical approach, Advantages and disadvantages.
Text 1: 5.1 -5.8 and 6.1-6.7 **10 Hrs**
Self Learning Component:
1**.** SIFT algorithm

UNIT – IV

Privacy Enhancement Using Biometrics: Introduction**,** Privacy concerns associated with biometric deployments, Identity and privacy, Privacy concerns, Biometrics with privacy enhancement**,** Comparison of various biometrics in terms of privacy, Soft Biometrics.
Biometric Cryptography and Multimodal Biometrics: Introduction to biometric cryptography, General purpose cryptosystem, Modern cryptography and attacks, Symmetric key ciphers, Cryptographic algorithms, Introduction to multimodal biometrics, Basic architecture of

multimodal biometrics, Multimodal biometrics using face and ear, Characteristics and advantages of multimodal biometrics,

Text 1:7.1-7.7and8.1-8.10 **10 Hrs**

Self Learning Component:

1. AADHAAR: An application of multimodal biometrics.

UNIT – V

Watermarking Techniques: Introduction**,** Data hiding methods**,** Basic framework of watermarking**,** Classification of watermarking**,** Applications of watermarking**,** Attacks on watermarks, Performance evaluation**,** Characteristics of watermarks, General watermarking process**,** Image watermarking techniques**,** Watermarking algorithm.

Biometrics Scope and Future: Scope and future market of biometrics, Biometric technologies**,** Applications of biometrics**,** Biometrics and information technology infrastructure**,** Role of biometrics in enterprise security**,** Role of biometrics in border security**,** Smart card technology and biometrics**,** Radio frequency identification (RFID) biometrics, DNA biometrics**,** Comparative study of various biometric techniques.

Text1: 9.1-9.11 and 10.1-10.10 **11 Hrs**

Self Learning Component:

1. Biometric Standards

2. Study of different types of Digital Image Watermarking Techniques and importance of Biometrics data security (Ref: JelenaTasic, SasaAdamovic, "Digital Image Watermarking Techniques and Biometrics data security: A Review", International Scientific Conference on Information Technology and Data related research, SINTEZA 2017)

Note: <u>No questions</u> from SLC component in the Semester End Exam (SEE), it is evaluated only in Continuous Internal Evaluation (CIE)

TEXT BOOK:

1. **"Biometrics: Concepts and Applications"**, G.R.Sinha, SandeepB.Patil, Wiley, 2013 edition. ISBN: 13: 978-81-265-3865-2

REFERENCE BOOKS:

1. Samir Nanavati, Michael Thieme, Raj Nanavati, **"Biometrics – Identity Verification in a Networked World"**, Wiley-dreamtech India Pvt Ltd, New Delhi, 2003. .ISBN: 978-0-471-09945-1
2. Paul Reid, **"Biometrics for Network Security"**, Pearson Education, New Delhi, 2004. ISBN 10: 8131716007.
3. John R Vacca, **"Biometric Technologies and Verification Systems"**, Elsevier Inc, 2007. ISBN: 9780750679671.
4. Anil K Jain, Patrick Flynn, Arun A Ross, **"Handbook of Biometrics"**, Springer, 2008. ISBN 978-0-387-71041-9

<u>C. Course Outcomes</u>

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Explain** the basics of biometric modalities and features of the biometrics.	**PO1, (L2)**
CO2	**Apply** the various morphological operations for feature extraction in various biometrics	**PO2, (L2)**
CO3	**Analyze** the use of various biometrics.	**PO3, (L4)**
CO4	**Understand** the role of watermarking techniques in biometrics	**PO2, (L2)**
CO5	**Summarize** the privacy issues and concerns related to biometric cryptography	**PO3, (L5)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	**3**												**3**	
#2		**2**												**2**
#3			**2**											
#4		**2**												**2**
#5			**1**											

Laboratory			
Course Title: **Circuit Simulation Laboratory**			
Course Code: **P18ECL66**	Semester: **VI**	L-T-**P**-**H** : 0-0-**3**-**3**	Credits:**1.5**
Contact Period : Lab: **36 Hrs**.; Exam: **3 Hrs**.	Weightage: CIE: **50 %**		SEE: **50%**

A. Course Learning Objectives (CLOs)

This course aims to:

1. Learning computer aided design and simulation tools
2. Design and verification of circuits at system level.
3. Capturing system requirements and optimize design.

