AMRITA VISHWA VIDYAPEETHAM
DEEMED TO BE UNIVERSITY
School of Engineering

AMRITAPURI, BENGALURU, COIMBATORE, CHENNAI

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

B.Tech. in ELECTRONICS AND COMPUTER ENGINEERING

(BTC-EAC)

CURRICULUM AND SYLLABI

(2019)

GENERAL INFORMATION

ABBREVIATIONS USED IN THE CURRICULUM

Cat	-	Category
L	-	Lecture
T	-	Tutorial
P	-	Practical
Cr	-	Credits
ENGG	-	Engineering Sciences (including General, Core and Electives)
HUM	-	Humanities (including Languages and others)
SCI	-	Basic Sciences (including Mathematics)
PRJ	-	Project Work (including Seminars)

AES	-	Aerospace Engineering
AIE	-	Computer Science and Engineering - Artificial Intelligence
BIO	-	Biology
CCE	-	Computer and Communication Engineering
CHE	-	Chemical Engineering
CHY	-	Chemistry
CSE	-	Computer Science and Engineering
CVL	-	Civil Engineering
CUL	-	Cultural Education
EAC	-	Electronics and Computer Engineering
ECE	-	Electronics and Communication Engineering
EEE	-	Electrical and Electronics Engineering
ELC	-	Electrical and Computer Engineering
HUM	-	Humanities
MAT	-	Mathematics
MEE	-	Mechanical Engineering
PHY	-	Physics

Course Outcome (CO) – Statements that describe what students are expected to know, and are able to do at the end of each course. These relate to the skills, knowledge and behaviour that students acquire in their progress through the course.

Program Outcomes (POs) – Program Outcomes are statements that describe what students are expected to know and be able to do upon graduating from the Program. These relate to the skills, knowledge, attitude and behaviour that students acquire through the program. NBA has defined the Program Outcomes for each discipline.

PROGRAM OUTCOMES FOR ENGINEERING

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

SEMESTER I

Cat.	Code	Title	Credit
SCI	19MAT101	Single Variable Calculus	1
SCI	19MAT102	Matrix Algebra	2
ENGG	19EAC101	Introduction to Computer Engineering	3
ENGG	19CSE100	Problem Solving and Algorithmic Thinking	4
SCI	19PHY103	Physics of Electronic Materials	3
ENGG	19MEE100	Engineering Graphics - CAD	3
ENGG	19EEE111	Electrical and Electronics Engineering	3
ENGG	19EEE182	Electrical and Electronics Engineering Practice	1
ENGG	19ECE101	Introduction to IoT	1
HUM	19CUL101	Cultural Education - I	2
		TOTAL	23

SEMESTER II

Cat.	Code	Title	Credit
HUM	19ENG111	Technical Communication	3
SCI	19MAT115	Discrete Mathematics	4
ENGG	19EAC111	Digital Circuits and Systems	4
ENGG	19CSE102	Computer Programming*(C/C++)	4
ENGG	19EAC112	Solid State Devices	3
ENGG	19EAC181	Digital Systems Lab	1
ENGG	19MEE181	Manufacturing Practice	1
HUM	19CUL111	Cultural Education - II	2
		TOTAL	22

SEMESTER III

Cat.	Code	Title	Credit
SCI	19MAT209	Linear Algebra and Optimization Techniques	4
ENGG	19EAC204	Computer Organization and Architecture	3
ENGG	19EAC203	Data Structures and Algorithms	3
ENGG	19EAC205	Mathematics of Signal Processing	3
ENGG	19EAC201	Electronic Circuits I	3
HUM	19AVP201	Amrita Values Program I	1
ENGG	19EAC281	Mathematics of Signal Processing Lab	1
ENGG	19EAC202	Network Theory	3
ENGG	19EAC282	Electronic Circuits I Lab	1
		TOTAL	22

SEMESTER IV

Cat.	Code	Title	Credit
SCI	19MAT205	Probability and Random Processes	4
ENGG	19EAC212	Electronic Circuits II	3
ENGG	19EAC213	Digital Signal Processing and Processors	3
ENGG	19EAC211	Operating Systems	3
ENGG	19EAC214	Microprocessor and Microcontroller	3
ENGG	19EAC283	Digital Signal Processing and Processors Lab	1
ENGG	19EAC284	Electronic Circuits II Lab	1
ENGG	19EAC285	Microcontroller Lab	1
HUM	19AVP211	Amrita Values Program II	1
HUM	19SSK211	Soft Skills I	2
		TOTAL	22

SEMESTER V

Cat.	Code	Title	Credit
ENGG	19EAC301	Fundamentals of Machine Learning	3
ENGG		Professional Elective I*	3
ENGG	19EAC302	Embedded Systems Design	3
ENGG	19EAC303	Information Theory and Coding	4
ENGG	19ECE313	VLSI Design	3
ENGG	19EAC381	Machine Learning lab with Python	1
ENGG	19ECE383	VLSI Design lab	1
ENGG	19SSK301	Soft Skills II	2
ENGG	19LIV390	Live-in –Labs***	[3]
ENGG	19ENV300	Environmental Science	P/F
		TOTAL	20

SEMESTER VI

Cat.	Code	Title	Credit
ENGG	19EAC311	Computer Networks	3
ENGG	19EAC312	Data Base Management Systems	3
ENGG	19EAC313	Data Science	3
PRJ	19EAC383	Technical Presentation and Writing	2
ENGG		Professional Elective II*	3
HUM	19SSK311	Soft Skills III	2
ENGG	19EAC386	Open Lab/Professional Elective III*	2
ENGG	19EAC384	Computer Networks Lab	1
ENGG	19EAC385	R Programming Lab (Data Science)	1
ENGG	19LIV490	Live-in –Labs***	[3]
		TOTAL	20

SEMESTER VII

Cat.	Code	Title	Credit
ENGG	19EAC401	Introduction to Cyber Security	4
ENGG		Professional Elective IV*	3
ENGG		Professional Elective V*	3
ENGG		Professional Elective VI*	3
ENGG	19EAC496	Open Lab/Professional Elective VII*	2
PRJ	19EAC495	Project Phase I	2
HUM	19LAW300	Indian Constitution	P/F
HUM	19MNG300	Disaster Management	P/F
		TOTAL	17

SEMESTER VIII

Cat.	Code	Title	Credit
ENGG		Professional Elective VIII*	3
HUM		Free Elective I**	3
PRJ	19EAC499	Project Phase II	10
		TOTAL	16

		TOTAL CREDITS		**162**

***Professional Elective** - Electives categorised under Engineering, Science ,Mathematics, Live-in-Labs, and NPTEL Courses . Student can opt for such electives across departments/campuses.Students with CGPA of 7.0 and above can opt for a maximum of 2 NPTEL courses with the credits not exceeding 8.

** **Free Electives** - This will include courses offered by Faculty of Humanities and Social Sciences/ Faculty Arts, Commerce and Media / Faculty of Management/Amrita Darshanam -(International Centre for Spiritual Studies).

*** **Live-in-Labs** - Students undertaking and registering for a Live-in-Labs project, can be exempted from registering for an Elective course in the higher semester.

PROFESSIONAL ELECTIVES

Computer Science			
Cat.	**Code**	**Title**	**Credit**
ENGG	19CSE459	Advanced Algorithms and Analysis	3
ENGG	19CSE340	Advanced Computer Networks	3
ENGG	19CSE357	Big Data Analytics	3
ENGG	19CSE445	Cloud Computing	3
ENGG	19CSE458	Computational Intelligence	3
ENGG	19CSE435	Computer Vision	3
ENGG	19CSE331	Cryptography	3
ENGG	19CSE312	Distributed Systems	3
ENGG	19CSE442	Pervasive and Ubiquitous Systems	3
ENGG	19CSE458	Computational Intelligence	3
ENGG	19CSE444	Real Time Systems	3
ENGG	19CSE453	Natural Language Processing	3
ENGG	19CSE440	Biometrics	3

Analog Electronics			
Cat.	**Code**	**Title**	**Credit**
ENGG	19ECE332	Mixed Signal Design	3
ENGG	19ECE334	Analog IC Design	3
ENGG	19ECE335	Applications of Linear Integrated Circuits	3
ENGG	19ECE331	Biomedical Instrumentation	3
ENGG	19ECE432	Software Defined Networks	3

Signal Processing			
ENGG	19ECE458	Adaptive Signal Processing	3
ENGG	19ECE442	Avionics	3
ENGG	19ECE455	Biomedical Signal Processing	3
ENGG	19ECE456	Hyperspectral Image Analysis	3
ENGG	19ECE454	Image Processing	3
ENGG	19ECE357	Pattern Recognition	3
ENGG	19ECE451	Spoken Language Processing	3
ENGG	19ECE463	Smart Sensors	3
ENGG	19ECE457	Wavelets and Application	3
ENGG	19ECE436	Wireless Sensor Networks	3

VLSI			
ENGG	19ECE346	Digital IC Design	3
ENGG	19ECE347	Electronic System Level Design and Verification	3
ENGG	19ECE342	Hardware Security and Trust	3
ENGG	19ECE461	Intelligent Control Systems	3
ENGG	19CE348	VLSI Testing and Testability	3
ENGG	19ECE349	RISC Processor Design using HDL	3
ENGG	19ECE337	VLSI Fabrication Technology	3
ENGG	19ECE343	FPGA Based System Design	3
ENGG	19ECE434	MIMO and Multicarrier Communication	3
ENGG	19ECE350	VLSI Signal Processing	3
ENGG	19ECE313	VLSI System Design	3

PROFESSIONAL ELECTIVES UNDER SCIENCE STREAM

CHEMISTRY			
Cat.	**Code**	**Title**	**Credit**
SCI	19CHY243	Computational Chemistry and Molecular Modelling	3
SCI	19CHY236	Electrochemical Energy Systems and Processes	3
SCI	19CHY240	Fuels and Combustion	3
SCI	19CHY232	Green Chemistry and Technology	3
SCI	19CHY239	Instrumental Methods of Analysis	3
SCI	19CHY241	Batteries and Fuel Cells	3
SCI	19CHY242	Corrosion Science	3
PHYSICS			
SCI	19PHY340	Advanced Classical Dynamics	3
SCI	19PHY342	Electrical Engineering Materials	3
SCI	19PHY331	Physics of Lasers and Applications	3
SCI	19PHY341	Concepts of Nanophysics and Nanotechnology	3
SCI	19PHY343	Physics of Semiconductor Devices	3
SCI	19PHY339	Astrophysics	3
Mathematics			
SCI	19MAT341	Statistical Inference	3
SCI	19MAT342	Introduction to Game Theory	3
SCI	19MAT343	Numerical Methods and Optimization	3

FREE ELECTIVES

FREE ELECTIVES OFFERED UNDER MANAGEMENT STREAM			
Cat.	**Code**	**Title**	**Credit**
HUM	19MNG331	Financial Management	3
HUM	19MNG332	Supply Chain Management	3
HUM	19MNG333	Marketing Management	3
HUM	19MNG334	Project Management	3
HUM	19MNG335	Enterprise Management	3
HUM	19MNG338	Operations Research	3
HUM	19MEE401	Industrial Engineering	3
HUM	19MEE346	Managerial Statistics	3
HUM	19MEE347	Total Quality Management	3
HUM	19MEE342	Lean Manufacturing	3
HUM	19CSE358	Software Project Management	3
HUM	19CSE359	Financial Engineering	3
HUM	19CSE360	Engineering Economic Analysis	3
HUM	19MNG331	Financial Management	3
HUM	19CSE362	Information Systems	3

FREE ELECTIVES OFFERED UNDER HUMANITIES / SOCIAL SCIENCE STREAMS			
Cat.	**Code**	**Title**	**Credit**
HUM	19CUL230	Achieving Excellence in Life - An Indian Perspective	2
HUM	19CUL231	Excellence in Daily Life	2
HUM	19CUL232	Exploring Science and Technology in Ancient India	2
HUM	19CUL233	Yoga Psychology	2
HUM	19ENG230	Business Communication	2
HUM	19ENG231	Indian Thought through English	2
HUM	19ENG232	Insights into Life through English Literature	2
HUM	19ENG233	Technical Communication	2
HUM	19ENG234	Indian Short Stories in English	2
HUM	19FRE230	Proficiency in French Language (Lower)	2

HUM	**19FRE231**	**Proficiency in French Language (Higher)**	**2**
HUM	**19GER230**	**German for Beginners I**	**2**
HUM	**19GER231**	**German for Beginners II**	**2**
HUM	**19GER232**	**Proficiency in German Language (Lower)**	**2**
HUM	**19GER233**	**Proficiency in German Language (Higher)**	**2**
HUM	**19HIN101**	**Hindi I**	**2**
HUM	**19HIN111**	**Hindi II**	**2**
HUM	**19HUM230**	**Emotional Intelligence**	**2**
HUM	**19HUM231**	**Glimpses into the Indian Mind - the Growth of Modern India**	**2**
HUM	**19HUM232**	**Glimpses of Eternal India**	**2**
HUM	**19HUM233**	**Glimpses of Indian Economy and Polity**	**2**
HUM	**19HUM234**	**Health and Lifestyle**	**2**
HUM	**19HUM235**	**Indian Classics for the Twenty-first Century**	**2**
HUM	**19HUM236**	**Introduction to India Studies**	**2**
HUM	**19HUM237**	**Introduction to Sanskrit Language and Literature**	**2**
HUM	**19HUM238**	**National Service Scheme**	**2**
HUM	**19HUM239**	**Psychology for Effective Living**	**2**
HUM	**19HUM240**	**Psychology for Engineers**	**2**
HUM	**19HUM241**	**Science and Society - An Indian Perspective**	**2**
HUM	**19HUM242**	**The Message of Bhagwad Gita**	**2**
HUM	**19HUM243**	**The Message of the Upanishads**	**2**
HUM	**19HUM244**	**Understanding Science of Food and Nutrition**	**2**
HUM	**19JAP230**	**Proficiency in Japanese Language (Lower)**	**2**
HUM	**19JAP2313**	**Proficiency in Japanese Language (Higher)**	**2**
HUM	**19KAN101**	**Kannada I**	**2**
HUM	**19KAN111**	**Kannada II**	**2**
HUM	**19MAL101**	**Malayalam I**	**2**
HUM	**19MAL111**	**Malayalam II**	**2**
HUM	**19SAN101**	**Sanskrit I**	**2**
HUM	**19SAN111**	**Sanskrit II**	**2**
HUM	**19SWK230**	**Corporate Social Responsibility**	**2**
HUM	**19SWK231**	**Workplace Mental Health**	**2**
HUM	**19TAM101**	**Tamil I**	**2**
HUM	**19TAM111**	**Tamil II**	**2**

SEMESTER I

19MAT101	SINGLE VARIABLE CALCULUS	L-T-P-C: 1-0-0-1

Course Objectives

- Understand the various functions and their graphs.
- Understand the basic concept of continuous function and find the extreme values of the continuous functions.
- Understand the definite integral and various integration techniques.

Course Outcomes

CO1: To Understand the concepts of single variable calculus.
CO2: To Sketch graphs for functions using the concepts of single variable calculus and apply the fundamental theorem of calculus to evaluate integrals.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3										
CO2	1	2			2							

Syllabus

Calculus

Graphs: Functions and their Graphs. Shifting and Scaling of Graphs. (1.5)
Limit and Continuity: Limit (One Sided and Two Sided) of Functions. Continuous Functions, Discontinuities, Monotonic Functions, Infinite Limits and Limit at Infinity. (2.1, 2.6)
Graphing : Extreme Values of Functions, Concavity and Curve Sketching, (4.1, 4.4).
Integration: Definite Integrals, The Mean Value Theorem for definite integrals, Fundamental Theorem of Calculus, Integration Techniques. (5.2 - 5.3, 8.1 – 8.5)

Text Book
'*Calculus', G.B. Thomas Pearson Education, 2009, Eleventh Edition.*

Reference
'Calculus', Monty J. Strauss, Gerald J. Bradley and Karl J. Smith, 3rd Edition, 2002.

Course Evaluation pattern:
At the end of the course, a two hours test will be conducted for 50 marks. The marks will be converted to 100 for grading.

19MAT102	MATRIX ALGEBRA	L-T-P-C: 2-0-0-2

Course Objectives

- Understand basic concepts of eigen values and eigen vectors.
- Apply eigen values and eigen vectors for diagonalization and quadratic form.
- Apply various iterative techniques to solve the system of equations.

Course Outcomes

CO1: Understand the notion of eigenvalues and eigenvectors, analyze the possibility of diagonalization and hence compute a diagonal matrix, if possible.
CO2: Apply the knowledge of diagonalization to transform the given quadratic form into the principal axes form and analyze the given conic section.
CO3: Understand the advantages of the iterative techniques and apply it to solve the system of equations and finding eigenvectors.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									
CO2	2	3	1									
CO3	3		1									

Syllabus

Review: System of linear Equations, linear independence. (3 hrs)

Eigen values and Eigen vectors: Definitions and properties. Positive definite, negative definite and indefinite. (8 hrs)

Diagonalization and Orthogonal Diagonalization. Properties of Matrices. Symmetric and Skew Symmetric Matrices, Hermitian and Skew Hermitian Matrices and Orthogonal matrices. (Sections: 8.1-8.4) (10 hrs)

Numerical Computations: L U factorization, Gauss Seidal and Gauss Jacobi methods for solving system of equations. Power Method for Eigen Values and Eigen Vectors. (Sections: 20.2, 20.3, 20.8) (8 hrs)

Text Book(s)
Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Tenth Edition, 2018.

Reference(s)
Advanced Engineering Mathematics by Dennis G. Zill and Michael R.Cullen, second edition, CBS Publishers, 2012.
'Engineering Mathematics', Srimanta Pal and Subhodh C Bhunia, John Wiley and Sons, 2012, Ninth Edition.

Course Evaluation Pattern: Class test / Tutorial / Assignment : 30 marks. At the end of the course, a two hours test will be conducted for 70 marks.

19EAC101	INTRODUCTION TO COMPUTER ENGINEERING	L-T-P-C :3 0 0 3

Course Objective

- To give an insight into computers and computer systems, how they work and how they are constructed and programmed.
- Enable students to gain an understanding of the way computers store and process information.
- This course also helps the students to understand the organization of hardware, the way computer networks work, the principles used to produce efficient and reliable software, the basic database concepts and query language.

Course Outcomes

CO1: Ability to realize how data is represented and stored in a computer.
CO2: Ability to understand the data manipulation process in a computer.
CO3: Ability to learn the fundamentals & structure of Operating Systems.
CO4: Ability to understand how computers can be linked together to share information and resources.
CO5: Ability to help the students to design and develop efficient, reliable software products.
CO6: Demonstrate understanding of the basic definitions of relational database theory.
CO7: Ability to introduce the theory and practice of computer graphics.
CO8: Ability to understand the basics of Internet of Things (IoT) and design simple IoT systems for societal benefit.

CO- PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												2	
CO2	3	3											2	
CO3	3	3	3										2	
CO4	3	3	3	1									2	
CO5	3	3	3	2	1								2	
CO6	3	3	3	3	2								2	
CO7	3	3	3	2	1								2	
CO8	3	3	3	3	2	1							2	1

Module I: Introduction to Computer Science: Role of Algorithms, History of Computing, Science of Algorithms, Abstractions. Basics of data encoding and storage: Bits and their storage, Main memory, Mass Storage, Representing Information as Bit Patterns. Machine Architecture: CPU Basics, Stored Program concepts, Machine Language Introduction with example, Program Execution with illustrative example.

Module II: Operating Systems: History of OS, OS Architecture, Coordinating Machine Activities. Networking and the Internet: Network Fundamentals, The Internet, The World Wide Web. Software Engineering: Introduction, Software Life Cycle. Database Systems: Database Fundamentals, Relational Model.

Module III: Computer Graphics: Scope of Computer Graphics, Overview of 3D Graphics. Artificial Intelligence: Intelligence and Machines, Perception, Reasoning. An Introduction to topics of research in the department.

Module III: IoT-An Architectural Overview–Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals, Real –world Design Constraints

Text Book(s)

J. Glenn Brookshear, "Computer Science: An Overview", Addison-Wesley, Twelfth Edition, 2014.

Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence",1stEdition, Academic Press, 2014.

Evaluation Pattern 50:50 (Internal: External)

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE100	PROBLEM SOLVING AND ALGORITHMIC THINKING	L-T-P-C: 2-1-3-4

Course Objectives

- This course provides the foundations of computational problem solving.
- The course focuses on principles and methods thereby providing transferable skills to any other domain.
- The course also provides foundation for developing computational perspectives of one's own discipline.

Course Outcomes

CO1: Apply algorithmic thinking to understand, define and solve problems.
CO2: Design and implement algorithm(s) for a given problem.
CO3: Apply the basic programming constructs for problem solving.
CO4: Understand an algorithm by tracing its computational states, identifying bugs and correcting them.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1					2							1
CO2	3	2	3		3		2	3	3	3			2	
CO3	2	1												
CO4	1	1												2

Syllabus

Unit 1
Problem Solving and Algorithmic Thinking Overview – problem definition, logical reasoning; Algorithm – definition, practical examples, properties, representation, algorithms vs programs.

Unit 2
Algorithmic thinking – Constituents of algorithms – Sequence, Selection and Repetition, input-output; Computation – expressions, logic; algorithms vs programs, Problem Understanding and Analysis – problem definition, input-output, variables, name binding, data organization: lists, arrays etc. algorithms to programs.

Unit 3
Problem solving with algorithms – Searching and Sorting, Evaluating algorithms, modularization, recursion. C for problem solving – Introduction, structure of C programs, data types, data input, output statements, control structures.

Text Book(s)
Riley DD, Hunt KA. Computational Thinking for the Modern Problem Solver. CRC press; 2014 Mar 27.

Reference(s)
Ferragina P, Luccio F. Computational Thinking: First Algorithms, Then Code. Springer; 2018.
Beecher K. Computational Thinking: A beginner's guide to Problem-solving and Programming. BCS Learning & Development Limited; 2017.
Curzon P, McOwan PW. The Power of Computational Thinking: Games, Magic and Puzzles to help you become a computational thinker. World Scientific Publishing Company; 2017.

Evaluation Pattern:

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19PHY103	PHYSICS OF ELECTRONIC MATERIALS	L-T-P-C: 3 0 0 3

Course Objectives

- To introduce the structure and physics of materials used in electronics
- To introduce the properties that characterize a material as a conductor, semiconductor or dielectric
- To analyze the electrical, magnetic and optical behavior of materials

Course Outcomes

CO1: Ability to understand the structure and physics of materials used in electronics.
CO2: Ability to understand the different parameters and terminology used in describing electronic properties of materials.
CO3: Ability to understand different properties of materials that result in specific electrical, optical and magnetic behavior.
CO4: Ability to understand and analyze the behavior of active and passive devices built from electronic materials.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	2
CO2	3	2	-	-	-	-	-	-	-	-	-	2
CO3	3	2	-	-	-	-	-	-	-	-	-	2
CO4	3	2	-	-	-	-	-	-	-	-	-	2

Keywords: Electronic Properties of Materials, Semiconductor Physics, Electronic and Optoelectronic Devices

Contents:

Module I: Crystal Structure of Solids
Crystal directions and planes, crystal properties, defects and vacancies, two phase solids.

Module II: Elementary Quantum Physics, Conductors
Wave particle duality, uncertainty principle, potential well, tunnelling, potential box. Simulated emission and lasers. Conductors: Drude model, temperature dependence of resistivity, skin effect, AC conductivity, metal films, thin metal films, interconnects in microelectronics, electromigration.

Module III: Semiconductors, Dielectrics
Classification of semiconductors, doping, temperature dependence, minority carriers and recombination, diffusion and conduction equations, continuity equation, optical absorption, piezoresistivity. Dielectric materials: Polarization, polarization mechanisms, dielectric breakdown in solids, capacitors and their construction, piezoelectricity, ohmic and non ohmic contacts.

Module IV: Magnetic Properties of Materials, Superconductors
Dipole moment, permeability, classification of magnetic materials, saturation and Curie temperature, superconductivity.

Module V: Optical Properties
Light propagation in a homogeneous medium, absorption, scattering, luminescence, phosphors, LEDs, polarization, LCDs, electro optic effects.

Textbook(s)/Reference(s)

S O Kasap, "Principles of Electronic Materials and Devices", 4th Edition, McGraw Hill Education, 2018.
LSolymar, D Walsh and R R A Syms, "Electrical Properties of Materials", 9th Edition, Oxford University Press, 2014.
Rolf. E Hummel, "Electronic Properties of Materials", 4th Edition, Springer, 2012.
Eugene A Irene, Electronic Material Science, Wiley-Blackwell, 2005.

Evaluation Pattern 50:50

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19MEE100	ENGINEERING GRAPHICS – CAD	L-T-P-C: 2-0-3-3

Course Objectives

- Students will be able to develop drawings using CAD software, incorporating BIS standards and also interpret the same.
- Will be able to communicate effectively through drawings.
- Enhance visualization skills, which could be used for better understanding of forth coming courses.

Course Outcomes

CO1: Understand the engineering drawing standards and their usage.
CO2: Interpret engineering drawings.
CO3: Construct and dimension geometric entities and simple machine parts using CAD software.
CO 4: Improve coherent visualization skills.
CO 5: Translate ideas into visual exhibits.
CO 6: Understand the concepts of orthographic projections and isometric projection.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	1	2	3	1	2	3		3	2	2
CO2	3	3	3	3		2	3	1	2	3		3	2	2
CO3	3	3	3	3	3	2	3	1	2	3		3	2	2
CO4	3	3	3	3		2	3	1	2	3		3	2	2
CO5	3	3	3	3	3	2	3	1	2	3		3	2	2
CO6	3	3	3	3	3	2	3	1	2	3		3	2	2

Syllabus

Unit 1
Basic principles of engineering drawing, Drawing Instruments and their uses, lettering and types of lines, Layout of the Software, standard tool bar/menus, navigational tools. Co-ordinate system and reference planes. Creation of 2 dimensional environment. Selection of drawing size and scale. Commands and Dimensioning.

Unit 2
Orthographic Projections: Introduction, Planes of projection, reference line. Projection of points in all the four quadrants. Projection of straight lines, Projection of Plane Surfaces, and Projection of Solids in first angle projection system.

Unit 3
Draw simple building floor plan.

Text Book(s)
Basant Agarwal and C M Agarwal. Engineering Drawing. Second Edition, McGraw Hill Education; 2015

Reference(s)

Bhat N D, Panchal V M Engineering Drawing Plane and Solid Geometry. Forty Second Edition, Charoatar Publishing House; 2010
James D Bethune. Engineering Graphics with AutoCAD. Pearson Education; 2014
K R Gopalakrishna. Engineering Drawing. Subhas Publications; 2014
Narayan K L, Kannaiah P. Engineering Drawing, SciTech Publications; 2003
John K C. Engineering Graphics for Degree. First edition, Prentice Hall India; 2009

Evaluation Pattern

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE111	ELECTRICAL AND ELECTRONICS ENGINEERING	L-T-P-C: 3-0-0-3

Course Objectives

- To impart basic knowledge of electrical quantities and provide working knowledge for the analysis of DC and AC circuits.
- Understand the characteristics and applications of diode and Transistors.
- To facilitate understanding of Thyristors and operational amplifier circuits.

Course Outcomes

CO1: Ability to understand the basic electric and magnetic circuits.
CO2: Ability to analyse DC and AC circuits.
CO3: Ability to understand the basic principles of pn junctions and transistors.
CO4: Ability to analyse basic transistor and opamp based circuits.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-	2	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-	3	-

SYLLABUS

Module I: Introduction to Electrical Engineering, current and voltage sources, Resistance, Inductance and Capacitance; Ohm's law, Kirchhoff's law, Energy and Power – Series parallel combination of R, L, C components,Voltage Divider and Current Divider Rules – Super position Theorem, Network Analysis – Mesh and Node methods- Faraday's Laws of Electro-magnetic Induction, Magnetic Circuits, Self and Mutual Inductance, Generation of sinusoidal voltage, Instantaneous, Average and effective values of periodic functions, Phasor representation. Introduction to 3-phase systems, Introduction to electric grids.

Module II: PN Junction diodes, Diode Characteristics, Diode approximation- Clippers and Clampers, Rectifiers: Half wave, Full wave, Bridge- Zener Diode- Design of regulator and characteristics, Optoelectronic devices, Introduction to BJT, Characteristics and configurations, Transistor as a Switch.

Module III: Field Effect Transistors – Characteristics, Thyristors – operation and characteristics, Diac, Triac – Thyristor based power control, IC 555 based Timer-multi-vibrators, Operational Amplifiers – Inverting and Non-inverting amplifier, Oscillators, Instrumentation amplifiers.

Textbooks

Edward Hughes. "Electrical and Electronic Technology", 10th Edition, Pearson Education Asia, 2019.
A. P. Malvino, "Electronic Principles", 7th Edition, Tata McGraw Hill, 2007.

Reference Books

S. K. Bhattcharya, "Basic Electrical and Electronics Engineering", Pearson, 2012.
Vincent Del Toro, "Electrical Engineering Fundamentals", Prentice Hall of India Private Limited, 2nd Edition, 2003.
David A. Bell, "Electronic Devices and Circuits", 5th Edition, Oxford University Press, 2008.
Michael Tooley B. A., "Electronic circuits: Fundamentals and Applications", 3rd Edition, Elsevier Limited, 2006.

Evaluation Pattern 50:50 (Internal: External)

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE182	ELECTRICAL AND ELECTRONICS ENGINEERING PRACTICE	L-T-P-C: 0-0-3-1

Course Outcomes

CO1: Ability to create basic electrical connections for domestic applications
CO2: Ability to measure the various electrical parameters in the circuit
CO3: Ability to construct and analyze basic electronic circuits
CO4: Ability to construct the amplifier circuits using Op-Amp

LIST OF EXPERIMENTS

1. Electrical
    a) Wiring practices
    b) Study of Electrical protection systems.
2. Verification of circuit theorem
3. VI characteristics of PN junction and Zener diode
4. Implementation of Half wave and Full wave rectifier using PN junction diode
5. Transistor as a switch
6. Characteristics of BJT
7. Experiment on Thyristor
8. Implementation of inverting and non-inverting amplifier using Op-amp
9. Experiments on Oscillators and Multivibrators

REFERENCES / MANUALS / SOFTWARE:
Lab Manuals

Evaluation Pattern 80:20 (Internal: External)

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

•CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE101	INTRODUCTION TO INTERNET OF THINGS	L-T-P-C:0-0-3-1

Course Objectives

- To develop basic Programming Skills through Graphical Programming.
- To learn Hardware Interfacing and Debugging Techniques.
- To design and develop Android App for Smart Home Automation.

Course Outcomes

CO 1: To demonstrate various sensor interfacing using Visual Programming Language.
CO 2: To analyze various Physical Computing Techniques.
CO 3: To demonstrate Wireless Control of Remote Devices.
CO 4: To design and develop Mobile Application which can interact with Sensors and Actuators.

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		2											
CO2	3	2	3		2									
CO3	3		3											
CO4	3	3	3	3	2	2	2	2	3	3			3	2

Keywords:
Scratch for arduino, Ardublock, MIT App Inventor.

Contents:

1. Digital I/O Interface - Multi colour Led, IR Sensor, PIR, Slot Sensor.
2. Analog Read and Write - Potentiometer, Temperature Sensor, Led Brightness Control.
3. Dc Motor Control - Dc Motor Speed and Direction Control.
4. Fabrication and direction control of wheeled robot using Arduino.
5. Serial Communication - Device Control
6. Wireless Module Interface - Bluetooth and Wifi.
7. Wireless Control of wheeled Robot using Bluetooth/Wifi.
8. Basic Android App Development using MIT App Inventor.
9. Smart Home Android App Development using App Inventor and Arduino.
10. Assembly of Quadcopter/Tello Mini Drone.
11. Programming and Flight Control of Quad copter.

Textbooks/Reference(s)

Sylvia Libow Martinez, Gary S Stager, Invent To Learn: Making, Tinkering, and Engineering inthe Classroom, Constructing Modern Knowledge Press,2016
Michael Margolis, Arduino Cookbook, Oreilly,2011

Evaluation Pattern 80:20 (Internal: External)

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CUL101	CULTURAL EDUCATION I	L-T-P-C: 2-0-0-2

Course Objective

To introduce students to the depths and richness of the Indian culture and knowledge traditions, and to enable them to obtain a synoptic view of the grandiose achievements of India in diverse fields. To equip students with a knowledge of their country and its eternal values.

Course Outcome

CO1: Be introduced to the foundational concepts of Indian culture and heritage, the cultural ethos of Amrita VishwaVidyapeetham, and Amma's life and vision of holistic education.
CO2: Understand the foundational concepts of Indian civilization like purusharthas, karma siddhanta, Indian Society and Varna-ashrama-dharma which contributes towards personality growth.
CO3: Gain a positive appreciation of symbols of Indian culture, itihasas, festivals, traditions and the spirit of living in harmony with nature.
CO4: Imbibe the principles and practices of Yoga.
CO5: Get guidelines for healthy and happy living from the great spiritual masters.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								2		1		3		
CO2						1	1	3	2			3		
CO3						1	2	3	1			3		
CO4						3	3	3	3			3		
CO5						1	1	3	3			3		

Syllabus

Unit 1
Introduction to Indian culture; Understanding the cultural ethos of Amrita VishwaVidyapeetham; Amma's life and vision of holistic education.

Unit 2
Goals of Life – Purusharthas; Introduction to Varnasrama Dharma; Law of Karma; Practices for Happiness.

Unit 3
Symbols of Indian Culture; Festivals of India; Living in Harmony with Nature; Relevance of Epics in Modern Era; Lessons from Ramayana; Life and Work of Great Seers of India.

Text Books:
Cultural Education Resource Material Semester-1

Reference Books:
The Eternal Truth (A compilation of Amma's teachings on Indian Culture)
Eternal Values for a Changing Society. Swami Ranganathananda. BharatiyaVidyaBhavan.
Awaken Children (Dialogues with Mata Amritanandamayi) Volumes 1 to 9
My India, India Eternal. Swami Vivekananda. Ramakrishna Mission.

Evaluation Pattern

Assessment	Internal	End Semester
CIA– Sketch Book evaluation	20	
CIA- Lab session assessment	40	
Mid-Term Examination	20	
End Semester		20

SEMESTER II

19ENG111	TECHNICAL COMMUNICATION	L-T-P-C: 2-0-3-3

Course Objectives

- To introduce the students to the fundamentals of mechanics of writing
- To facilitate them with the style of documentation and specific formal written communication
- To initiate in them the art of critical thinking and analysis
- To help them develop techniques of scanning for specific information, comprehension and organization of ideas
- To enhance their technical presentation skills

Course Outcome

CO1: To gain knowledge about the mechanics of writing and the elements of formal Correspondence.
CO2: To understand and summarise technical documents
CO3: To apply the basic elements of language in formal correspondence
CO4: To interpret and analyze information and to organize ideas in a logical and coherent manner.
CO5: To compose project reports/ documents, revise them for language accuracy and make technical presentations

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1										3				
CO2				1						2				
CO3										3				
CO4				1						2				
CO5									2	1				

Syllabus

Unit 1
Mechanics of Writing: Grammar rules -articles, tenses, auxiliary verbs (primary & modal) prepositions, subject-verb agreement, pronoun-antecedent agreement, discourse markers and sentence linkers
General Reading and Listening comprehension - rearrangement & organization of sentences

Unit 2
Different kinds of written documents: Definitions- descriptions- instructions-recommendations- user manuals - reports – proposals
Formal Correspondence: Writing formal Letters
Mechanics of Writing: impersonal passive & punctuation
Scientific Reading & Listening Comprehension

Unit 3

Technical paper writing: documentation style - document editing – proof reading - Organising and formatting
Mechanics of Writing: Modifiers, phrasal verbs, tone and style, graphical representation
Reading and listening comprehension of technical documents
Mini Technical project (10 -12 pages)
Technical presentations

Reference(s)

Hirsh, Herbert. L "Essential Communication Strategies for Scientists, Engineers and Technology Professionals". II Edition. New York: IEEE press, 2002
Anderson, Paul. V. "Technical Communication: A Reader-Centred Approach". V Edition. Harcourt Brace College Publication, 2003
Strunk, William Jr. and White. EB. "The Elements of Style" New York. Alliyan& Bacon, 1999.
Riordan, G. Daniel and Pauley E. Steven. "Technical Report Writing Today" VIII Edition (Indian Adaptation). New Delhi: Biztantra, 2004.
Michael Swan. '' Practical English Usage'', Oxford University Press, 2000

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (CA)	10	
Lab	40	
End Semester		30

•CA – Can be Quizzes, Assignment, Projects, and Reports

19MAT115	DISCRETE MATHEMATICS	L-T-P-C: 3-1-0-4

Course Objectives

- Familiar various concepts in logic and proof techniques.
- Understand the concepts of various types of relations, partial ordering and equivalence relations.
- Understand the concepts of generating functions and apply to solve the recurrence relations.
- Familiar basic results in number theory and understand it applications in information security.

Course Outcomes

CO1: Understand the basic concepts of Mathematical reasoning and basic counting techniques. Also understand the different types of proves like mathematical induction.
CO2: Understand the concepts of various types of relations, partial ordering and equivalence relations.
CO3: Apply the concepts of generating functions to solve the recurrence relations.
CO4: Apply the concepts of divide and conquer method and principle of inclusion and exclusion to solve some simple algorithms in discrete mathematics.
CO5: Understand various definitions in number theory and study their properties.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									
CO2	3	3	2									
CO3	3	3	2									
CO4	3	2	1									
CO5	2	3	2									

Syllabus

Unit 1
Logic, Mathematical Reasoning and Counting: Logic, Prepositional Equivalence, Predicate and Quantifiers, Theorem Proving, Functions, Mathematical Induction. Recursive Definitions, Recursive Algorithms, Basics of Counting, Pigeonhole Principle, Permutation and Combinations. (Sections: 1.1 -1.3, 1.5 -1.7, 2.3, 4.1 - 4.4, 5.1 - 5.3 and 5.5)

Unit 2
Relations and Their Properties: Representing Relations, Closure of Relations, Partial Ordering, Equivalence Relations and partitions. (Sections: 7.1, 7.3 - 7.6)
Advanced Counting Techniques and Relations: Recurrence Relations, Solving Recurrence Relations, Generating Functions, Solutions of Homogeneous Recurrence Relations, Divide and Conquer Relations, Inclusion-Exclusion. (Sections: 6.1 - 6.6)

Unit 3
Number Theory: Divisibility and Factorization**b.** Simultaneous linear congruences, Chinese Remainder Theorem. Wilson's Theorem, Fermat's Theorem, pseudoprimes and Carmichael numbers, Euler's Theorem. Arithmetic functions and Quadratic residues:

Text Book(s)
Kenneth H. Rosen, "Discrete Mathematics and its Applications", Tata McGraw- Hill Publishing Company Limited, New Delhi, Sixth Edition, 2007.
James Strayer, Elementary Number Theory, Waveland Press, 2002.

Reference(s)

R.P. Grimaldi, "Discrete and Combinatorial Mathematics", Pearson Education, Fifth Edition, 2007.
Thomas Koshy, "Discrete Mathematics with Applications", Academic Press, 2005.
Liu, "Elements of Discrete Mathematics", Tata McGraw- Hill Publishing Company Limited , 2004.

Evaluation Pattern: 50:50

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC111	DIGITAL CIRCUITS AND SYSTEMS	L-T-P-C: 3-1-0-4

(Pre-Requisite: Basic knowledge about binary systems, switches and transistors)

Course Objective

- To understand number representation and conversion between different representation in digital electronic circuits.
- To analyze logic processes and implement logical operations using combinational logic circuits.
- To understand concepts of sequential circuits and to analyze sequential systems in terms of state machines.