B. Course Content

The design flow must consists of the following

PART –A

Draw the schematic and perform

- Transient analysis,

- AC sweep analysis using **Pspice simulator** for given specification

1. Clipper and Clamper Circuit.
2. MOSFET Amplifier.
3. CMOS Inverter.
4. Current Controlled Voltage Source
5. Voltage Controlled Current Source.
6. Summing Amplifier
7. ADC

PART –B

For the following set of experiments the design flow must consists of

- Draw the schematic
- Draw the PCB layout and verify with DRC
- Generate the gerber file for given specification

1. Inverting amplifier
2. Design a full adder using basic gates.
3. Monostable / Astablemultivibrator
4. Power supply design with regulators
5. Amplitude modulator
6. Frequency modulator
7. Counter design with display.

Open Ended Experiment

1. Temperature monitoring based on environmental condition.
2. Implement home automation with the help of relays

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** the knowledge of the digital system to design the schematic in Pspice Orcad tools.	**PO1, PO5 (L1)**
CO2	**Interpret** the concept of transient and ac sweep analysis using Pspice Simulator	**PO2, PO4 (L4)**
CO3	**Design** PCB for the basic analog and digital circuit using Orcad tool	**PO3, PO5 (L5)**
CO4	**Analyze and Optimize** the circuit for given specification	**PO2, PO3, PO4, PO5 (L4) ,(L3)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	3				3								3	
#2		3		3										3
#3			2		3									
#4		3	2	2	3									3

Laboratory			
Course Title: **Analog and Digital VLSI Design Laboratory**			
Course Code: **P18ECL67**	Semester: **VI**	L-T-**P-H** : 0-0-**3**-**3**	Credits: **1.5**
Contact Period : Lab: **36 Hrs**.; Exam:**3 Hrs**.		Weightage: CIE: **50%** SEE: **50%**	

A. Course Learning Objectives (CLOs)

This course aims to:

1. Explore the CAD tool and understand the flow of the Full Custom IC design cycle.
2. Learn DRC, LVS and Parasitic Extraction of the various designs.
3. Design and simulate the various basic CMOS analog circuits and use them in higher circuits like operational amplifiers using design abstraction concepts.
4. Design and simulate the various basic CMOS digital circuits and use them in higher circuits like adders and shift registers using design abstraction concepts.
5. Understand simulation and synthesis of digital design.
6. Analyze the ASIC Design flow.
7. RTL Design, simulate and verify digital circuits.

B. Course Content

Part A: Analog VLSI Design

Analog Design Flow:

The design flow must consist of the following:

1. Draw the schematic and verify the following:
   - DC Analysis
   - Transient Analysis
2. Draw the Layout and verify the DRC, ERC, and LVS.
3. Check for LVS.
4. Extract RC and Back annotate the same and verify the Design
5. Design an Inverter gate with given specification.
6. Design an NAND and NOR gate with given specification.
7. Design the following circuits, in different styles, for the given specification
   - Common source amplifier
   - Common Drain amplifier.
8. Design a Single Stage Differential Amplifier for given specifications.
9. Design an OPAMP for given specifications using Differential Amplifier.
10. Analysis, Design and Characterization of SRAM memory cell/block.

Part B. Digital VLSI Design

ASIC-Digital Design / FPGA Digital Design

1. Develop Verilog Code for the n inverter, Buffer and their Test Bench for verification.
2. Develop Verilog Code for the Transmission gate and their Test Bench for verification.
3. Design and Develop Verilog code for 4/8-bit Carry Ripple Adder.
4. Design and Develop Verilog code for 4/8-bit Carry Look Ahead adder.
5. Develop Verilog Code for Radix-4 Booth Multiplication.
6. Develop Verilog code for 4/8-bit Universal Shift Register.

Open Ended Experiment

1. Design and simulate Gilbert cell for Analog multiplication

OR

2. Demonstration of place and Route steps with DMA MAC example using INNOVUS.

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** the knowledge of the digital system to design of the schematic and layout in cadence tools.	**PO1 (L1)**
CO2	**Interpret** the outcome of DC Analysis, AC Analysis and Transient Analysis in analog circuits.	**PO4, PO9 (L4)**
CO3	**Design** and **simulate** basic CMOS circuits like inverter, common source amplifier and differential amplifiers.	**PO3, PO5, PO8, (L5)**
CO4	**Analysis** of the **design** for power, timing and area.	**PO2, PO5 (L4)**
CO5	**Develop** 4/8-bit Carry Ripple Adder, Carry Look Ahead adder and Booth Multiplication using Verilog code.	**PO3, PO5, PO7, (L5)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	**3**												**3**	
#2				**2**					**3**					
#3			**2**		**3**			**2**						
#4		**3**			**3**									**3**
#5			**2**		**3**		**2**							

Skill Laboratory - Core			
Course Title : **Skill Oriented Laboratory – II**			
Course Code: **P18ECL68**	Semester : **VI**	L-T-**P-H** : 0-0-**2-2**	Credits: **1**
Contact Period: Lab: **26 Hrs.,** Exam: **2 Hrs.**		Weightage: CIE: **50%** SEE: **50%**	

Track-1: Embedded Systems and Applications Laboratory

A. Course Learning Objectives (CLO'S)

This course aims to:

1. Understand how to apply standard IOT architectures for your IOT project.
2. Understand different basic programming for IOT applications.
3. Understand the interface of different sensors and signalling peripherals to arduino & raspberry pi.
4. Perform basic real-time experiments.

5. Analyze the overall operation of IOT application.

B. Course Content

1) Introduction to IOT Signaling Peripherals:
   a) Perform an experiment to check the LED patterns and control Analog I/O- LED fading.

2) Motor Speed and Digital Clock:
   a) Perform an experiment to control the speed of a Motor.
   b) Perform an experiment to implement a Simple Digital Clock.

3) Perform an experiment to verify Wireless connectivity.

4) LED Controlling:
   a) Perform an experiment check Inter/ Intranet Controlled LEDs.
   b) Perform an experiment check Internet-based Multicolour-LED control.

5) Design an experiment to demonstrate Internet-based Home Automation.

6) Demonstrate the effectiveness of Internet-based Home Security System.

7) Perform an experiment to interface Temperature Sensor& IOT.

8) Perform an experiment to implement Switch-based Counter.

9) Design an Internet-based Street Light Control.

10) Design a water level control unit using the Internet.

11) Perform an experiment for real-time Moisture Sensing and logging the data.

REFERENCE BOOKS:

1. **"21 Internet of Things (IOT) Experiments",** Yashavant Kanetkar/ Shrirang Korde, BPB Publications (Paperback), 1st edition, ISBN: 9789386551832**,** 2018.
2. **"Internet of Things with Arduino and Bolt",** Pajankar Ashwin, BPB Publications (Paperback), ISBN: 9789387284265, 9789387284265**,** 2018.

Track-2: System Verilog Laboratory

A. Course Learning Objectives (CLO'S)

This course aims to:

1. Understand the basics of programming in System Verilog.
2. Learn System Verilog Constraint Random Verification to verify VLSI designs, usage of System Verilog communication features like Semaphores, events and mail boxes.
3. Understand and use the System Verilog RTL design and synthesis features.
4. Understand the methods of robust verification.
5. Develop a stimulus generator to create constrained random test stimulus.

C. Course Content

1. Using the assertions construct of System Verilog develop a code to validate the behaviour of a given design.

2. Develop a System Verilog code to create a mail box and use it for exchanging data between two threads.
3. Develop a System Verilog code to simulate and verify the operation of a serial adder.
4. Develop a System Verilog code to simulate, verify and synthesize the function of a RAM for given specifications.
5. Design and develop a System Verilog code to simulate and synthesize a state machine for the specific requirements also develop test cases to verify its functionality.
6. Design and develop a System Verilog test bench to verify the operation of a given functional block with respect to its specifications.
7. Using class data type in System Verilog develop a code for control register with given specifications and simulate its operation.
8. Using System Verilog data types and facilities develop a code to verify the operation of binary search tree logic block.
9. Develop a System Verilog code to check the consistency of data flow between the modules of a given functional block.
10. Using System Verilog Class data type, constraints and randomization facilities develop a code for SRAM functionality and verify its operation through simulation.
11. Using System Verilog Threads and mail box facility develop a code to verify the operation of a given logical functionality.

REFERENCE BOOKS:

3. **"System Verilog for Verification: A Guide to Learning the Test bench Language Features"**, Chris Spear, Springer-Verlag New York, Inc, 3rd edition, ISBN 978-1-4614-0714-0, 2012,
4. **"Hardware Verification with System Verilog (An Object Oriented Framework)**", Mike Mintz and Robert Ekehndal, Springer, USA, 2007, ISBN 0-387-71738-2.

Track-3: Java and Web Technologies Laboratory

A. Course Learning Objectives (CLO'S)

This course aims to:

1. To understand object oriented concepts in Java
2. To execute basic SQL queries
3. To develop an ability to design and implement websites with client side scripts, and server side scripting.

B. Course Content

1) Programs on HTML5:

a) Write a java program to develop a website page to handle simple billing system on HTML5.

2) CSS (Cascading Style Sheets):

a) Write a program to develop a website page on CSS.

3) **Executing basic SQL queries: Insert, Delete, Search, Update:**
   a) Design a database using MySQL to insert and delete entries of an application based management system.
4) **Executing basic SQL queries: Search:**
   a) Design a database using MySQL to search for specify entries in an application based data management system.
5) **Executing basic SQL queries: Update:**
   a) Design a database using MySQL to update/over write entries in an application based management system.
6) **Programs on Java Script.**
   a) Writing Java Scripts for different applications and other interfaces.
7) **PHP programs:**
   a) PHP program writing.