Course Outcomes

CO1: Ability to understand the basics of Boolean logic, number system and codes for representing Boolean variables.
CO2: Ability to develop Boolean equations and truth tables for synthesis using different logic gates.
CO3: Ability to make student understand analysis and synthesis of multiple output function and its optimization
CO4: Ability to design of various combinational circuits
CO5: Ability to understand various sequential circuit elements and its conversions
CO6: Ability to develop various synchronous sequential circuits and analyze.

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	3	2	1	1	1	3	
CO2	3	3	1	2	2	1	3	
CO3	3	3	2	3	1	1	3	1
CO4	3	3	2	3	1	1	3	1
CO5	3	2	2	3	1		3	1
CO6	3	3	2	3	1		3	1

.
Keywords: Digital Circuit, Flipflops, Register, Memory.

Module I: Introduction to logic families: ECL – TTL - Tri state logic. Implementation technology: Transistor switches - NMOS logic gates - CMOS logic gates - Negative logic systems. Introduction to logic circuits: Variables and functions, inversion- Truth tables- Logic gates and Networks- Boolean algebra - Synthesis using gates - Design examples - Optimized implementation of logic functions: Karnaugh map - Strategy for minimization - Minimization of product of sums forms - Incompletely specified functions - Multiple output circuits - Tabular method for minimization - Number representation and arithmetic circuits**:** Addition of unsigned numbers- Signed numbers-Fast adders.
Module II: Combinational circuit building blocks: Multiplexers - Decoders - Encoders - Code converters - Arithmetic comparison circuits. Sequential circuit building blocks: Basic latch - Gated SR latch - Gated D latch - Master slave and edge triggered - D flip-flops - T flip-flop - JK flip-flop - Registers - Counters - Reset synchronization - Other types of counters.
Module III: Synchronous sequential circuits: Basic design steps - State assignment problem - Mealy state model - Serial adders - State minimization. Asynchronous sequential circuits:Analysis of asynchronous circuits.

Textbooks/Referene(s):

Stephen Brown, ZvonkoVranesic, "Fundamentals of Digital Logic with VerilogDesign", Tata McGraw Hill Publishing Company Limited, Second Edition.
M Morris Mano, Micheal D Ciletti "Digital Design with an introduction to the Verilog HDL", Pearson Education, Fifth Edition, 2013
Donald D Givone, "Digital Principles and Design", Tata McGraw Hill Publishing Company Limited, 2003
John F. Wakerly, "Digital Design Principles and Practices", Pearson Education, 3rd Ed, 2003.

Evaluation Pattern: 50:50

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE102	COMPUTER PROGRAMMING	L-T-P-C: 3-

Course Objectives

- To provide the foundations of programming
- To provide necessary skills to understand and analyze a given program
- To provide necessary skills to effectively use programming constructs while developing solutions for problem scenarios.

Course Outcomes

CO1: Ability to understand the typical programming constructs.
CO2: Ability to understand and analyze a given program by tracing, identify coding errors and debug them.
CO3: Ability to make use of the programming constructs appropriately and effectively.
CO4: Ability to develop computer programs that implement suitable algorithms for problem scenarios and applications.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1													
CO2	1	1	1											
CO3	1	2	2											
CO4	2	3	2											

Keywords:

Computer programming, programming constructs, program tracing, debugging, program synthesis.

Contents

Introduction and Review of C language constructs. Functions – inter function communication – standard functions –scope. Recursion – recursive definition – recurivse solution – designing recursive functions – limitations of recursion –Arrays – 1D numeric – searching and sorting – 2D numeric arrays.
Pointers: introduction – compatibility – arrays and pointers – Dynamic memory allocation – arrays of pointers – pointer arithmetic – Strings: fixed length and variable length strings – strings and characters – string input – output –array of strings – string manipulation functions – sorting of strings.
Structures: structure vs array comparison – complex structures – structures and functions – Union – Files and streams –file input output – command line arguments.

Textbooks/Reference(s)

Behrouz A. Forouzan and Richard F. Filberg, "Computer Science A Structured Programming Approach Using C", Third Edition, Cengage Learning, 2006.
Brian W. Kernighan and Dennis M. Ritchie, "*The C Programming Language*", Second Edition, Prentic Hall, 1988.
Eric S. Roberts, "*Art and Science of C*", Addison Wesley, 1995.
Jeri Hanly and Elliot Koffman, "*Problem Solving and Program Design in C*", Fifth Edition, AddisoWesley (Pearson), 2007.

Evaluation Pattern: 50:50

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports.

19EAC112	SOLID STATE DEVICES	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce physics of semiconductor devices and the principles of their operation.
- To focus on current transport across semiconductor junctions, pn diodes, fundamentals of transistor electrical behavior, and band diagrams of these devices.
- To introduce students to the inner working of semiconductor devices such as PN junction diodes, MOSFETs, and BJTs, and will help understand parameters that control their electrical behavior.

Course Outcomes

CO1: Ability to understand the basics of semiconductor physics, concepts such as doping, diffusion and drift of carriers, drift velocity, mobility, diffusion equation.
CO2: Ability to analyze the continuity equation, and comprehend semiconductor behavior using band diagrams
CO3: Ability to apply the concepts of carrier transport and energy bands towards semiconductor devices such as PN junctions, MOSFET, and BJT.
CO4: Ability to understand the principles and electrical characteristics of MOS capacitors and MOSFETs.
CO5: Ability to understand the concept of scaling and short channel effects such as DIBL, GIDL etc.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	3
CO2	3	3	-	-	1	-	-	-	-	-	-	-	3	3
CO3	3	3	-	1	1	-	-	-	-	-	-	-	3	2
CO4	3	3	-	1	1	-	-	-	-	-	-	-	3	1
CO5	3	3	-	2	1	-	-	-	-	-	-	-	3	2

Syllabus

Module I : Review of Semiconductor basics - Extrinsic and intrinsic semiconductors - Density of states - Equilibrium Carrier concentrations - Drift velocity and mobility - Hall effect - Diffusion of Carriers - Built in fields - Excess Carriers – generation and recombination – continuity equation – time independent diffusion equations under low level injection – minority carrier diffusion - Haynes Shockley Experiment – Total current density

Module II: Basic structure of PN junctions – Built-in-potential – Space Charge region – electric field across junction - qualitative description in forward and reverse bias – band diagram – minority carrier distribution across junction in forward and reverse bias - boundary conditions - derivation of ideal IV relation across PN junction – PN junction IV characteristics - junction capacitance – junction breakdown – Metal-Semiconductor Junctions – Basics of MOSFET – Ideal MOS Capacitor – band diagram of MOS.

Module III: Effect of Real surface – Threshold Voltage – MOS Capacitance Voltage Characteristics – Current Voltage characteristics – MOSFET Output characteristics – Transfer Characteristics – Subthreshold characteristics – Short Channel effects – Substrate bias effect – Scaling and Hot carrier effects – Drain Induced Barrier Lowering. Fundamentals of BJT Operation – Modes – Amplification – Minority Carrier Distribution and Terminal Currents – generalized biasing.

Text Book(s)

Ben G. Streetman and Sanjay Kumar Banerjee, "Solid State Electronic Devices", Prentice Hall India, Sixth Edition, 2009.

Donald A. Neamen, "Semiconductor Physics and Devices: Basic Principles", McGraw-Hill International, Third Edition, 2003.

Reference(s)

S. M. Sze and Kwok K. NG, "Physics of Semiconductor Devices", John Wiley and Sons, Inc., Third Edition, 2007.

S. O. Kasap, "Principles of Electronic Materials and Devices", Tata McGraw Hill, Third Edition, 2007.

Evaluation Pattern: 50:50

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC181	DIGITAL SYSTEM LAB	L-T-P-C:0-0-3-1

Course Outcomes

CO1: Ability to familiar with digital gates and implementing Boolean logics.
CO2: Ability to implement ALU circuits.
CO3: Ability to construct and analyze sequential circuits.
CO4: Ability to construct the synchronous and asynchronous circuits.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	2	2	-	-	-	-	-	-	-	-	-	2	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-	2	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-	2	-

1. Familiarization of Digital trainer Kit and study of logic gates
2. Realization of Boolean expressions using logic gates
3. Realization of Boolean expressions using universal gates
4. Realization of code converters
5. Design of Adders/Subtractors
6. Design of Multiplexers/De-Multiplexers
7. Design of Encoders/Decoders
8. Study of flip-flops
9. Design of Synchronous counters
10. Design of Asynchronous counters

Text Book(s)

Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital logic with Verilog Design", Tata McGraw Hill Publishing Company Limited, Special Indian Edition, 2007.
M Morris Mano and Michael D Ciletti, "Digital Design with Introduction to the Verilog HDL", Pearson Education, Fifth Edition, , Fifth Edition, 2015

Reference(s)

John F. Wakerly, "Digital Design Principles and Practices", Pearson Education, Fourth Edition, 2008.
K A Navas, "Electronic Lab Manual" – Volume 1, Fifth Edition, Prentice Hall of India, 2015.

Evaluation Pattern 80:20 (Internal: External)

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

•CA – Can be Quizzes, Assignment, Projects, and Reports

19MEE181	MANUFACTURING PRACTICE	L-T-P-C: 0-0-3-1

Course Objectives

- To introduce basic concepts pertaining to product dismantling and assembly
- To familiarize basic pneumatic components; design and validate simple circuits
- To familiarize sheet metal tools and operations
- To provide hands-on training on welding and soldering
- To introduce basic plumbing tools and process
- To inculcate the fundamental principle of operation and applications of 3D printing

Course Outcomes

CO1: Dismantle and assemble various products
CO2: Design and simulate pneumatic and electro-pneumatic circuits
CO3: Fabricate sheet metal objects.
CO4: Performance welding and soldering operations
CO5: Make simple plumbing joints.
CO6: Design and build simple geometries using 3D printers

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1							2	1		1	1	
CO2	2	2	1		1				2	1		1	1	1
CO3	2	2							2	1		1	1	
CO4	2	1							2	1		1	1	
CO5	2		2		2							1	1	1
CO6	2	2	1		1				2	1		1	1	1

Syllabus

Unit 1
Product Workshop : Disassemble the product of sub assembly-Measure various dimensions using measuring instruments-Free hand rough sketch of the assembly and components-Name of the components and indicate the various materials used-Study the functioning of the assembly and parts-Study the assembly and components design for compactness, processing, ease of assembly and disassembly-Assemble the product or subassembly.

Unit 2
Pneumatic and PLC Workshop: Study of pneumatic elements-Study of PLC and programming. Design and simulation of simple circuits using basic pneumatic elements-Design and simulation of simple circuits using electro-pneumatics.

Unit 3
Sheet Metal Workshop: Study of tools and equipment - Draw development drawing of simple objects on sheet metal (cone, cylinder, pyramid, prism, tray etc.)-Fabrication of components using small shearing and bending machines-Riveting practice.

Unit 4
Welding, Soldering and Plumbing Workshops
Study of tools and equipment - Study of various welding & soldering methods-Arc welding practice - fitting, square butt joint and lap joint - Soldering practice. Plumbing tools – Make a piping joint to a simple piping layout (should include cutting, threading and pipe fixing)

Unit 5

3D-Printing Workshop: Introduction to Additive Manufacturing process, Fused Filament Fabrication, Materials for 3D printing, Process parameters, CAD for 3D printing, G code generation, 3D printing of simple geometries, Applications of 3D printing.

(Note: Classes will be conducted in sequence. End-Semester exam will be conducted in the last class of the semester)

Reference(s)

Concerned Workshop Manuals

Evaluation Pattern:

Assessment	Internal	End Semester
*Continuous Assessment (CA)	80	
End semester		20

•CA – Can be Quizzes, Assignment, Projects, and Reports

19CUL111	CULTURAL EDUCATION II	L-T-P-C: 2-0-0-2

Course Objective

To deepen students' understanding and further their knowledge about the different aspects of Indian culture and heritage. To instill into students a dynamic awareness and understanding of their country's achievements and civilizing influences in various fields and at various epochs. To bring a greater ability to deal with life's challenges by helping students towards a balanced and harmonized personality.

Course Outcome

CO1: To get an overview of India's contribution to the world in the field of art, architecture, and science; to understand the foundational concepts of ancient Indian education system; to glean insights from Mahabharata.
CO2: Learn the important concepts of Vedas, Vedangas, and Yogasutras for the refinement of personality**.**
CO3: Familiarize themselves with the Bhagavad-Gita and its relevance to daily life; Understand the sagacity of Chanakya; Role of Women in ancient Indian society.
CO4: To understand the principles of Yoga and its applicability through practice.
CO5: Gain a deep understanding of the underlying principles of diverse traditions of worship.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												
CO2	3	3	2	2	2	3	2							
CO3	1		3				3							
CO4			3	2			3							
CO5			3				3							

Syllabus

Unit1
To the World from India; Education System in India; Insights from Mahabharata; Human Personality. India's Scientific System for Personality Refinement.

Unit2
The Vedas: An Overview; One God, Many Forms; Bhagavad Gita – The Handbook for Human Life; Examples of Karma Yoga in Modern India.

Unit-3
Chanakya's Guidelines for Successful Life; Role of Women; Conservations with Amma.

Text Book(s)
Cultural Education Resource Material Semester-2

Reference Book(s)
Cultural Heritage of India. R.C.Majumdar. Ramakrishna Mission Institute of Culture.
The Vedas. Swami ChandrashekharaBharati. BharatiyaVidyaBhavan.
Indian Culture and India's Future. Michel Danino. DK Publications.
The Beautiful Tree. Dharmapal. DK Publications.
India's Rebirth. Sri Aurobindo. Auroville Publications.

Evaluation Pattern

Assessment	Internal	End Semester
CIA– Sketch Book evaluation	20	
CIA- Lab session assessment	40	
Mid-Term Examination	20	
End Semester		20

SEMESTER III

19MAT209	LINEAR ALGEBRA AND OPTIMIZATION TECHNIQUES	L-T-P-C:

Course Objectives

The course is expected to enable the students

- To solve simultaneous algebraic equations using methods of matrix algebra.
- To use vector space methods and diagonalization in practical problems.
- To understand the concept of search space and optimality for solutions of engineering problems.
- To understand some computation techniques for optimizing single variable functions.
- To carry out various computational techniques for optimizing severable variable functions.

Course Outcomes

CO1: Understand the basic concepts of vector space, subspace, basis and dimension.
CO2: Understand the basic concepts of inner product space, norm, angle, Orthogonality and projection and implementing the Gram-Schmidt process, to obtain least square solution.
CO3: Understand the concept of linear transformations, the relation between matrices and linear transformations, kernel, range and apply it to change the basis, to get the QR decomposition, and to transform the given matrix to diagonal/Jordan canonical form.
CO4: Understand different types of Optimization Techniques in engineering problems. Learn Optimization\ methods such as Bracketing methods, Region elimination methods, Pointestimation methods.
CO5: Understand the Optimality criteria for functions in several variables and learn to apply OT methods like unidirectional search and direct search methods.
CO6: Learn constrained optimization techniques. Learn to verify Kuhn-Tucker conditions and Lagrangian Method.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									
CO2	3	3	2									
CO3	3	3	2									
CO4	3	2	1									
CO5	2	1	2									

Syllabus

Linear Algebra
Review of matrices and linear systems of equations.

Vector Spaces: Vector spaces - Sub spaces - Linear independence - Basis - Dimension - Inner products - Orthogonality - Orthogonal basis - Gram Schmidt Process - Change of basis. Orthogonal complements - Projection on subspace - Least Square Principle.

Linear Transformations: Positive definite matrices - Matrix norm and condition number - QR- Decomposition - Linear transformation - Relation between matrices and linear transformations - Kernel and range of a linear transformation.

Optimization:
Introduction: Optimization - optimal problem formulation, engineering optimization problems, optimization algorithms, numerical search for optimal solution.

Single Variable optimization: Optimality criteria, bracketing methods - exhaustive search method, bounding phase method- region elimination methods - interval halving, Fibonacci search, golden section search, point estimation method- successive quadratic search, gradient based methods.

Multivariable Optimization: Optimality criteria, unconstrained optimization - solution by direct substitution, unidirectional search – direct search methods evolutionary search method, simplex search method, Hook-Jeeves pattern search method, gradient based methods – steepest descent, Cauchy's steepest descent method, Newton's method, conjugate gradient method - constrained optimization. Kuhn-Tucker conditions.

Text Book(s)

Howard Anton and Chris Rorrs, "Elementary Linear Algebra", Ninth Edition, John Wiley & Sons, 2000.
S.S. Rao, "Optimization Theory and Applications", Second Edition, New Age International (P) Limited Publishers, 1995.

Reference(s)

D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
Gilbert Strang, "Linear Algebraand its Applications", Third Edition, Harcourt College Publishers, 1988.
Kalyanmoy Deb, "Optimization for Engineering Design Algorithms and Examples", Prentice Hall of India, New Delhi, 2004.
Edwin K.P. Chong and Stanislaw H. Zak, "An Introduction to Optimization", Second Edition, Wiley-Interscience Series in Discrete Mathematics and Optimization, 2004.
M. Asghar Bhatti, "Practical Optimization Methods: with Mathematics Applications", Springer Verlag Publishers, 2000.

Evaluation Pattern:

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC204	COMPUTER ORGANIZATION AND ARCHITECTURE	L-T-P-C: 3-0-0-3

Course Objectives

- To conceptualize the basics of organizational and architectural issues of a digital computer.
- To analyze performance issues in processor and memory design of a digital computer.
- To understand various data transfer techniques in digital computer.
- To analyze processor performance improvement using instruction level parallelism

Course Outcomes

CO1: Ability to understand the design principles of Instruction Set Architecture (ISA).
CO2: Ability to design, Implementation and Analysis of data path for instruction execution.
CO3: Ability to understand design of instruction and analyze and evaluate the performance of processors.
CO4: Ability to uunderstand Pipelined architecture and Design of 3 and 5 stage pipeline processor in MIPS
CO5: Ability to uunderstand the working of Arithmetic and Logic Unit
CO6: Ability to uunderstanding the concepts of Memory Organization

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	3	1										3	2
CO 2	3	3	3	2	2								3	2
CO 3	2	2	2							1		1	3	2
CO 4	2	2	3	2						1		1	3	2
CO 5	2	2	2	2	1					1		1	3	2
CO 6	2	2											3	2

Keywords: Data Path, Cache, Memory, CISC, RISC.

Module I: Introduction to computer system - Brief history of computer systems- Fixed point arithmetic – Addition – Subtraction -Multiplication and division - Booth's algorithm - Non-restoring division algorithm - Floating point arithmetic. Various addressing modes and designing of an Instruction set.

Module II: Data path and controller design - Introduction to CPU design -Processor organization -Execution of complete instruction- Design of control unit - Micro programmed control unit

Module III: Memory and system organization - Concepts of semiconductor memory - CPU-memory interaction - Organization of memory modules - Cache memory and related mapping and replacement policies - Virtual memory. Introduction to input/output processing: Programmed controlled I/O transfer - Interrupt controlled I/O transfer DMA - Secondary storage and type of storage devices - Introduction to buses - Introduction to RISC and CISC paradigm - Design issues of a RISC processor and example of an existing RISC processor - Introduction to pipelining.

Text Book/Reference(s)

John P.Hayes, "Computer architecture and Organisation", Tata McGraw-Hill, Third edition 1998.
V.CarlHamacher, Zvonko G. Varanesic and Safat G. Zaky, "Computer Organisation", Fifth edition, McGraw-Hill Inc, 1996.
Morris Mano, "Computer System Architecture", Prentice-Hall of India, 2000.
BehroozParhami, "Computer Architecture", Oxford Press.
P.Pal Chaudhuri, , "Computer organization and design", 2nd Ed., Prentice Hall of India,2007.
G.Kane&J.Heinrich, "MIPS RISC Architecture", Englewood cliffs, New Jersey, Prentice Hall, 1992.

Evaluation Pattern: 50:50

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC203	DATA STRUCTURES AND ALGORITHMS	L-T-P-C: 2-0-3-3

Course Objectives

- To Develop a solid understanding of the theory and implementation of data structures, algorithms and associated implementation.
- To Cover the theory of data structures and algorithms and complement it with an implementation of each topic covered in the units below.

Course Outcomes

CO1: Ability to implement linear and non-linear data structure operations using C
CO2: Ability to solve problems using appropriate data structures
CO3: Ability to analyze the algorithms and its complexity
CO4: Ability to employ sorting and searching algorithms using relevant data structures

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	-	-	3	3	-	3	3	-
CO2	3	3	-	3	-	-	-	-	3	3	-	-	3	-
CO3	3	3	3	3	-	-	-	-	3	3	-	3	3	-
CO4	3	3	-	3	3	-	-	-	3	3	-	-	3	-

Module I:

Introduction: Overview of Data Structures – A Philosophy of Data Structures - The Need for Data Structures – Cost and Benefits - Abstract Data Types and Data Structures - Principles, and Patterns. Basic complexity analysis – Best, Worst, and Average Cases - Asymptotic Analysis - Analyzing Programs – Space Bounds, Arrays, Linked Lists and Recursion: Using Arrays - Lists - Array based List Implementation – Linked Lists – LL ADT – Singly Linked List – Doubly Linked List – Circular Linked List – recursion - linear, binary, and multiple recursions.
Stacks and Queues: Stack ADT - Array based Stacks, Linked Stacks – Implementing Recursion using Stacks, Queues - ADT, Array based Queue, Linked Queue, Double-ended queue, Circular queue.
Lab component to focus primarily on implementation of Dynamic arrays, inked lists, recursive operations, and queues.

Module II

Trees: Tree Definition and Properties – Tree ADT - Basic tree traversals - Binary tree - Data structure for representing trees – Linked Structure for Binary Tree – Array based implementation. Priority queues: ADT – Implementing Priority Queue using List – Heaps. Maps and Dictionaries: Map ADT – List based Implementation – Hash Tables - Dictionary ADT - Skip List – Complexity.
Lab component to focus primarily on implementation of trees, queues, and lists and corresponding topics covered in this unit.

Module III
Search trees – Binary search tree, AVL tree, Trees – K-D Trees - B-Trees. Sorting and Selection – Linear Sorting – Heap Sort - Divide and Conquer Strategy – Analysis using Recurrence Tree based Method - Merge Sort - Quick Sort - Studying Sorting through an Algorithmic Lens – Selection – External Memory Sorting and Searching. Graphs: ADT- Data structure for graphs - Graph traversal - Transitive Closure - Directed Acyclic graphs - Weighted graphs – Shortest Paths - Minimum spanning tree – Greedy Methods for MST.
Lab component focuses primarily on implementation of algorithms covered in this unit.
Final project lab exercise to build a real-life use-case using data structures and algorithms covered in this class.

TEXT BOOK(S)

Goodrich M T and Tamassia R, "Data Structures and Algorithms in Java", Fifth edition, Wiley publication, 2010.
Clifford A. Shaffer, "Data Structures and Algorithm Analysis", Third Edition, Dover Publications, 2012.

REFERENCES

Goodrich M T, Tamassia R and Michael H. Goldwasser, "Data Structures and Algorithms in Python++", Wiley publication, 2013.
Tremblay J P and Sorenson P G, "An Introduction to Data Structures with Applications", Second Edition, Tata McGraw-Hill, 2002.

Evaluation Pattern: 50:50

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC205	MATHEMATICS OF SIGNAL PROCESSING	L-T-P-C: 3-0-0-3

(Prerequisites – Basic knowledge of Differentiation, Integration and Complex numbers)

Course Objectives

- To introduces the basic principles of signals and system analysis.
- To cover various basic tools of signal and system analysis such as signal classification, LTI systems and its properties, Convolution, Frequency Response, Laplace transform, Z transform and Fourier analysis.
- To make the students understand and analyze various important concepts such as convolution, impulse/ frequency response, causality, stability of systems will be especially emphasized.

Course Outcomes

CO1: Ability to represent the basic continuous time and discrete time signals and systems.
CO2: Ability to understand the spectral characteristics of continuous / discrete-time periodic and aperiodic signals using Fourier analysis.
CO3: Ability to analyze system properties based on impulse response and Fourier analysis.
CO4: Ability to analyze and characterize LTI system using transforms.

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	2	2	-	-	-	-	-	-	-	-	2	3	2
CO4	3	3	2	-	-	-	-	-	-	-	-	2	3	2

Keywords: Signals, Systems, LTI, Convolution, Fourier analysis, Sampling.

Module I:
Introduction: Signals: Classification of signals, Continuous - Discrete time; Even/Odd signals, Periodic/ Non-periodic signals, Deterministic/Random signals, Energy/Power signals; Basic operations on signals: Basic (Continuous/Discrete) signals - unit step, unit impulse, sinusoidal and complex exponential signals etc. Systems (Continuous/Discrete): Representation, Classification - Linear/Nonlinear, Causal/Non-causal, Time invariant/Time variant, with/ without memory; BIBO stability, Feedback system. LTI system – Response of LTI system, Convolution, Properties (Continuous/Discrete); LTI systems – Differential/Difference equation representation and solution.

Module II:
Fourier series: Fourier series – half range expansions – Parseval's identity – Transform integrals – Fourier Integrals – theorem – Sine and cosine integrals. Fourier analysis of continuous time signals and systems: Fourier series for periodic signals; Fourier transform - Properties of continuous time FT. Sampling: Sampling theorem, Reconstruction of signal, Aliasing, Sampling of discrete time signals; Introduction to DFT and its properties.

Module III:
Laplace transform analysis of systems – Inverse transforms, linearity, shifting, Transforms of derivatives and integrals – ROC – Frequency response of continuous time LTI systems. Z transforms – definition – ROC – inverse transforms – properties, frequency response of discrete time LTI systems. Inter-relationship between different representations and transforms.

Text Book(s)/Reference(s)

Simon Haykin, Barry Van Veen, "Signals and Systems", Second Edition, John Wiley and Sons, 2005.

Alan V. Oppenheim, Alan S. Willsky ,S, Hamid Nawab, "Signals and Systems", Prentice Hall India Private Limited, 1997.

Michael. J. Roberts, "Fundamentals of Signals and Systems", First Edition, Tata McGraw Hill Publishing Company Limited, 2007.

Rodger E. Ziemer, William. H. Tranter, D. Ronald Fannin, "Signals and Systems", Fourth Edition, Pearson Education, 2004.

Evaluation Pattern: 50:50

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC201	ELECTRONIC CIRCUITS I	L-T-P-C: 3-0-0-3

(Pre-Requisite: Semiconductor device physics)

Course Objectives

- To understand operation of semiconductor devices
- To understand DC analysis and AC models of MOSFET and BJT.
- To use MOSFET and BJT as switches and amplifiers

Course Outcomes

CO1: Ability to understand diode characteristics and to design diode based circuits.
CO2: Ability to understand the operation of MOSFET.
CO3: Ability to design MOSFET based circuits.
CO4: Ability to understand BJT.
CO5: Ability to design and analyze BJT based circuits.

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	2	-	-	-	-	-	-	-	2	-
CO2	3	3	3	-	2	-	-	-	-	-	-	-	2	-
CO3	3	3	-	-	2	-	-	-	-	-	-	-	2	-
CO4	3	3	-	-	2	-	-	-	-	-	-	-	2	-

Keywords: Diode, MOSFET, BJT, Amplifier

Module I:

Diode Fundamentals: Diode characteristics - Physics of diode operation and modeling of diodes. Diode applications: Rectifiers - Clipper and clamper circuits - Voltage multipliers - Voltage regulator using zener diode.

Module II:

Field effect transistors: Introduction - Device structure and operation of JFET (Junction Field Effect Transistor) and MOSFETs - I-V characteristics of JFET and MOSFET - MOSFET applications – brief Analysis of MOS as a switch and as an amplifier, biasing, small signal analysis.

Module III:

Single stage MOS amplifiers (CS, CD, CG), MOS capacitances – Low frequency and Miller effect - MOS high frequency model and amplifier frequency analysis, cut off frequency fα and fβ unity gain and Determination of bandwidth of single stage - MOSFET current sources, introduction current mirrors.

Module IV:

Bipolar junction transistors: Introduction - Operation of BJT- I-V characteristics of BJT. BJT Applications: BJT biasing techniques - Analysis of BJT as a switch and as an amplifier (CE amplifier) – Small signal analysis.

Text Book(s)/Reference(s)

Sedra A and Smith K C, "Microelectronic circuits", Sixth Edition, Oxford University Press, 2010.
Neamen D A, "Electronic circuit analysis and design", McGraw Hill, 2001.
Boylestad R L and Nashelsky L, "Electronic devices and circuit theory", Upper Saddle River N.J., Pearson/Prentice Hall, Tenth Edition, 2009.
Millman J and C Halkias, "Integrated electronics", second edition, McGraw –Hill, 2010

Evaluation Pattern: 50:50

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19AVP201	**AMRITA VALUES PROGRAMME I**	**1 0 0 1**
19AVP211	**AMRITA VALUES PROGRAMME II**	**1 0 0 1**

Amrita University's Amrita Values Programme (AVP) is a new initiative to give exposure to students about richness and beauty of Indian way of life. India is a country where history, culture, art, aesthetics, cuisine and nature exhibit more diversity than nearly anywhere else in the world.

Amrita Values Programmes emphasize on making students familiar with the rich tapestry of Indian life, culture, arts, science and heritage which has historically drawn people from all over the world.

Students shall have to register for any two of the following courses, one each in the third and the fourth semesters, which may be offered by the respective school during the concerned semester.

Course Outcome

CO1: Understanding the impact of *itihasas* on Indian civilization with a special reference to the *Adiparva* of Mahabharata

CO2: Enabling students to importance of fighting *adharma* for the welfare of the society through Sabha and Vanaparva.

CO3: Understanding the nuances of dharma through the contrast between noble and ignoble characters of the epic as depicted in the Vana, Virata, Udyoga and Bhishma parvas.

CO4: Getting the deeper understanding of the Yuddha Dharma through the subsequent Parvas viz., Drona, Karna, Shalya, Sauptika Parvas.

CO5: Making the students appreciative of spiritual instruction on the ultimate triumph of dharma through the presentations of the important episodes of the MB with special light on Shanti, Anushasana, Ashwamedhika, Ashramavasika, Mausala, Mahaprasthanika and Swargarohana Parvas.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	2	2	3	3	3	-	3	-	-
CO2	-	-	-	-	-	3	3	3	3	2	-	3	-	-
CO3	-	-	-	-	-	3	2	3	3	3	-	3	-	-
CO4	-	-	-	-	-	3	-	3	3	3	-	3	-	-
CO5	-	-	-	-	-	3	-	3	3	2	-	3	-	-

Courses offered under the framework of Amrita Values Programmes I and II

Message from Amma's Life for the Modern World

Amma's messages can be put to action in our life through pragmatism and attuning of our thought process in a positive and creative manner. Every single word Amma speaks and the guidance received in on matters which we consider as trivial are rich in content and touches the very inner being of our personality. Life gets enriched by Amma's guidance and She teaches us the art of exemplary life skills where we become witness to all the happenings around us still keeping the balance of the mind.

Lessons from the Ramayana

Introduction to Ramayana, the first Epic in the world – Influence of Ramayana on Indian values and culture – Storyline of Ramayana – Study of leading characters in Ramayana – Influence of Ramayana outside India – Relevance of Ramayana for modern times.

Lessons from the Mahabharata

Introduction to Mahabharata, the largest Epic in the world – Influence of Mahabharata on Indian values and culture – Storyline of Mahabharata – Study of leading characters in Mahabharata – Kurukshetra War and its significance - Relevance of Mahabharata for modern times.

Lessons from the Upanishads
Introduction to the Upanishads: Sruti versus Smrti - Overview of the four Vedas and the ten Principal Upanishads - The central problems of the Upanishads – The Upanishads and Indian Culture – Relevance of Upanishads for modern times – A few Upanishad Personalities: Nachiketas, Satyakama Jabala, Aruni, Shvetaketu.

Message of the Bhagavad Gita
Introduction to Bhagavad Gita – Brief storyline of Mahabharata - Context of Kurukshetra War – The anguish of Arjuna – Counsel by Sri. Krishna – Key teachings of the Bhagavad Gita – Karma Yoga, Jnana Yoga and Bhakti Yoga - Theory of Karma and Reincarnation – Concept of Dharma – Concept of Avatar - Relevance of Mahabharata for modern times.

Life and Message of Swami Vivekananda
Brief Sketch of Swami Vivekananda's Life – Meeting with Guru – Disciplining of Narendra - Travel across India - Inspiring Life incidents – Address at the Parliament of Religions – Travel in United States and Europe – Return and reception India – Message from Swamiji's life.

Life and Teachings of Spiritual Masters India
Sri Rama, Sri Krishna, Sri Buddha, Adi Shankaracharya, Sri Ramakrishna Paramahamsa, Swami Vivekananda, Sri Ramana Maharshi, Mata Amritanandamayi Devi.

Insights into Indian Arts and Literature
The aim of this course is to present the rich literature and culture of Ancient India and help students appreciate their deep influence on Indian Life - Vedic culture, primary source of Indian Culture – Brief introduction and appreciation of a few of the art forms of India - Arts, Music, Dance, Theatre.

Yoga and Meditation
The objective of the course is to provide practical training in YOGA ASANAS with a sound theoretical base and theory classes on selected verses of Patanjali's Yoga Sutra and Ashtanga Yoga. The coverage also includes the effect of yoga on integrated personality development.

Kerala Mural Art and Painting
Mural painting is an offshoot of the devotional tradition of Kerala. A mural is any piece of artwork painted or applied directly on a wall, ceiling or other large permanent surface. In the contemporary scenario Mural painting is not restricted to the permanent structures and are being done even on canvas. Kerala mural paintings are the frescos depicting mythology and legends, which are drawn on the walls of temples and churches in South India, principally in Kerala. Ancient temples, churches and places in Kerala, South India, display an abounding tradition of mural paintings mostly dating back between the 9th to 12th centuries when this form of art enjoyed Royal patronage. Learning Mural painting through the theory and practice workshop is the objective of this course.

Course on Organic Farming and Sustainability
Organic farming is emerging as an important segment of human sustainability and healthy life. Haritamritam' is an attempt to empower the youth with basic skills in tradition of organic farming and to revive the culture of growing vegetables that one consumes, without using chemicals and pesticides. Growth of Agriculture through such positive initiatives will go a long way in nation development. In Amma's words "it is a big step in restoring the lost harmony of nature".

Benefits of Indian Medicinal Systems
Indian medicinal systems are one of the most ancient in the world. Even today society continues to derive enormous benefits from the wealth of knowledge in Ayurveda of which is recognised as a viable and sustainable medicinal tradition. This course will expose students to the fundamental principles and philosophy of Ayurveda and other Indian medicinal traditions.

Traditional Fine Arts of India
India is home to one of the most diverse Art forms world over. The underlying philosophy of Indian life is 'Únity in Diversity" and it has led to the most diverse expressions of culture in India. Most art forms of India are an expression of devotion by the devotee towards the Lord and its influence in Indian life is very pervasive. This course will introduce students to the deeper philosophical basis of Indian Art forms and attempt to provide a practical demonstration of the continuing relevance of the Art.

Science of Worship in India

Indian mode of worship is unique among the world civilisations. Nowhere in the world has the philosophical idea of reverence and worshipfulness for everything in this universe found universal acceptance as it in India. Indian religious life even today is a practical demonstration of the potential for realisation of this profound truth. To see the all-pervading consciousness in everything, including animate and inanimate, and constituting society to realise this truth can be seen as the epitome of civilizational excellence. This course will discuss the principles and rationale behind different modes of worship prevalent in India.

TEXT BOOKS/REFERENCES:

1. Rajagopalachari. C, *The Ramayana*

2. Valmiki, *The Ramayana*, Gita Press

19EAC281	MATHEMATICS OF SIGNAL PROCESSING I LAB	L-T-P-C: 0-0-3-1

Course Objectives

- To introduce MATLAB as a programming language and to explore the concepts learnt in Signals and Systems.
- To understand the abstract simulation environment and thereby use simulation as a method to generate data, perform operations on the data and to analyze the system in both time domain and frequency domain.

Lab sheets

1. Introduction to MATLAB
2. Generation of Sequences
3. Basic Operations on Signals
4. Properties of Systems
5. Convolution
6. Difference and Differential Equations
7. Frequency response of LTI systems
8. Frequency Domain Representation

Evaluation Pattern 80:20 (Internal: External)

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC202	NETWORK THEORY	L-T-P-C:3-0-0-3

Course Objectives

- To review the concepts of mesh and nodal analysis.
- To introduce the different network theorems for DC and AC analysis.
- To introduce transient analysis of first order and second order circuits.
- To introduce the basic concepts of filters and filter design.

Course Outcomes

CO1: Able to understand the mesh analysis and nodal analysis of circuits with dependent and independent sources.
CO2: Able to apply the basic concepts and theorems to the analysis of dc and ac networks.
CO3: Able to analyze the first and second order circuits in the time domain.
CO4: Able to determine the network parameters of any two port network.
CO5: Able to design and analyze passive filter circuits.

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	2	2	
CO2	3		-	-	-	-	-	-	-	-	-	2	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-	2	-

Keywords:

Kirchoffs Laws, Network Theorems, Transient Analysis, Network Parmeters.

Contents:

Module I:

Mesh current and node voltage analysis of circuits with independent and dependent sources. Network Reduction - Source transformation - Star-Delta transformation. Network Theorems : Thevenin and Norton'stheorems - Superposition theorem - Maximum power transfertheorem.

Module II:

Transient Analysis - Time domain analysis of first and second order circuits – source free excitation- with DC Excitation. Frequency response of Series and Parallel circuits - Resonance - Q-factor and Bandwidth.

Module III:

Two-port Networks - impedance - admittance – hybrid - transmission parameters. Passive filters as two port networks - poles and zeroes, filter design.

TEXT BOOKS/REFERENCES:

Charles K Alexander, Mathew N. O. Sadiku, Fundamentals of Electric circuits, Tata McGraw Hill, 2003.
D. Roy Chaudhary, Networks and Systems, New Age International Publisher, 2003.
John D. Ryder, Myril Baird Reedand W. L. Everitt, Foundation for Electric Network Theory, Prentice Hall of India, Second Edition, 2013.
M. E. Van Valkenburg, Network Analysis, Prentice Hall India Private Limited, Third Edition, 1999.

Evaluation Pattern: 50:50

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC282	ELECTRONICS CIRCUITS I LAB	L-T-P-C: 0-0-3-1

Course Objectives

- To be able to operate laboratory equipment.
- To be able to use datasheets and extract various device parameters.
- To set up and characterize simple electronic devices like diodes and transistors.
- To be able to design, prototype and troubleshoot simple electronic circuits using diodes and transistors.

Course Outcomes

CO1: Ability to handle and operate laboratory equipment.
CO2: Knowledge of how to use datasheets and extract information from them.
CO3: Practical ability to set up, troubleshoot and validate simple electronic circuits.
CO4: Ability to use simulation tools (PSpice) to understand and analyse circuits.

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	2	-	-	-	3	3	-	2	2	-
CO2	3	3	3	-	2	-	-	-	3	3	-	2	2	-
CO3	3	3	-	-	2	-	-	-	3	3	-	2	2	-
CO4	3	3	-	-	2	-	-	-	3	3	-	2	2	-

Keywords
Didoes; Transistors; Regulators; Amplifiers

1. Diode characterisation and rectifiers (HWR/FWR)
2. Voltage regulator using bridge rectifiers and zener diode
3. Clipper and Clampers using normal diode
4. PMOS/NMOS I-V characteristics (LT Space simulation also)
5. MOSFET Amplifier frequency response (CS,CD,CG) (LT Space simulation also)
6. Current mirror using MOSFET (LT Space simulation also)
7. BJT I-V characteristics (LT Space simulation also)
8. BJT Amplifier frequency response (CE) (LT Space simulation also).

Evaluation Pattern 80:20 (Internal: External)

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

•CA – Can be Quizzes, Assignment, Projects, and Reports

SEMESTER IV

19MAT205	PROBABILITY AND RANDOM PROCESS	L-T-P-C: 3-1-0-4

Course objectives

- To understand the concepts of basic probability and random variables.
- To understand some standard distributions and apply to some problems.
- To understand the concepts of random process, stationarity and autocorrelation functions.
- To understand markov process and markov chain and related concepts.