REFERENCE BOOKS:

1. **"Java: The Complete Reference",** Schildt Herbert, McGraw Hill Education, 7th edition, ISBN: 9780070636774, 9780070636774**.**
2. **"HTML & CSS: The Complete Reference",** Powell Thomas, Tata McGraw-Hill Education India, 5th edition, ISBN: 9780070701946, 9780070701946.
3. **"PHP: The Complete Reference",** Steven Holzner, Mcgrawhill HED, 1st edition, ISBN: 9780070223622, 0070223629.

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	Ability to **understand and verify** basic concepts of embedded theory, Java programming and System Verilog programming with experimentation	**PO1(L1), PO2 (L2)**
CO2	Ability to **analyse and discriminate** intricacies of embedded theory, Java programming and System Verilog programming	**PO1(L2), PO2(L4), PO3 (L2)**
CO3	Ability to **use modern tools** and get tuned to industrial requirements	**PO5 (L3)**
CO4	Will be able to **develop** small projects through knowledge	**PO2(L4), PO3 (L3)**

	gained out of practical session	
CO5	Will learn **professional ethics**, project management capabilities and working in a team	**PO8(L2), PO9 (L3)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	**2**	**1**											**2**	**1**
#2	**2**	**2**	**1**										**2**	**2**
#3					**3**									
#4		**2**	**3**											**2**
#5								**2**	**2**					

Course Title: **Technical Skills - II**			
Course Code: **P18HU69**	Semester: **VI**	**L**-T-P-**H** : 2-0-0-**2**	Credits: **1**
Contact Period : Lecture: **36 Hrs**. Exam: **2 Hrs**.		Weightage: CIE: **50%** SEE: **50%**	

A. Course Learning Objectives (CLO'S)

This course aims to:

1. Strengthen their understanding of Introduction to Computer Science, C, and Data Structures.
2. Write effective codes on **C** Programming

B. Course Content

UNIT- I

Introduction to Computer Science: Basic Structure of Computers: Basic Operational Concepts, Bus Structures, Performance– Processor Clock, Basic Performance Equation, Clock Rate, Performance Measurement.

Operating System - An Introduction: Definition and functions of operating systems. discussion on evolution of operating systems and different structures of operating systems.

3 Hrs

UNIT - II

C Programming Language: Medium to **difficult level** of Snippets for

- Understanding basic syntax
- If - else statement
- Switch case
- Struct
- For loop
- While and do - while loop
- Array
- Strings
- Pointers
- Function
- String
- File handling
- Preprocessing

18 Hrs

UNIT - III

Introduction to Data Structures:

Data Structures Basics: Structure and Problem Solving, Data structures, Data structure Operations, Algorithm: complexity, Time- space tradeoff.

- Linked List
- Stack and Queue
- Searching and Sorting Techniques

15 Hrs

Overall Syllabus Breakup:				
Sl. No.	**Module Name**	**Classroom (Hours)**	**Lab (Hours)**	**Total duration (Hours)**
1.	Introduction to Computer Science	3	0	3
2.	C Programming	0	18	18
3.	Introduction to Data Structures	6	9	15
	Total Hours	**9**	**27**	**36**

Assessments:

Each of the modules (C and Data Structures) will have two types of assessments -

- Multiple-choice assessment for programming logic, concepts and debugging
- Coding

Learning Outcomes:

After undergoing training in this course, the students will be in a position to –

- Write complete program based on the requirements and to debug.
- Frame effective programs using C programming and Data Structures.

C. Course Outcomes

CO #	Course Outcome	Program Outcome Addressed (PO #) with BTL
CO1	**Understand** the basics of computer structure and operation of computers and their peripherals and need of Operating System.	**PO1 (L1)**
CO2	**Understand** the concepts of snippets in a programming term for a small region of re-usable source code, machine code, or text. In C it could be part of the program - A Function, typedef or a part of the algorithm or code.	**PO2 (L1)**
CO3	**Apply** the concepts of snippets in a programming	**PO3 (L2)**
CO4	**Understand** the concepts of programs as sequences or machine instructions.	**PO1 (L1)**
CO5	**Understand** and **Design** the programs by using common data structures and the algorithms that build and manipulate them including various sorting and searching algorithms. Data structures include arrays, linked lists, stacks, queues, Features, properties, applications, enumerators, and performance issues.	**PO3 (L5)**

D. Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
#1	**3**												**3**	
#2		**2**												**2**
#3			**3**											
#4	**2**												**2**	
#5			**2**											