Course Outcomes

CO1: Understand the basic concepts of probability and probability Modelling.
CO2: Gain knowledge about statistical distributions of one and two dimensional random variables and correlations.
CO3: Understand the basic concepts of stochastic processes and the stationarity.
CO4: Understand the purpose of some special processes
CO5: Gain knowledge about spectrum estimation and spectral density function

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	-	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-
CO5	2	2	2	-	-	-	-	-	-	-	-	-

MODULE I
Review of probability concepts - conditional probability- Bayes theorem.
Random Variable and Distributions: Introduction to random variable – discrete and continuous random variables and its distribution functions- mathematical expectations – moment generating function and characteristic function.

MODULE II
Binomial, Poisson, Geometric, Uniform, Exponential, Normal distribution functions (moment generating function, mean, variance and simple problems) – Chebyshev's theorem.

MODULE III
Stochastic Processes:
General concepts and definitions - stationary in random processes - strict sense and wide sense stationary processes - autocorrelation and properties- special processes – Poisson points, Poisson and Gaussian processes and properties- systems with stochastic inputs - power spectrum- spectrum estimation, ergodicity –Markov process and Markov chain, transition probabilities, Chapman Kolmogrov theorem, limiting distributions classification of states. Markov decision process.

Text Book

Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, (2005) John Wiley and Sons Inc.

A. Papoulis, and Unni krishna Pillai, "Probability, Random Variables and Stochastic Processes", Fourth Edition, McGraw Hill, 2002.

Reference Books

J. Ravichandran, "Probability and Random Processes for Engineers", First Edition, IK International, 2015.

Scott L. Miller, Donald G. Childers, "Probability and Random Processes", Academic press, 2012.

Evaluation Pattern: 50:50

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC212	ELECTRONICS CIRCUIT II	L-T-P-C: 3-0-0-3

Course objectives

- To review the MOSFET characteristics and use MOSFET as amplifier, feedback etc.
- To provide a basic understanding about the differential amplifier and characteristics of differential amplifier.
- To make the students familiarize about the characteristics of Op-amp and Applications of Op-amp.

Course Outcomes

CO 1: Able to understand the construction of feedback circuits**.**
CO 2: Able to understand the various specification parameters of op-amp.
CO 3: Able to design and analyze linear and non-linear circuits with op-amps.
CO 4: Able to design and analyze ADC, DAC, oscillators and multivibrators.

CO – PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO3	2	3	3	-	-	-	-	-	-	-	-	-	3	-
CO4	2	3	3	-	-	-	-	-	-	-	-	-	3	-

Keywords:
Amplifier, feedback, differential amplifier, opamp.

Contents:

Module I:
Review of MOSFET characteristics and MOSFET as an amplifier. Amplifier parameters - Multistage amplifiers. Feedback: Introduction to the concept of feedback - positive and negative feedback - Properties of feedback - Feedback topologies - Non-ideal effects.

Module II:
Differential Amplifier: The MOS differential pair- Common-mode and Differential signals. Small-signal operation - Differential gain and CMRR. Operational amplifiers: Ideal op-amp- parameters and characteristics - Inverting and non-inverting amplifiers.

Module III:
Op-amp circuits: Difference Amplifiers - Instrumentation amplifiers – Adder – Subtractor – Integrator – Differentiator – Comparators- Schmitt trigger- Peak detector- Sample and hold circuits- Precision rectifiers- FLASH ADC, Dual-slope ADC – DVM- R-2R type DAC- Multivibrators - Monostable - Astable and Bistable - Oscillators: RC phase shift and Wein-bridge oscillators -555 Timer.

Text Book/ Reference(s)

Deitel. Deitel and Choffnes, "Operating System", Third edition, Prentice Hall, 2003.
Neamen D A, "Electronic circuit analysis and design", McGraw-Hill, 2001.
Franco S., "Design with operational amplifiers and analog integrated circuits", New York, McGraw-Hill, Third Edition, 2002.
Ramakant A. Gayakwad, "Op-amps and linear integrated circuit technology" Prentice Hall, Fourth Edition, 2000.
Application Notes and Data Sheets of ICs from various manufacturers.

Evaluation Pattern 50:50 (Internal: External)

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC213	DIGITAL SIGNAL PRPCESSING AND PROCESSORS	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the mathematical methods applied for signal processing.
- to provide a thorough understanding and working knowledge of signal processing techniques
- Design and Implementation of digital filters.

Course Outcomes

CO1: Ability to use concepts of trigonometry, complex algebra, Fourier transform, z-transform.
CO2: Ability select proper tools for time domain and frequency domain implementation-DFT FFT
CO3: Ability to design, implementation, analysis and comparison of digital filters.
CO4: Familiar with DSP processors.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	-	-	-	-	-	-	-	3	3	-
CO2	2	3	-	1	1	-	-	-	-	-	-	-	3	-
CO3	3	3	2	3	-	-	-	-	-	-	-	3	3	-
CO4	3	3	2	3	3	-	-	-	-	-	-	-	3	3

Keywords:
DTFT, DFT, FFT, Filters.

Contents:

Module I: Discrete Fourier transforms: Fourier Transform, Fourier analysis of discrete time signals and systems: Discrete time Fourier series – Discrete Time Fourier Transform - properties of DTFT – Introduction to DFT- properties of DFT – linear filtering methods based on DFT – FFT – efficient computation of the DFT of a 2N-point real sequences – correlation – use of FFT in linear filtering and correlation.

Module II: Digital filters: Introduction, specifications of practical filters, Characteristics of commonly used analog filters – IIR filters: design by approximation of derivatives – impulse invariance and Bilinear transformation – frequency transformations for analog and digital filters. FIR filters: symmetric and anti-symmetric FIR filters – design of linear phase FIR filter using Windows – FIR differentiators – Hilbert transforms – comparison of design methods for linear phase FIR filters

Module III: Digital filters realizations: Structures for IIR systems – direct form structures, cascade form structures, parallel form structures, Structures for FIR systems – direct form structures, Linear phase and cascade form structures.Applications of DSP - a few case studies. Elementary idea about the architecture and important instruction sets of TMS320C 5416/6713 processor, writing of small programs in assembly Language.

Text Book(s)/Reference(s)

John G Proakis, G. Manolakis, "Digital Signals Processing Principles, Algorithms, Applications", Prentice Hall India Private Limited, Fourth Edition, 2007.
Sanjit K. Mitra, "Digital Signal Processing. A Practical approach", Tata McGraw Hill Publishing Company Limited, 2005.
Allen V. Oppenheim, Ronald W. Schafer, "Discrete time Signal processing", Prentice Hall India Private Limited, Fifth Edition, 2000.
Digital Signal Processing-implementation using DSP microprocessors with examples from TMS320C54XX, Avtar Singh & S. Srinivasan, Cengage Learnings.

Evaluation Pattern 50:50 (Internal: External)

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC211	OPERATING SYSTEMS	L-T-P-C: 2-0-2-3

Course Objectives

- To make the students to understand the structure and implementation of modern operating systems, virtual machines and their applications.
- To summarize techniques for achieving process synchronization and managing resources like memory and CPU in an operation system.
- To compare and contrasts the common algorithms used for both pre-emptive and non-pre-emptive scheduling of tasks in operating systems (such a priority, performance comparison, and fair-share schemes).
- To give a broad overview of memory hierarchy and the schemes used by the operating systems to manage storage requirements efficiently.

Course Outcomes

CO1: Understand the architecture and functionalities of modern OS.
CO2: Understand and apply the algorithms for scheduling.
CO3: Understand and apply the algorithms for resource management
CO4: Apply semaphores and monitors for classical and real-world synchronization scenarios

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	-	-	-	-	-	-	-	-	-	2	3
CO2	2	2	3	1	-	-	-	-	-	-	-	-	2	3
CO3	2	2	3	1	-	-	-	-	-	-	-	-	2	3
CO4	2	3	3	1	-	-	-	-	-	-	-	-	2	3

Module I

Introduction to Operating Systems: Overview - Types of systems - Computer system operations - Hardware Protection - Operating systems services - System calls - System structure - Virtual machines. Process Management: Process concepts - Process scheduling - Operations on Process - Cooperating process - Interprocess communication - Multithreading models - Threading issues - Thread types - CPU scheduling –scheduling algorithms.

Module II

Process Synchronization: Critical section problem - synchronization hardware – Semaphores - Classical problems of synchronization - Critical regions – Monitors – Deadlocks - Deadlock characterization - Methods of handling deadlocks - Deadlock prevention – Avoidance - Detection and recovery.

Module III

Storage Management: Memory management – Swapping - Contiguous memory allocation. Paging – Segmentation - Segmentation with Paging - Virtual memory - Demand paging - Process creation – page replacement - Thrashing. File Systems: Directory structure - Directory implementation - Disk scheduling. Case study: Threading concepts in Operating systems, Kernel structures.

Text Book

Silberschatz and Galvin, "Operating System Concepts", Ninth Edition, John Wiley and Sons, 2012.

Reference(s)

Deitel. Deitel and Choffnes, "Operating System", Third edition, Prentice Hall, 2003.
Tannenbaum A S, "Modern Operating Systems", Third edition, Prentice Hall, 2007.
Stevens W R and Rago S A, "Advanced Programming in the Unix Environment", Second Edition, Addison-Wesley, 2008.
Gary Nutt, "Operating Systems", Third Edition, Addison Wesley, 2009

Evaluation Pattern 50:50 (Internal: External)

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC214	MICROPROCESSORS AND MICROCONTROLLERS	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the advanced features of an advanced RISC Microprocessor.
- To apply the knowledge of Embedded C Programming for configuring various peripherals of a microcontroller.
- To Design and Develop Microcontroller based solution for solving real world problems.

Course Outcomes:

CO1: Ability to understand microprocessor basics.
CO2: Ability to understand and analyse different microprocessor and microcontroller architectures.
CO3: Ability to familiarize Instruction sets.
CO4: Ability to develop Programming skills.
CO5: Ability to understand different Simulation Environments.
CO6: System Memory Architectures.

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	
CO3	3	3	3	-	-	-	-	-	3	3	-	-	2	-
CO4	3	3	3	3	2	-	-	-	3	3	-	-	3	3

Module I

8085 Microprocessor: Architecture – Functional block diagram - Registers, ALU, Bus Systems - Timing and Control Signals – Machine cycles and timing diagrams, memory & IO interfacing.

Module II

ARM Architecture: RISC Machine – Architectural Inheritance – Programmers Model. ARM Assembly Language Programming: Data Processing Instructions – Data Transfer Instructions – Control Flow Instructions. ARM Organization and Implementation: 3-stage Pipeline – 5-stage Pipeline – ARM Instruction Execution – ARM Implemenation – Coprocessor Interface. ARM Instruction Set – Architectural Support for High-Level Programming – Thumb Instruction Set.

Module III

Architectural Support for System Development: ARM memory Interface – AMBA Interface – The ARMulator – JTAG Boundary Scan Architecture – Embedded Trace. ARM Processor Cores: ARM7TDMI – ARM8 – ARM9TDMI – ARM10TDMI. Memory Hierarchy – Memory Size and Speed – ON-Chip Memory – Caches. Architecture Support for Operating System: ARM System Control Coprocessor – CP15 Protection Unit Registers – ARM MMU Architecture. ARM CPU Cores: ARM710T – ARM720T – ARM740T – ARM810 – Strong ARM SA-110.

Text Book(s)

Ramesh S Goankar, "Micropocessor Architecture: Programming and Applications with the 8085", Penram International, Fifth Edition, 2002.
Jochen Steve Furber, "ARM System-on-Chip Architecture", Addison Wesley Trade Computer Publications, Second Edition, 2000.

Reference(s)

Douglas V Hall, "Microprocessor and Interfacing: Programming and Hardware", McGraw Hill Inc,. New Delhi 2002.
Kenneth L Short, "Microprocessors and Programming Logic", Prentice Hall of India, Second Edition.
Andrew Sloss, Dominic Symes and Chris Wright, "ARM System Developers Guide", Elsevier, Third Edition, 2004.

Evaluation Pattern 50:50 (Internal: External)

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC283	DIGITAL SIGNAL PROCESSING AND PROCESSOR LAB	L-T-P-C: 0-0-3-1

Course Objectives:

- To introduce the efficient transforms in the frequency domain and analyze their properties.
- To develop knowledge in designing and developing systems suitable for various applications.
- To apply knowledge in designing filters for various domain.

Course Outcomes:

CO1: Able to understand the operation of signals and systems.
CO2: Able to compute DFT efficiently using different techniques
CO3: Able to analyze the characteristics of FIR and IIR filters under different constraints.
CO4: Able to demonstrate the applications of DSP systems for the given specifications.

Keywords:
Discrete Fourier transforms, FFT, FIR and IIR filters.

CO – PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	-	3	-
CO2	3	2	2	-	-	-	-	-	-	-	-	-	2	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-	2	-
CO4	3	2	2	1	-	-	-	-	-	-	-	-	2	2

1. Generation of signals
2. Sampling of analog signals and study of aliasing
3. Computation of DFT using direct /linear transformation method
4. Properties of DFT
5. Computation of 2-N point DFT of a real sequence by using an N point DFT just once.
6. Linear filtering using Overlap add / save method
7. Design of FIR filter (different windowing technique)
8. Design of IIR Butterworth filter
9. Applications of DSP - a few case studies
10 DSP Kit familiarization and case studies

Evaluation Pattern 80:20 (Internal: External)

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC284	ELECTRONIC CIRCUITS II LAB	L-T-P-C: 0-0-3-1

Course Objectives

- To be able to design, prototype and troubleshoot using Operational Amplifier
- To set up and characterize multivibrators and oscillators using Operational Amplifier
- To design and implement ADC and DAC and analyze.

Course Outcomes

CO 1: Able to characterize op-amp.
CO 2: Able to understand the various specification parameters of op-amp.
CO 3: Able to design, simulate, analyze and implement linear and non-linear circuits with op-amps.
CO 4: Able to design, simulate, analyze and implement sinusoidal oscillator circuits.

CO – PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	2	-	-	-	3	-
CO2	3	3	-	-	-	-	-	-	2	-	-	-	3	-
CO3	2	3	3	-	2	-	-	-	2	-	-	-	3	-
CO4	2	3	3	-	2	-	-	-	2	-	-	-	3	-

1. Differential amplifier
2. Op-amp Characterization
3. Inverting and non-inverting amplifier
4. Integrator, differentiator, summing amplifier.
5. Instrumentation amplifier
6. Schmitt trigger
7. Astable and monostable multivibrator
8. RC oscillator
9. Flash ADC
10. R-2R DAC

Evaluation Pattern 80:20 (Internal: External)

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC285	MICROCONTROLLER LAB	L-T-P-C: 0-0-3-1

Course Objectives

To understand the microcontroller programming and design simple embedded systems.

Course Outcomes

CO1: To understand the basic concepts of Embedded Systems and working of a general purpose 8-bimicroprocessor operations.
CO2: To write and interpret assembly program based on the instruction set of the microprocessor
CO3: To interpret the execution time for the 8085 assembly instructions based on the machine cycle and timing diagram and processor speed
CO4: To understand the ARM System-on-chip architecture using ARM assembly program
CO5: Analyze how to access Microcontroller ports using Embedded C program
CO6: Debugging and verification of Embedded program using a simulator and on the real microcontroller.
CO7: Develop problem solving skill to solve real world problems using Finite State Machine

CO-PO MAPPING

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	1	-	3	-	-	-	-	-	-	-	-	-	-
CO3	3	3	1	-	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	1	-	3	-	-	-	-	-	-	-	-	-	-
CO5	3	3	1	-	3	-	-	-	-	-	-	-	-	-	-
CO6	3	3	1	3	3	-	-	-	1	-	-	-	-	-	-
CO7	3	3	3	3	3	-	3	-	1	-	-	-	-	-	-

1. ARM Assembly program for Arithmetic and Logical Operations
2. ARM Assembly program for Multi-byte Operations
3. ARM Assembly program for Control Manipulation
4. ARM Assembly program for String Manipulation
5. ARM Assembly program for Thumb Instructions
6. Embedded C Programming using Keil Simulator
7. Simple C Programs
8. Port Programming
9. Peripheral Interfacing – Keypad, Motor, LED etc.

Textbooks

Steve Furber ―ARM system On Chip Architecture‖, Addison Wesley, 2000.
Jonathan W. Valvano, 'Embedded Systems: Introduction to ARM Cortex-M Microcontrollers', 2016.

Evaluation Pattern 80:20 (Internal: External)

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

•CA – Can be Quizzes, Assignment, Projects, and Reports

19SSK211	SOFT SKILLS I	L-T-P-C: 1-0-3-2

Course Outcome

CO 1 - Soft Skills: At the end of the course, the students would have developed self-confidence and positive attitude necessary to compete and challenge themselves. They would also be able to analyse and manage their emotions to face real life situations.

CO 2 - Soft Skills: Soft Skills: At the end of the course, the students would hone their presentation skills by understanding the nuances of content creation, effective delivery, use of appropriate body language and the art of overcoming nervousness to create an impact in the minds of a target audience.

CO 3 - Aptitude: At the end of the course, the student will have acquired the ability to analyze, understand and classify questions under arithmetic, algebra and logical reasoning and solve them employing the most suitable methods. They will be able to analyze, compare and arrive at conclusions for data analysis questions.

CO 4 – Verbal: At the end of the course, the students will have the ability to dissect polysyllabic words, infer the meaning, inspect, classify, contextualise and use them effectively.

CO 5 - Verbal: At the end of the course, the students will have the ability to understand the nuances of English grammar and apply them effectively.

CO 6 – Verbal: At the end of the course, the students will have the ability to identify, analyse and interpret relationship between words and use the process of elimination to arrive at the answer. They will also have the ability to judge, evaluate, summarise, criticise, present and defend their perceptions convincingly.

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								2	3	3		3
CO2									2	3		3
CO3		3		2								
CO4										3		3
CO5										3		3
CO6									3	3		3

Soft skills and its importance: Pleasure and pains of transition from an academic environment to work - environment. Need for change. Fears, stress and competition in the professional world. Importance of positive attitude, Self motivation and continuous knowledge upgradation.

Self-confidence: Characteristics of the person perceived, characteristics of the situation, characteristics of the perceiver. Attitude, values, motivation, emotion management, steps to like yourself, positive mental attitude, assertiveness.

Presentations: Preparations, outlining, hints for efficient practice, last minute tasks, means of effective presentation, language, gestures, posture, facial expressions, professional attire.

Vocabulary building: A brief introduction into the methods and practices of learning vocabulary. Learning how to face questions on antonyms, synonyms, spelling error, analogy, etc. Faulty comparison, wrong form of words and confused words like understanding the nuances of spelling changes and wrong use of words. Listening skills: The

importance of listening in communication and how to listen actively.

Prepositions, articles and punctuation: A experiential method of learning the uses of articles and prepositions in sentences is provided.

Problem solving level I: Number system; LCM &HCF; Divisibility test; Surds and indices; Logarithms; Ratio, proportions and variations; Partnership;

Problem solving level II: Time speed and distance; work time problems;

Data interpretation: Numerical data tables; Line graphs; Bar charts and Pie charts; Caselet forms; Mix diagrams; Geometrical diagrams and other forms of data representation.

Logical reasoning: Family tree; Deductions; Logical connectives; Binary logic; Linear arrangements; Circular and complex arrangement; Conditionalities and grouping; Sequencing and scheduling; Selections; Networks; Codes; Cubes; Venn diagram in logical reasoning; Quant based reasoning; Flaw detection; Puzzles; Cryptogrithms.

TEXTBOOKS

A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.
Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.
Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
The Hard Truth about Soft Skills, by Amazone Publication.
Quantitative Aptitude by R. S. Aggarwal,S. Chand
Quantitative Aptitude – Abijith Guha, TMH.
Quantitative Aptitude for Cat - Arun Sharma. TMH.

REFERENCES:

Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova.
More Games Teams Play, by Leslie Bendaly, McGraw Hill Ryerson.
The BBC and British Council online resources
Owl Purdue University online teaching resources
www.the grammarbook.com - online teaching resources www.englishpage.com- online teaching resources and other useful websites.

SEMESTER V

19EAC301	FUNDEMENTALS OF MACHINE LEARNING	L-T-P-C: 2-1-0-3

Course Objectives:

- To introduce mathematical methods for design of machine learning algorithms.
- To provide an overview of cluster analysis process and cluster quality evaluation techniques.
- To enable design and performance evaluation of classifiers for typical classification problems.
- To enable design of frequent itemset mining system for typical solve market-basket analysis problems.

Course Outcomes:

CO 1: Able to generate, analyze and interpret data summaries.
CO 2: Able to carry out analysis on machine learning algorithms.
CO 3: Able to design and implement classifiers for machine learning applications.
CO 4: Able to design and implement frequent itemset mining systems.

CO – PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	2	-	2	-	-	-	-	-	-	-	3	-
CO3	-	2	3	2	2	-	-	-	-	-	-	-	3	-
CO4	-	2	3	2	2	-	-	-	-	-	-	-	3	-

Keywords:
Data summary, Cluster analysis, Classification, Frequent itemset.

Module I
Introduction to Machine learning: Supervised learning, Unsupervised learning, The five tribes in Machine Learning, linear classification, perceptron update rule, Perceptron convergence, generalization, Maximum margin classification, Classification errors, regularization, logistic regression, Linear regression, estimator bias and variance, active learning

Module II
Non-linear predictions, kernels, Kernel regression, kernels, Support vector machine (SVM) and kernels, kernel optimization.

Module III
Model selection, Model selection criteria, Description length, feature selection, Combining classifiers, boosting, Bagging, margin, and complexity, Margin and generalization (EM) algorithm, EM, regularization, clustering, Clustering, Spectral clustering, Markov models, Hidden Markov models (HMMs), Bayesian networks, Learning Bayesian networks, Probabilistic inference, Current problems in machine learning.

Text Book
Bishop, Christopher. Neural Networks for Pattern Recognition. *New York, NY: Oxford University Press, 1995*

Reference(s)

*Duda, Richard, Peter Hart, and David Stork, "*Pattern Classification" *Second Edition, New York, NY: Wiley-Interscience, 2000.*
*Hastie, T., R. Tibshirani, and J. H. Friedman, "*The Elements of Statistical Learning: Data Mining, Inference and Prediction*", New York, Springer, 2001.*
*MacKay, David, "*Information Theory, Inference, and Learning Algorithms*", Cambridge University Press, 2003.*

Evaluation Pattern 50:50 (Internal: External)

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC302	EMBEDDED SYSTEMS DESIGN	L-T-P-C: 3-0-0-3

Course Objectives:

- To be able to design, describe, validate and optimise embedded electronic systems in different industrial application areas.
- To be able to define hardware and software communication and control requirements.
- To acquire knowledge of and be able to use tools for the development and debugging of programs implemented on microcontrollers and DSPs.
- To design electronic circuits for the processing of information in communications and control systems

Course Outcomes

CO1: Students will be able to understand all fundamental concepts involved in Sensing, Computing, Communicating and actuating a real-world system using hardware and software components.
CO2: Ability to formulate mathematical models, perform simulations and solve engineering problems.
CO3: Ability to apply the knowledge of Electronics, Signal Processing and real-time operating systems (RTOS) and Systems design to meet application requirement

CO- PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	3	3	3	3								
CO2	3	2	2	2	3	3								
CO3	2	2	2	2	2	3								

Module I
Introduction to embedded systems – Application area – Compiling – Linking and locating – Downloading and debugging, embedded processor architecture definitions – SIMD – MIMD – SISD – MISD – VLIW – Superscalar – Pipelining – RISC – CISC – DSP Processors architectures – Modified hardware architecture – Barrel shifter – Multipliers – MAC unit – Manufacturers of DSP Processors.

MODULE II
Real time operating system concepts – Tasks – Task states – Context switching – Message box – Message queue – Semaphores – Binary counting and mutex semaphore -- Deadlock – priority inversions – Scheduling algorithms – Round robin – Rate monotonic – Earliest deadline first.

MODULE III
Applications in critical domains -- design and analysis of computational systems that interact with physical processes -- Understand sensing using sensors and actuation using actuators -- Applications of such systems include examples from domains - medical devices and systems -- consumer electronics, toys and games, assisted living, traffic control and safety, environmental control, communication systems. Use of ARM family processors and ARM instruction set for designs mentioned above, and highlighting reliability, availability and serviceability, as well security issues

Text Books/References(s)

Rajib Mall, "Real-Time Systems: Theory and Practice," Pearson, 2008.
Jane W. Liu, "Real-Time Systems" Pearson Education, 2001.
Krishna and Shin, "Real-Time Systems," Tata McGraw Hill. 1999.
Introduction to Embedded Systems - A Cyber-Physical Systems Approach, Second Edition, by E. A. Lee and S. A. Seshia, 2015.

Evaluation Pattern 50:50 (Internal: External)

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC303	INFORMATION THEORY AND CODING	L-T-P-C: 3-1-0-4

Course Objectives

- To provide an insight into the concept of information in the context of communication theory and its significance in the design of communication receivers.
- To explore in detail, the calculations of channel capacity to support error-free transmission and also, the most commonly used source coding and channel coding algorithms.
- To encourage and train to design coding schemes for data compression and error correction, and they will also get an overall perspective of how this impacts the design of an optimum communication receiver.

Course Outcomes:

CO1: Overview of Probability Theory, significance of "Information" with respect to Information Theory.
CO2: Derive equations for entropy, mutual information and channel capacity for all kinds of channels.
CO3: Implement the various types of source coding algorithms and analyse their performance.
CO4: Explain various methods of generating and detecting different types of error correcting codes
CO5: Understand the fundamentals of Field Theory and polynomial arithmetic
CO6: Design linear block codes and cyclic codes (encoding and decoding).
CO7: Implement and decode a sequence at the receiver using Trellis decoder and Viterbi decoder.
CO8: Perform mathematical analysis of problems in Information Theory and Coding, Implementation and verification using MATLAB simulation

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	1
CO2	3	3	1	-	-	-	-	-	-	-	-	-	3	1
CO3	3	3	-	2	3	-	-	-	-	-	-	-	3	1
CO4	3	3	-	1	-	-	-	-	-	-	-	-	3	1
CO5	3	1	-	-	-	-	-	-	-	-	-	-	3	1
CO6	3	2	-	-	1	-	-	-	-	-	-	-	3	2
CO7	3	2	-	1	-	-	-	-	-	-	-	-	3	2
CO8	3	3	1	2	3	-	-	-	1	-	-	-	3	2

Keywords: Information, Shannon's Capacity, Source Coding, Channel coding, algorithms

Contents:

Module I

Introduction to Probability – Random Variables, Random variable, Sample space, Conditional probability, Joint probability. Modeling of Information Sources – Self Information, Entropy, Mutual Information. Source Coding Theory and algorithms - Kraft inequality, Huffman algorithm, Arithmetic coding, Lempel Ziv coding. Modeling of Communication channels - Binary symmetric channel, Binary Erasure channel, Channel coding theorem.

Module II

Error Correction Codes – Introduction to Galois fields, polynomial arithmetic, linear block codes for error correction - Generator matrix, Encoding, Parity Check matrix, Decoding – Standard array decoding and Syndrome decoding. Cyclic Codes – Generation of codes, encoding and syndrome decoding.

Module III: BCH Codes – Minimal polynomial encoding and decoding. Convolutional encoder - Introduction to Convolutional codes, distance properties – Trellis codes, Viterbi decoder. Numerical problems and MATLAB based problem solving on selected topics of the course.

Textbooks/References:

Ranjan Bose, "Information Theory, Coding and Cryptography", Tata McGraw Hill, 2nd edition.
P.S. Satyanarayana, "Concepts of Information Theory and Coding", Dynaram Publication, 2005
Richard B. Wells, "Applied Coding and Information Theory for Engineers" Pearson Education, LPE 2004.
Shu Lin and Daniel Castello, "Error Control Coding – Fundamentals and Applications", second edition 2004
Thomas M Cover, Joy Thomas, "Elements of Information Theory", MGH 2006.

Evaluation Pattern 50:50 (Internal: External)

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC313	VLSI DESIGN	L-T-P-C: 3-0-0-3

Course Objectives

- To develop understanding of MOSFETs and its characteristics to enable designing digital logic circuits.
- Provides the fundamental knowledge to analyze static, transient and dynamic response of CMOS digital logic design.
- Delivers a comprehensive foundation about CMOS physical design.

Course Outcomes

CO 1: Able to understand and implement simple logic circuits using CMOS.
CO 2: Able to analyze different CMOS gate realizations.
CO 3: Able to understand and analyze performance trade-offs in CMOS VLSI systems.
CO4: Able to implement layouts of simple CMOS circuits.

CO–PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	-	-	-	-	-	-	-	-	-	2	2
CO2	3	3	-	-	-	-	-	-	-	-	-	-	2	2
CO3	3	3	-	-	-	-	-	-	-	-	-	2	2	2
CO4	3	-	3	-	-	-	-	-	-	-	-	2	2	2

Keywords:
Integrated Circuit Design, CMOS, Memory.

Contents:

Module I
Issues in Digital Integrated Circuit Design - From Custom to Semicustom and Structured Array Design Approaches -MOSFETs as switches –Device characteristics- Non ideal I-V effects. NMOS and CMOS physical layouts and stick diagrams, Design Rules. Physical Design - NMOS and CMOS layers - Designing FET arrays - FET sizing and unit transistor - Physical design of logic gates and design hierarchies.

Module II
Analysis of MOS logic gates - DC switching characteristics of NMOS and CMOS inverters - DC characteristics of NAND and NOR gates - Transient response - Gate design for transient performance - Transmission gates and pass transistors.

Module III
Designing high speed CMOS logic networks - Gate delays - Driving large capacitive loads - BiCMOS drivers - Clocking and data flow control - Advanced techniques in CMOS logic circuits: Mirror circuits - Pseudo-NMOS - Tristate circuits - Clocked CMOS, Dynamic CMOS logic circuits- Static Latches and Registers- Dynamic Latches and Registers.

Text Books/Reference(s)

J. P. Uyemura, Introduction to VLSI Circuits and Systems, John Wiley and Sons, Second Edition, 2002.

Jan M. Rabey, AnanthaChandrakasan, and Borivoje Nikolic, Digital Integrated Circuits-A Design Perspective, Second Edition, Prentice Hall/Pearson, 2003.

Neil Weste, David Harris, Ayan Banerjee, CMOS VLSI Design: A Circuits and Systems Perspective, Pearson Education, 4th Edition, 2011.

Sung-Mo Kang, Yusuf Leblechi, CMOS Digital Integrated Circuits - Analysis and Design, Tata McGraw Hill Publishing Company Limited, Third Edition, 2003.

Evaluation Pattern 50:50 (Internal: External)

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC381	MACHINE LEARNING LAB WITH PYTHON	L-T-P-C: 0-0-3-1

Course Objectives

To understand the basic concepts and techniques of Machine Learning through python programming.
To develop skills of using recent machine learning packages for solving practical problems.
To gain experience of doing independent study and research.

Course Outcomes

CO 1: Familiarize Python
CO 2: Able to generate, analyze and interpret data using Python.
CO 3: Use Python to design and implement classifiers for machine learning applications.
CO 4: Implement an end to end Machine Learning System

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	-	1	-	-	-	-	-	-	-	-	-	-
CO2	1	3	2	1	1	-	-	-	-	-	-	-	3	-
CO3	1	2	3	2	-	-	-	-	-	-	-	-	3	-
CO4	1	2	3	2	2	-	-	-	-	-	-	-	3	-

1. Introduction to Python- Importing datasets- Data visualization.
2. Lab experiments demonstrating Dimensionality Reduction, Regression, Discriminant analysis, SVM, Gaussian Mixture models, k-Nearest Neighbor Classification, Naive Bayes classification, K- Means clustering, Hidden Markov models (HMMs)
3. Case Study involving classification including document classification or with applications like recommendation systems, advertising on the web, using ML tools.

TextBook/References:

C. M. Bishop. Pattern Recognition and Machine Learning. First Edition. Springer, 2006. (Second Indian Reprint, 2015).
P. Flach. Machine Learning: The Art and Science of Algorithms that Make Sense of Data. First Edition, Cambridge University Press, 2012.
S. J. Russell, P. Norvig. Artificial Intelligence: A Modern Approach. Third Edition, Prentice-Hall, 2010.
Y. S. Abu-Mostafa, M. Magdon-Ismail, H.-T. Lin. Learning from Data: A Short Course. First Edition, 2012.

Evaluation Pattern 80:20 (Internal: External)

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

•CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE383	VLSI DESIGN LAB	L-T-P-C: 3-1-0-4

Course Objectives

- To explore and understand the characteristics, parameters and second order effects of PMOS and NMOS.
- To experiment and analyze the DC characteristics of CMOS gates.
- To build and analyze the complex Boolean expressions using different logic realizations.

Course Outcomes:

CO1: Able to analyze transfer and output characteristics of PMOS and NMOS.
CO2: Able to understand the different VTC characteristics of basic gates.
CO3: Able to synthesize and implement combinational and sequential digital circuits using CMOS logic.
CO4: Able to implement combinational logics using Mirror, Pseudo, Dynamic logics.

CO – PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	3	-	-	-	3	2	-	3	2	-
CO2	3	3	2	-	3	-	-	-	3	2	-	3	2	-
CO3	3	3	2	2	3	-	-	-	3	2	-	3	2	2
CO4	3	3	-	-	3	-	-	-	3	2	-	3	2	-

Keywords: Cadence, DC characteristics, CMOS, Pseudo, Dynamic.

1. Transfer and Output Characteristics of PMOS and NMOS: Measurement of Threshold voltage, β, γ, and λ.
2. Pass transistor and transmission logic based AND and OR gates: checking “strong” and “weak” ones and zeros.
3. Inverter output response for a given input: Measurement of rise time, fall time, propagation delay, short circuit power and switching power for zero load and a finite capacitance load.
4. Voltage transfer characteristics (VTC) of Inverter: Measurement of mid-point voltage (switching threshold) and noise margin.
5. Realization of CMOS NAND and NOR gates: VTC characteristics and measurement of switching thresholds.
6. Realization of Boolean function: sizing for equal rise time and fall time.
7. Mirror logic based XOR and XNOR gates.
8. Pseudo NMOS based Boolean expression realization: Checking the output swing, input capacitance and short circuit power.
9. Dynamic and Domino logic based Boolean expression realization: Checking charge sharing and monotonicity.
10. Transistor level realization of D Flip-flop with set and reset.

Evaluation Pattern 80:20 (Internal: External)

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

•CA – Can be Quizzes, Assignment, Projects, and Reports

19SSK301	SOFT SKILLS II	L-T-P-C: 1-0-3-2

Course Outcomes

CO # 1 - Soft Skills: At the end of the course, the students will have the ability to communicate convincingly and negotiate diplomatically while working in a team to arrive at a win-win situation. They would further develop their inter-personal and leadership skills.

CO # 2 - Soft Skills: At the end of the course, the students shall learn to examine the context of a Group Discussion topic and develop new perspectives and ideas through brainstorming and arrive at a consensus.

CO # 3 - Aptitude: At the end of the course, students will be able to identify, recall and arrive at appropriate strategies to solve questions on geometry. They will be able to investigate, interpret and select suitable methods to solve questions on arithmetic, probability and combinatorics.

CO # 4 – Verbal: At the end of the course, the students will have the ability to relate, choose, conclude and determine the usage of right vocabulary.

CO # 5 - Verbal: At the end of the course, the students will have the ability to utilise prior knowledge of grammar to recognise structural instabilities and modify them.

CO # 6 – Verbal At the end of the course, the students will have the ability to comprehend, interpret, deduce and logically categorise words, phrases and sentences. They will also have the ability to theorise, discuss, elaborate, criticise and defend their ideas.

Syllabus

Professional grooming and practices: Basics of corporate culture, key pillars of business etiquette. Basics of etiquette: Etiquette – socially acceptable ways of behaviour, personal hygiene, professional attire, cultural adaptability. Introductions and greetings: Rules of the handshake, earning respect, business manners. Telephone etiquette: activities during the conversation, conclude the call, to take a message. Body Language: Components, undesirable body language, desirable body language. Adapting to corporate life: Dealing with people.

Group discussions: Advantages of group discussions, structured GD – roles, negative roles to be avoided, personality traits to do well in a GD, initiation techniques, how to perform in a group discussion, summarization techniques.

Listening comprehension advanced: Exercise on improving listening skills, grammar basics: Topics like clauses, punctuation, capitalization, number agreement, pronouns, tenses etc.

Reading comprehension advanced: A course on how to approach middle level reading comprehension passages.

Problem solving level III: Money related problems; Mixtures; Symbol based problems; Clocks and calendars; Simple, linear, quadratic and polynomial equations; special equations; Inequalities; Functions and graphs; Sequence and series; Set theory; Permutations and combinations; Probability; Statistics.

Data sufficiency: Concepts and problem solving.

Non-verbal reasoning and simple engineering aptitude: Mirror image; Water image; Paper folding; Paper cutting; Grouping of figures; Figure formation and analysis; Completion of incomplete pattern; Figure matrix; Miscellaneous.

Spacial aptitude: Cloth, leather, 2D and 3D objects, coin, match sticks, stubs, chalk, chess board, land and geodesic problems etc., related problems.

TEXTBOOK(S)

A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.
Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.
Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
The Hard Truth about Soft Skills, by Amazone Publication.
Quick Maths – Tyra.
Quicker Arithmetic – Ashish Aggarwal

Test of reasoning for competitive examinations by Thorpe.E. TMH
Non-verbal reasoning by R. S. Aggarwal, S. Chand

REFERENCE(S)

Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova
More Games Teams Play, by Leslie Bendaly, McGraw Hill Ryerson.
The BBC and British Council online resources
Owl Purdue University online teaching resources
www.the grammarbook.com - online teaching resources www.englishpage.com- online teaching resources and other useful websites.

19LIV390	LIVE-IN-LAB I	L-T-P-C: 0-0-0-3

Course Objectives

- Identify and analyse the various challenge indicators present in the village by applying concepts of Human Centered Design and Participatory Rural Appraisal.
- User Need Assessment through Quantitative and Qualitative Measurements
- Designing a solution by integrating Human Centered Design concepts
- Devising proposed intervention strategies for Sustainable Social Change Management

Course Outcome

CO1: Learn ethnographic research and utilise the methodologies to enhance participatory engagement.
CO2: Prioritize challenges and derive constraints using Participatory Rural Appraisal.
CO3: Identify and formulate the research challenges in rural communities.
CO4: Design solutions using human centered approach.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3		3		1	1		3	3		3
CO2		3						3	3	3		
CO3		3					1		3	3		3
CO4	3		3				3	3	3	3		3

Syllabus

This initiative is to provide opportunities for students to get involved in coming up with technology solutions for societal problems. The students shall visit villages or rural sites during the vacations (after 4th semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth semester.
Thematic Areas

- Agriculture & Risk Management
- Education & Gender Equality
- Energy & Environment
- Livelihood & Skill Development
- Water & Sanitation
- Health & Hygiene
- Waste Management & Infrastructure

The objectives and the projected outcome of the project will be reviewed and approved by the department chairperson and a faculty assigned as the project guide.

Evaluation Pattern

Assessment	Marks
Internal (Continuous Evaluation) [75 marks]	
Workshop (Group Participation)	15
Village Visit Assignments & Reports	15
Problem Identification and Assessment	15
Ideation: Defining the Needs, Proposed Designs & Review	20
Poster Presentation	10
External [25 marks]	
Research Paper Submission	25
Total	**100**
Attendance (To be added separately)	5
Grand Total	**105**

SEMESTER VI

19EAC311	COMPUTER NETWORKS	L-T-P-C: 3-0-0-3

Course Objectives:

- To lay a solid foundation on the theoretical aspects of communication networks and learning about computer network organization and implementation.
- To introduce computer communication network design and its operations.
- To include the following topics: Open Systems Interconnection (OSI) communication model; error detection and recovery; local area networks; bridges, routers and gateways; network naming and addressing; and local and remote procedures.

Course Outcomes

CO 1: Able to understand the fundamental networking principles and protocol concepts.
CO 2: Able to connect networking principles with the practical network protocols currently used in the Internet.
CO 3: Able to analyze the performance of network protocols and system architectural design choices.
CO 4: Able to simulate, implement and monitor the performance of standard networking protocols by a network simulator, socket programming and a packet sniffer, respectively.

CO–PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	3	3	-
CO2	3	3	-	-	-	-	-	-	-	-	-	3	3	-
CO3	3	3	3	3	3	-	-	-	-	-	-	3	3	3
CO4	-	3	3	3	3	-	-	-	-	-	-	3	3	3

Keywords: OSI, TCP, Internet, Topologies, Protocols

Contents:

Module I: The Internet – Network Edge, Network Core, delay, loss and throughput in Packet Switched Networks, Protocol layers and their service models, Principles of Network Applications: Web and HTTP, File transfer: FTP, Electronic Mail in the Internet, DNS, Peer-to-peer applications.

Module II:OSI Reference Model, Physical Layer – bus, tree, ring, mesh topologies - The Link Layer and Local Area Networks – Introduction and Services, Error detection and correction techniques, Multiple access protocols, link layer addressing, Ethernet, Point-to-point protocol. Network Interconnections – LAN-to-LAN, LAN-to-Host, Repeaters, Bridges, Routers and Gateways.

Module III: Transport Layer – Connection Oriented Transport – TCP, TCP Congestion control. Introduction to Network layer: Virtual circuit and datagram networks, Inside a Router, The Internet Protocol – Forwarding and addressing, Routing algorithms, broadcast and multicast routing.

Textbooks/References

James Kurose and Keith Ross, "Computer Networking: A Top-down Approach" 5th/6th edition, Addison Wesley 2010.
Andrew S Tannenbaum, David J. Whetheral, "Computer Networks", Prentice Hall, 5th edition, 2010.
William Stallings, "Data and Computer Communications", 7th edition, Pearson Education Asia, 2004.
Behrouz Forouzan, "Data Communication and Networking", Tata McGraw Hill 3rd edition, 2004.
Larry L. Peterson and Bruce S. Davie, "Computer Networks – A Systems Approach", Morgan Kaufmann, 5th edition, 2011.

Evaluation Pattern 50:50 (Internal: External)

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC312	DATA BASE MANAGEMENT SYSTEMS	L-T-P-C: 2-0-3-3

Course Objective

- To gain the knowledge about database systems has become an essential part of an education in engineering.
- To understand the concepts of database, database design, normalization, database-system implementation and maintenance.

Course Outcome

CO1: Ability to understand the purpose and architecture of DBMSs.
CO2: Ability to design of relational databases and writing SQL and PL/SQL statements to query relational databases.
CO3: Ability to design and build ER models for sample databases.
CO4: Ability to design and build a normalized database management system for real world databases.
CO5: To understand the principles of transaction processing and concurrency control.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	2	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	3	1	-	-	-	-	-	-	-	3	2
CO3	1	3	3	3	1	-	-	-	-	-	-	-	3	2
CO4	2	3	2	3	--	-	-	-	-	-	-	-	3	2
CO5	1	1	-	2	-	-	-	-	-	-	-	-	3	2

Module I: Introduction: Overview of DBMS, File vs DBMS, elements of DBMS. Database design: E-R model, Notations, constraints, cardinality and participation constraints, ER design issues, Weak and strong entity sets, Extended ER features. Relational Data Model: Introduction to relational model, Structure of relational mode, domain, keys, tuples to relational models.

Module II: Relational Database Design: Functional dependency, Normalization: 1NF, 1NF, 2NF, 3NF, BCNF, Relational Synthesis algorithm, Lossless join testing algorithm, Decomposition Using Functional Dependencies, Functional-Dependency Theory - Reduction of ER model to Relational model. SQL: Various DDLs, DMLs, DCLs.

Module III: Indexing Mechanisms: Clustered, Non-Clustered, B-tree, B+tree, Hash based. Transactions: Transaction Concept, Transaction model, Storage Structure, Transaction Atomicity and Durability, Transaction Isolation, Serializability Concurrency control: Lock-based protocols – Locks, Granting of Locks, The Two-Phase Locking Protocol, Implementation of Locking, Graph-Based Protocols. Deadlock handling: Deadlock Prevention, Deadlock Detection, Recovery from Deadlock.
ACID properties, NOSQL databases, Timeseries databases, Introduction to data warehousing and big-data, databases in embedded systems and small devices.
Other than the topics covers in the unit descriptions lab exercises to cover setup of a local database, database management console, schema setup, NOSQL database setup and operation, timeseries database operations.

Text Book

Silberschatz A, Korth H F and Sudharshan S, "Database System Concepts", Sixth Edition, Tata McGraw-Hill Publishing Company Limited, 2010.

Reference(s)

Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom, "Database Systems: The Complete Book", Second edition, 2011.

Elmasri R and Navathe S B, "Fundamentals of Database Systems", Fifth Edition, Addison Wesley, 2006.

Ramakrishnan R and Gehrke J, "Database Management Systems", Third Edition, McGraw-Hill, 2003

Evaluation Pattern 50:50 (Internal: External)

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC313	DATA SCIENCE	L-T-P-C: 3-0-0-3

Course Objectives

- To gain useful conclusions from large and diverse data sets through exploration, prediction, and inference.

Course Outcomes

CO1: Ability to understand the statistical foundations of data science.
CO2: Ability to apply pre-processing techniques over raw data so as to enable further analysis.
CO3: Ability to conduct exploratory data analysis and create insightful visualizations to identify patterns.
CO4: Ability to identify machine learning algorithms for predictions and classification.
CO5: Ability to analyze the degree of certainty of predictions using statistical test and models

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1												3	2
CO2	1	1		1	3								3	2
CO3	3	1	1	2	3								3	2
CO4	3	1	1	2	2								3	2
CO5	3	3	1	3	2								3	2

Module I:

Introduction: What is Data Science? Big Data and Data Science – Datafication - Current landscape of perspectives - Skill sets needed; Matrices - Matrices to represent relations between data, and necessary linear algebraic operations on matrices -Approximately representing matrices by decompositions (SVD and PCA); Statistics: Descriptive Statistics: distributions and probability - Statistical Inference: Populations and samples - Statistical modeling - probability distributions - fitting a model - Hypothesis Testing.

Module II:

Data pre-processing: Data cleaning - data integration - Data Reduction Data Transformation and Data Discretization. Evaluation of classification methods – Confusion matrix, Students T-tests and ROC curves- Exploratory Data Analysis - Basic tools (plots, graphs and summary statistics) of EDA, Philosophy of EDA - The Data Science Process.

Module III :Basic Machine Learning Algorithms: Association Rule mining - Linear Regression- Logistic Regression - Classifiers - k-Nearest Neighbors (k-NN), k-means -Decision tree - Naive Bayes- Ensemble Methods - Random Forest. Feature Generation and Feature Selection - Feature Selection algorithms - Filters; Wrappers; Decision Trees; Random Forests.

Data Visualization: Basic principles, ideas and tools for data visualization.

Text Book(s)

Cathy O'Neil and Rachel Schutt, "Doing Data Science, Straight Talk From The Frontline", O'Reilly, 2014.
Jiawei Han, MichelineKamber and Jian Pei, "Data Mining: Concepts and Techniques", Third Edition. ISBN 0123814790, 2011.
Mohammed J. Zaki and Wagner Miera Jr, "Data Mining and Analysis: Fundamental Concepts and Algorithms", Cambridge University Press, 2014.
Matt Harrison, "Learning the Pandas Library: Python Tools for Data Munging, Analysis, and Visualization, O'Reilly, 2016.
Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media, 2015.
Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", O'Reilly Media, 2012.
GalitShmueli, Peter C Bruce, InbalYahav, Nitin R Patel, Kenneth C Lichtendahl Jr. "Data Mining for Business Analytics: Concepts, Techniques, and Applications in R" ISBN: 978-1-118-87936-8, Wiley.

Evaluation Pattern 50:50 (Internal: External)

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC386	OPEN LAB	L-T-P-C: 1-0-3-2

Pre Requisite(s): Nil

Course Objectives

- To provide platform for creative and innovative thinking
- To develop competency in design, development and analysis of solutions to real time problems
- To enable hardware prototyping of solutions to effectively transform ideas to reality

Course Outcomes

CO1: Ability to analyze practical problems and investigate scope for applying technology to develop feasible solutions
CO2: Ability to review the state of the art literature in the selected technology domain and arrive at functional solutions
CO3: Design the required system using appropriate EDA tools and implement the hardware
CO4: Ability to analyze the implementation impact and suggest improvements or modifications
CO5: Present the concept with adequate validation on technical aspects and cost analysis using a report and seminar

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	2	-	-	2	-	-	2	3	-
CO2	-	3	-	-	-	-	2	-	2	-	-	2	3	-
CO3	-	-	3		2	-	-	2	-	-	-	-	3	2
CO4	-	-	-	3	2	-	-	-	-	-	-	-	3	2
CO5	-	-	-	-	-	-	-	2	2	3	2	-	-	-

Evaluation Pattern

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC383	TECHNICAL PRESENTATION AND WRITING	L-T-P-C: 0-2-0

Pre Requisite(s): Nil

Course Objectives

- To develop skill in collection and review the literature in selected technology domain
- To comprehend the literature and derive conclusion
- To develop technical presentation skill
- To introduce technical paper writing skills and methods of documentation

Course Outcomes

CO1: Ability to understand and analyze the literature
CO2: Ability to understand design aspect and analyze solutions to engineering problems
CO3: Ability to qualitatively evaluate the solutions on sustainable and ethical aspects
CO4: Ability to conduct collaborative discussions and presentations

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	3	3	2
CO2	-	-	3	3	-	3	-	-	-	-	-	3	3	2
CO3	-	-	-	-	-	3	3	3	-	-	-	3	3	2
CO4	-	-	-	-	-	-	-	-	3	3	-	3	3	2

Evaluation Pattern

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports

19SSK311	SOFT SKILLS III	L-T-P-C: 1-0-3-2

Course Outcomes:

CO # 1 - Soft Skills: At the end of the course, the students will have the ability to prepare a suitable resume (including video resume). They would also have acquired the necessary skills, abilities and knowledge to present themselves confidently. They would be sure-footed in introducing themselves and facing interviews.

CO # 2 - Soft Skills: At the end of the course, the students will have the ability to analyse every question asked by the interviewer, compose correct responses and respond in the right manner to justify and convince the interviewer of one's right candidature through displaying etiquette, positive attitude and courteous communication.

CO # 3 - Aptitude: At the end of the course, students will be able to interpret, critically analyze and solve logical reasoning questions. They will have acquired the skills to manage time while applying methods to solve questions on arithmetic, algebra, logical reasoning, and statistics and data analysis and arrive at appropriate conclusions.

CO # 4 – Verbal: At the end of the course, the students will have the ability to understand and use words, idioms and phrases, interpret the meaning of standard expressions and compose sentences using the same.

CO # 5 - Verbal: At the end of the course, the students will have the ability to decide, conclude, identify and choose the right grammatical construction.

CO # 6 – Verbal: At the end of the course, the students will have the ability to examine, interpret and investigate arguments, use inductive and deductive reasoning to support, defend, prove or disprove them. They will also have the ability to create, generate and relate facts / ideas / opinions and share / express the same convincingly to the audience / recipient using their communication skills in English.

Team work: Value of team work in organisations, definition of a team, why team, elements of leadership, disadvantages of a team, stages of team formation. Group development activities: Orientation, internal problem solving, growth and productivity, evaluation and control. Effective team building: Basics of team building, teamwork parameters, roles, empowerment, communication, effective team working, team effectiveness criteria, common characteristics of effective teams, factors affecting team effectiveness, personal characteristics of members, team structure, team process, team outcomes.

Facing an interview: Foundation in core subject, industry orientation / knowledge about the company, professional personality, communication skills, activities before interview, upon entering interview room, during the interview and at the end. Mock interviews.

Advanced grammar: Topics like parallel construction, dangling modifiers, active and passive voices, etc.

Syllogisms, critical reasoning: A course on verbal reasoning. Listening comprehension advanced: An exercise on improving listening skills.

Reading comprehension advanced: A course on how to approach advanced level of reading, comprehension passages. Exercises on competitive exam questions.

Problem solving level IV: Geometry; Trigonometry; Heights and distances; Co-ordinate geometry; Mensuration.

Specific training: Solving campus recruitment papers, national level and state level competitive examination papers; Speed mathematics; Tackling aptitude problems asked in interview; Techniques to remember (In mathematics). Lateral thinking problems. Quick checking of answers techniques; Techniques on elimination of options, estimating and predicting correct answer; Time management in aptitude tests; Test taking strategies.

TEXTBOOK(S)

A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.
Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.
Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
The Hard Truth about Soft Skills, by Amazone Publication.
Data Interpretation by R. S. Aggarwal, S. Chand
Logical Reasoning and Data Interpretation – Niskit K Sinkha
Puzzles – Shakuntala Devi
Puzzles – George J. Summers.

REFERENCE(S)

Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova.
More Games Teams Play, by Leslie Bendaly, McGraw-Hill Ryerson.
The BBC and British Council online resources
Owl Purdue University online teaching resources

www.the grammarbook.com - online teaching resources www.englishpage.com- online teaching resources and other useful websites.

19EAC384	COMPUTER NETWORKS LAB	L-T-P-C: 0-0-3-1

Course Objective

- To gain practical experience in installation, monitoring, and troubleshooting of current LAN systems.

Course Outcomes

CO-PO Mapping

Course Details

1. Familiarization of Network Components and Lab Set up
2. Experimental Study of Application protocols using HTTP, FTP, SMTP
3. Network Simulators
4. Setting up an IP Network
5. Client Server Communication using basic socket communication (TCP and UDP)
6. Packet Sniffers for understanding the TCP protocol
7. Design and Implementation of Congestion Control in TCP/IP network.

Evaluation Pattern 80:20 (Internal: External)

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC385	R PROGRAMMING LAB(DATA SCIENCE)	L-T-P-C: 0-0-3-1

Course Objective

Basically, R is a functional and object-oriented programming language. This means the function is the central element of software and analyses. In this lab course we deal intensively with writing and testing functions in R.

Course Outcomes

CO1: Understanding the types, classes and functions of R Programming.
CO2: Accessing and Processing of Data.
CO3: Understanding the I/O interface programming.
CO4: Study and Analyse Data Visualisation.
CO5: Implement any application level simulation using R

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1													
CO2	1	2												
CO3	1	1	2										1	
CO4	1	2	2	2									1	1
CO5	1	2	3	3	2								2	2

Course Details

R types and classes, Functions, Data Structures, Reading and writing Data from files, Variables, Control Structures.

Input Output, Graphics, Data Visualization, Simulation-Generating Random Numbers, Setting the random number seed, Simulating a Linear Model, Random Sampling, Data Analysis Case Study.

TextBook /References

R Programming for Data Science, Roger D Peng, Lean Publication, 2016
R for Data Science: Import, Tidy, Transform, Visualize, and Model Data by Hadley Wickham, O'RELLY, 2017
Hands-On Programming with R: Write Your Own Functions and Simulations, Garrett Goleman, O'RELLY, 2014
http://cran.r-project.org

Evaluation Pattern 80:20 (Internal: External)

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

•CA – Can be Quizzes, Assignment, Projects, and Reports

19LIV490	LIVE-IN-LAB II	L-T-P-C: 0-0-0-3

Course Objectives

- Proposal writing in order to bring in a detailed project planning, enlist the materials required and propose budget requirement.
- Use the concept of CoDesign to ensure User Participation in the Design Process in order to rightly capture user needs/requirements.
- Building and testing a prototype to ensure that the final design implementation is satisfies the user needs, feasible, affordable, sustainable and efficient.
- Real time project implementation in the village followed by awareness generation and skill training of the users (villagers)

Course Outcome

CO1: Learn co-design methodologies and engage participatorily to finalise a solution
CO2: Understand sustainable social change models and identify change agents in a community.
CO3: Learn Project Management to effectively manage the resources
CO4: Lab scale implementation and validation
CO5. Prototype implementation of the solution

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	3	3			1	3	3	3		3
CO2									3	3		
CO3									3	3	3	
CO4	3		3			3	1	3	3	3		3
CO5			1						3	3		

Syllabus

The students shall visit villages or rural sites during the vacations (after 6th semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth semester.
Thematic Areas

- Agriculture & Risk Management
- Education & Gender Equality
- Energy & Environment
- Livelihood & Skill Development
- Water & Sanitation
- Health & Hygiene
- Waste Management & Infrastructure

Evaluation Pattern

Assessment	Marks
Internal (Continuous Evaluation) [63 marks]	
1. Proposed Implementation Presentation Round 1	**2**
2. Proposal Submission + Review	**6**
3. Co-design	**6**
i. Village Visit I (Co-Design Field Work Assignments)	4
ii. Presentation of Co-design Assessment	2
4. Prototype Design	**14**
i. Prototype Design	4
ii. Prototype Submission	8
iii. Sustenance Plan	2
5. Implementation	**35**
i. Implementation Plan Review	3
ii. Implementation	24
iii. Testing & Evaluation	4
iv. Sustenance Model Implementation	4
External [37 marks]	
6. Research Paper	**18**
7. Final Report	**15**
8. Poster Presentation	**4**
Total	**100**
Attendance	5
Grand Total	**10**

SEMESTER VII

19EAC401	INTRODUCTION TO CYBER SECURITY	L-T-P-C: 3-0-2-4

Course Objectives

- To give an introduction to cybersecurity.
- To help to understand the security requirements of Databases.
- To give an exposure to practical security methods in cyber domain.

Course Outcomes

CO1: Understanding the basic concepts of Cyber Security.
CO2: Gain Basic Programming Knowledge for Cyber Security
CO3: Understand the various attacks in web interface.
CO4: Understand the level of security in operating systems.
CO5: Know the concepts of Network Security.
CO6: Understand and apply the security concepts in data base management systems.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1													
CO2	1	2												
CO3	1	1	2										1	
CO4	1	1	2										1	
CO5	1	2	3										2	1
CO6	1	1	1	1	2								2	1

Module I: Introduction-Computer Security, Threats, Harm, Vulnerabilities, Controls. Toolbox-Authentication, Access Control and Cryptography. Programs and Programming-Unintentional (Non-malicious) Programming Oversights, Malicious Code-Malware, Countermeasures.

Module II: The Web User side- Browser Attacks, Web Attack Targeting Users, Obtaining user or website Data, Email Attacks. Operating Systems-Security in OS, Security in the design of OS, Rootkit.Networks-Network concepts, Threats to Network Communications, Wireless Network Security, Denial of Service, Distributed Denial-of-Service, Strategic Defenses: Security Countermeasures, Cryptography in Network Security, Firewalls, Intrusion Detection and Prevention Systems, Network Management.

Module III: Databases- Introduction to Databases, Security Requirements of Databases, Reliability and Integrity, Database Disclosure, Data Mining and Big Data.

TextBook/References

Pfleeger, C.P., Security in Computing 5th Edition, Prentice Hall, Copyright 2010 ISBN 0-13-239077-9.
Schneier, Bruce. Applied Cryptography, Second Edition, John Wiley & Sons, 1996.

Evaluation Pattern 50:50 (Internal: External)

Assessment	Internal	External
Periodical 1 (PI)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

•CA – Can be Quizzes, Assignment, Projects, and Reports

19EAC495	PROJECT PHASE I	L-T-P-C: 0-0-6-2

Course Objectives

- To define the problem of the proposed research work
- To apply the concepts of electronics engineering design in solving the research problem
- To demonstrate and validate the results of the design concept

Course Outcomes

CO1: Able to identify and formulate research problem
CO2: Able to design and develop solution to the problem
CO3: Able to analyze and solve the complex problems
CO4: Able to plan, implement and execute the project
CO5: Able to write effective technical report and demonstrate through presentation

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	3	3	-	3	-	-	-	3	3
CO2	3	3	3	-	2	-	-	3	3	-	-	3	3	3
CO3	-	-	3	3	3	2	2	3	3	-	-	3	3	3
CO4	-	-	-	-	3	2	3	3	3	3	3	3	3	2
CO5	-	-	-	-	-	-	-	2	3	3	-	3	-	-

Evaluation Pattern

Assessment	Internal	External
*Continuous Assessment (CA)	60	
End Semester		40

*CA – Can be Quizzes, Assignment, Projects, and Reports.

SEMESTER VIII

19EAC499	PROJECT PHASE II	L-T-P-C: 0-0-30-10

Pre Requisite(s): Nil

Course Objectives

- To define the problem of the proposed research work
- To apply the concepts of electronics engineering design in solving the research problem
- To demonstrate and validate the results of the design concept

Course Outcomes

CO1: Able to identify and formulate research problem
CO2: Able to design and develop solution to the problem
CO3: Able to analyze and solve the complex problems
CO4: Able to plan, implement and execute the project
CO5: Able to write effective technical report and demonstrate through presentation

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	3	3	-	3	-	-	-	3	3
CO2	3	3	3	-	2	-	-	3	3	-	-	3	3	3
CO3	-	-	3	3	3	2	2	3	3	-	-	3	3	3
CO4	-	-	-	-	3	2	3	3	3	3	3	3	3	2
CO5	-	-	-	-	-	-	-	2	3	3	-	3	-	-

Evaluation Pattern

Assessment	Internal	External
*Continuous Assessment (CA)	60	
End Semester		40

*CA – Can be Quizzes, Assignment, Projects, and Reports.

PROFESSIONAL ELECTIVES

19CSE459	ADVANCED ALGORITHMS AND ANALYSIS	L-T-P-C: 3-0-0-3

Pre-Requisite(s):19CSE302 Design and Analysis of Algorithms

Course Objectives

- This course introduces students to advanced techniques for the design and analysis of algorithms and explores a variety of applications.

Course Outcomes

CO1: Understand various methodology for analyzing the algorithms.
CO2: Apply different graph algorithms and analyze its Complexity.
CO3: Analyze various algorithm design techniques and solve different problems using those techniques and analyse its Complexity.
CO4: Evaluate the performance of various Network flow algorithms.
CO5: Understand NP completeness and Polynomial Reduction Techniques.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1			3		2			2			3	2
CO2	3	1	2	2	3	2		2		2			3	2
CO3	3	3	2	3		3	2	2		3			3	2
CO4	3	2	2	2	3	2		2		2			3	2
CO5	3	3	2	3		2				2			3	2

Syllabus

Unit 1
Algorithm Analysis - Methodologies for Analyzing Algorithms, Asymptotic growth rates, Amortized Analysis. Number Theory: Preliminaries, FLT, Euclid's algorithm (extended). Totient function, Sieve for primes, Inverse modulo n, Modular exponentiation, Applications of graph algorithms: Topological sort, Strongly Connected Components, Bi-connected Components, Bridges, Articulation points. All Pair Shortest Paths, Single Source Shortest Paths. Computational Geometry: Convex Hull, closest pair of points in 2D, the triangle with smallest perimeter in 2D, Determining whether a set of line segments have one or more intersections.

Unit 2
Applications of Divide-and-Conquer, Greedy techniques and Dynamic Programming - Knapsack, Median finding, Scheduling algorithms, Party planning, bitonic TSP etc., String matching algorithms: KMP, Rabin Karp, Aho-Corasick, 2D queries, efficient algorithms for longest palindrome, Longest Common Substring.

Unit 3

Flow Networks: Ford-Fulkerson, Edmonds Karp, Applications of maximum flows - Efficient algorithms for maximum bipartite matching, minimum cost matching. NP-Completeness: Important NP-Complete Problems, Polynomial time reductions, Approximation algorithms, Parallel Algorithms (overview): Tree Contraction - Divide and Conquer - Maximal Independent Set. External-Memory Algorithms - Accounting for the Cost of Accessing Data from Slow Memory – Sorting - B-trees - Cache-oblivious Algorithms for Matrix Multiplication and Binary Search.

Text Book(s)

Goodrich M T and Tamassia R. Algorithm Design and Applications, John Wiley and Sons; 2014.

Reference(s)

Cormen T H, Leiserson C E, Rivest R L and Stein C. Introduction to Algorithms, Prentice Hall of India Private Limited, Third Edition; 2009.

Motwani R, Raghavan P. Randomized algorithms. Cambridge university press; 1995.

Vijay V. Vazirani. Approximation Algorithm, Springer; 2003.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE340	ADVANCED COMPUTER NETWORKS	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 19CSE301 Computer Networks

Course Objectives

- This course focuses on advanced networking concepts for next generation network architecture and design
- It covers SDN and virtualization for designing next generation networks

Course Outcomes

CO1: Understand advanced concepts and next generation networks
CO2: Analyze TCP/IP variants, network Algorithm's, Protocols and their functionalities
CO3: Comprehend features of SDN and its application to next generation systems
CO4: Analyze the performance of various server implementations

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		2									3	2
CO2	3	3	2	3	2								3	2
CO3	2	2	2		2								3	2
CO4	3	3	3	2	2								3	2

Syllabus

Unit 1
Overview of data communication model - Internet Multicasting, NAT, VPN - Routing Algorithms - BGP, RIP, OSPF – Differentiated and Integrated Services - SONET, ATM – MPLS -Next generation Internet architectures, Green Communication Networks, and Data Center Networking.

Unit 2
Analysis of Network congestion Mechanism, Routing algorithms, ARQ protocols Multimedia Networking; Implementation of multi-threaded Web Server/Web Proxy with Caching/Filtering features, Sliding Window protocol implementation, performance study of various TCP/IP variants.

Unit 3
Software Defined Network -Comparison between SDN and traditional networks -SDN controller, Switch design, SDN Controller-Switch Protocols, Open Flow Protocol, Control Overhead & Handoff algorithms. Network Function Virtualization -NFV Architecture, Use cases, NFV Orchestration and NFV for 5G.

Text Book(s)
Tanenbaum AS, Wetherall DJ. Computer Networks. Fifth edition, Pearson Education, Inc. 2011.

Reference(s)

Stallings W. Data and Computer Communications. Pearson Education India; 2006.
Douglas E Comer. Internet Working with TCP/IP Volume -1, Sixth Edition, Addison-Wesley Professional;2013.
Goransson P, Black C, Culver T. Software Defined Networks: a Comprehensive Approach. Morgan Kaufmann; 2014.
Chayapathi R, Hassan SF, Shah P. Network Functions Virtualization (NFV) with a Touch of SDN: Netw Fun Vir (NFV ePub_1. Addison-Wesley Professional; 2016 Nov 14.
Marschke D, Doyle J, Moyer P. Software Defined Networking (SDN): Anatomy of OpenFlow Volume 1. 2015.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE357	BIG DATA ANALYTICS	L-T-P-C: 3-0-0-3

Course Objectives

- The aim of this course is to provide depth knowledge about Big data Technologies and tools used for Big data.
- The students will learn to implement and work on tools to handle large volume of data in parallel and distributed environments. Retrieval and analysis of unstructured data are done using NOSQL databases.

Course Outcomes

CO1: Understand fundamental concepts of Big Data and its technologies
CO2: Apply concepts of MapReduce framework for optimization
CO3: Analyze appropriate NoSQL database techniques for storing and processing large volumes of structure and unstructured data
CO4: Apply data analytics solutions using Hadoop ecosystems
CO5: Explore modern reporting tools for Machine learning

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1										3	2
CO2	1	3	2										3	2
CO3		3	2	1									3	2
CO4		3	2	1									3	2
CO5				2	3								3	2

Syllabus

Unit 1

Introduction to Big Data: Types of Digital Data - Characteristics of Data – Evolution of Big Data - Definition of Big Data - Challenges with Big Data-3Vs of Big Data - Non Definitional traits of Big Data - Business Intelligence vs. Big Data - Data warehouse and Hadoop environment - Coexistence. Big Data Analytics: Classification of analytics - Data Science - Terminologies in Big Data - CAP Theorem - BASE Concept. NoSQL: Types of Databases – Advantages – NewSQL - SQL vs. NOSQL vs NewSQL. Introduction to Hadoop: Features – Advantages – Versions - Overview of Hadoop Eco systems - Hadoop distributions - Hadoop vs. SQL – RDBMS vs. Hadoop - Hadoop Components – Architecture – HDFS - Map Reduce: Mapper – Reducer – Combiner – Partitioner – Searching – Sorting - Compression. Hadoop 2 (YARN): Architecture - Interacting with Hadoop Eco systems.

Unit 2

No SQL databases: Mongo DB: Introduction – Features - Data types - Mongo DB Query language - CRUD operations – Arrays - Functions: Count – Sort – Limit – Skip – Aggregate - Map Reduce. Cursors – Indexes - Mongo Import – Mongo Export. Cassandra: Introduction – Features - Data types – CQLSH - Key spaces - CRUD operations – Collections – Counter – TTL - Alter commands - Import and Export - Querying System tables.

Unit 3

Hadoop Eco systems: Hive – Architecture - data type - File format – HQL – SerDe - User defined functions - Pig: Features – Anatomy - Pig on Hadoop - Pig Philosophy - Pig Latin overview - Data types - Running pig - Execution modes of Pig - HDFS commands - Relational operators - Eval Functions - Complex data type - Piggy Bank - User defined Functions - Parameter substitution - Diagnostic operator. Jasper Report: Introduction - Connecting to Mongo DB - Connecting to Cassandra - Introduction to Machine learning: Linear Regression- Clustering - Collaborative filtering - Association rule mining - Decision tree.

Text Book(s)

Seema Acharya, Subhashini Chellappan, "Big Data and Analytics", Wiley Publication, 2015.

Reference(s)

Hurwitz JS, Nugent A, Halper F, Kaufman M. Big data for dummies. John Wiley & Sons; 2013.
Tom White, "Hadoop: The Definitive Guide", O'Reilly Publications, 2011.
Kyle Banker, "Mongo DB in Action", Manning Publications Company, 2012.
Russell Bradberry, Eric Blow, "Practical Cassandra A developers Approach ", Pearson Education, 2014.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	10	
Continuous Assessment (Lab) (CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE445	CLOUD COMPUTING	L-T-P-C: 2-0-3-3

Pre-Requisite(s):19CSE102 Computer Programming, 19CSE301 Computer Networks

Course Objectives

- This course introduces the basic principles of cloud computing, cloud native application development and deployment, containerization principles, micro-services and application scaling.
- It will also equip the students to understand major industry players in the public cloud domain for application development and deployment.

Course Outcomes

CO 1: Understand the basic principles of cloud computing.
CO 2: Apply cloud native application development for containerization and container orchestration.
CO 3: Analyze different types of cloud services – Delivery models, Deployment models.
CO 4: Implement different solution approaches in Cloud – containers in public cloud, setting up private cloud and convert monolithic applications to containers

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1								1		3	2
CO2	3	2	2	2	3	2	3	2	2	2	2	2	3	2
CO3	3	2	2	2	3	2	3	2	1		2		3	2
CO4	3	2	2	2	3	2	3	2	2	2	2	2	3	2

Syllabus

Unit 1
Distributed Computing Taxonomy – Cluster, Grid, P2P, Utility, Cloud, Edge, Fog computing paradigms; Introduction to Cloud Computing – Cloud delivery models (XaaS), Cloud deployment models (Private, Public, Hybrid); Characteristics of Cloud, Major use cases of Cloud; disadvantages and best practices; Major public cloud players in the market; Security Issues and Challenges; Cloud Native application development – Introduction to JavaScript Cloud native application development

Unit 2
Public Cloud – Using public cloud for infrastructure management (compute and storage services), Web application deployment using public cloud services, and Deploying container images in public cloud, Overview of cognitive services, Case study on architecting cloud-based solutions for a chosen scenario

Unit 3
Virtualization – Basics, Cloud vs Virtualization, Types of virtualization, Hypervisor types; Containers – Introduction to dockers and containers, containerization vs virtualization, docker architecture, Use cases, Learn how to build container images, Operations on container images; Kubernetes – Need for orchestration, container orchestration methods, Introduction to Kubernetes, Kubernetes architecture, using YAML file, Running Kubernetes via minikube

Text Book(s)
Rajkumar Buyya et.al. Mastering cloud computing, McGraw Hill Education;2013.
Matthias K, Kane SP. Docker: Up & Running: Shipping Reliable Containers in Production. " O'Reilly Media, Inc."; 2018.

Reference(s)

Kocher PS. Microservices and Containers. Addison-Wesley Professional; 2018.
Sarkar A, Shah A. Learning AWS: Design, build, and deploy responsive applications using AWS Cloud components. Packt Publishing Ltd; 2018.
Menga J. Docker on Amazon Web Services: Build, deploy, and manage your container applications at scale. Packt Publishing Ltd; 2018.
Bentley W. OpenStack Administration with Ansible 2. Packt Publishing Ltd; 2016.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	10	
Continuous Assessment (Lab) (CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE458	COMPUTATIONAL INTELLIGENCE	L-T-P-C: 2-0-3-3

Pre-Requisite(s):19MAT111 Multivariable Calculus, 19MAT112 Linear Algebra, 19MAT205 Probability and Random Processes

Course Objectives

- This course covers practical adaptation and self-organization concepts, paradigms, algorithms and implementations that enable or facilitate appropriate actions (intelligent behavior) in complex and changing environments.
- The course includes mainly bottom-up approaches to solutions of (hard) problems based on various heuristics (soft computing), rather than exact approaches of traditional artificial intelligence based on logic (hard computing) mainly nature-inspired methods.

Course Outcomes

CO1: Understand conventional artificial intelligence approaches, algorithms and methods.
CO2: Apply conventional artificial intelligence algorithms and approaches to real-life problems.
CO3: Analyze Fuzzy and swarm optimization systems in application scenarios.
CO4: Understand hybridization of conventional artificial intelligence algorithms.
CO5: Apply improved algorithmic approaches to application scenarios.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	1	1						3	2
CO2	3	2	2	2	3	2	2						3	2
CO3	3	2	2	2	3	2	2						3	2
CO4	3	1	2	2	3	1	1						3	2
CO5	3	1	2	2	3	2	2						3	2

Syllabus
Unit 1
Fuzzy Systems, Fuzzy Sets, Fuzzy Logic, Fuzzy Relationships, Fuzzy Inference, Alternate fuzzy logic operations, Adaptation of fuzzy systems, Disjunctive versus conjunctive reasoning

Unit 2
Swarm Intelligence, Foundations Ants, Termites, Gnats, Birds Applications, Feedforward Neural Networks, Foundations of pattern classification & regression, Rosenblatt Perceptron, Training Neural networks

Unit 3
Smithing QwikNet, Software Applications, Evolutionary Computation, Genetic Algorithms, Boundary Marking, Particle Swarm, Search

Text Book(s)
Eberhart RC, Shi Y. Computational intelligence: concepts to implementations. Elsevier; 2007.

Reference(s)
Karray F, Karray FO, De Silva CW. Soft computing and intelligent systems design: theory, tools, and applications. Pearson Education; 2004.
Engelbrecht AP. Computational intelligence: an introduction. John Wiley & Sons; 2007.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	10	
Continuous Assessment (Lab) (CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE435	COMPUTER VISION	L-T-P-C: 3-0-0-3

Course Objectives

- This course introduces the geometry of image formation and its use for 3D reconstruction and calibration.
- It introduces the analysis of patterns in visual images that are used to reconstruct and understand the objects and scenes.

Course Outcomes

CO1: Understand image formation and camera calibration.
CO2: Analyze and select image features and apply for image matching.
CO3: Understand recognition algorithms through case studies.
CO4: Understand the basics of stereo vision.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2		2	2	1	1	1				3	2
CO2	3	3	2	3	3	3	2	1	2	1			3	2
CO3	3	3	3	3	3	3	2	3	3	3			3	2
CO4	3	3	1	2	3	2	1	1	1	1			3	2

Syllabus
Unit 1
Introduction, Image Formation – geometric primitives and transformations, photometric image formation, digital camera, Camera calibration.

Unit 2
Feature Detection and Matching – points and patches, edges, lines, Feature-Based Alignment - 2D, 3D feature-based alignment, pose estimation, Image Stitching, Dense motion estimation – Optical flow - layered motion, parametric motion, Structure from Motion.

Unit 3
Recognition – object detection, face recognition, instance recognition, category recognition, Stereo Correspondence – Epipolar geometry, 3D reconstruction.

Text Book(s)
Szeliski R. Computer Vision: Algorithms and Applications Springer. New York. 2010.

Reference(s)
Shapiro LG, Stockman GC. Computer Vision: Theory and Applications. 2001.
Forsyth DA, Ponce J. Computer Vision: a modern approach;2012.
Davies ER. Machine vision: theory, algorithms, practicalities. Elsevier; 2004 Dec 22.
Jain R, Kasturi R, Schunck BG. Machine vision. New York: McGraw-Hill; 1995 Mar 1.
Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE331	CRYPTOGRAPHY	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 19MAT115 Discrete Mathematics

Course Objectives

- The course will cover how cryptography (symmetric and ssymmetric) work, how security is analyzed theoretically, and how exploits work in practice.
- It will also present Cryptanalysis attacks against the cryptographic techniques, and attack models.

Course Outcomes

CO1: Understand classical cryptography techniques and apply cryptanalysis
CO2: Analyze measures for securing cryptosystem
CO3: Apply and analyze operations on Feistel and non-Feistel structures
CO4: Apply asymmetric encryption techniques for securing messages

CO-PO Mapping

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2			1									2	1
CO2	2	2	1	1									2	1
CO3	2	3	2	1									2	1
CO4	2	2	1	1									3	1

Syllabus

Unit 1

Basics of number theory: Integers and operations on integers - Modular arithmetic - Prime Numbers - Primality related properties. Basic conventions and Terminology - Substitution Ciphers -Transposition ciphers - Rotor machines - Cryptanalysis.

Unit 2

Foundations of Modern Cryptography: Perfect Secrecy-Information and Entropy - Source Coding, Channel Coding, and Cryptography - Product cryptosystems. Symmetric Cryptosystems: Substitution Permutation Networks - DES and Enhancements - AES and its Modes.

Unit 3

Asymmetric Key Cryptography: Basic ideas of Asymmetric Key Cryptography - RSA Cryptosystem - Attacks on RSA Discrete Logarithm Problem and related algorithms – El-Gamal Cryptosystem – ECC. Digital Signatures and hash functions properties.

Text Book(s)

Stallings W. Cryptography and network security: principles and practice. Upper Saddle River: Pearson; 2018.
Padmanabhan TR, Shyamala C K, and Harini N. Cryptography and Security, First Edition, Wiley India Publications; 2011.

Reference(s)

Forouzan BA. Cryptography & network security. McGraw-Hill, Inc.; 2007 Feb 28.

Evaluation Pattern:

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE312	DISTRIBUTED SYSTEMS	L-T-P-C: 3-0-3-4

Course Objectives

- This course is an introduction to the design of distributed systems and algorithms that support distributed computing.
- It aims to provide a practical exposure into the design and functioning of existing distributed systems.

Course Outcomes

CO1: Understand the design principles in distributed systems and the architectures for distributed systems.
CO2: Apply various distributed algorithms related to clock synchronization, concurrency control, deadlock detection, load balancing, voting etc.
CO3: Analyze fault tolerance and recovery in distributed systems and algorithms for the same.
CO4: Analyze the design and functioning of existing distributed systems and file systems.
CO5: Design and implement a simple distributed system and implement different distributed algorithms over it.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2									3	2
CO2	3	3	2	2									3	2
CO3	3	3	2	2									3	2
CO4	3	3	2	2	2								3	2
CO5	3	3	3	1	2								3	2

Syllabus

Unit 1
A Taxonomy of Distributed Systems - Models of computation: shared memory and message passing systems, synchronous and asynchronous systems. Communication in Distributed Systems: Remote Procedure Calls, Message Oriented Communications and implementations over a simple distributed system.

Unit 2
Global state and snapshot algorithms. Logical time and event ordering, clock synchronization, Distributed mutual exclusion, Group based Mutual Exclusion, leader election, concurrency control, deadlock detection, termination detection, implementations over a simple distributed system.

Unit 3
Consistency and Replication: Data Centric Consistency, Client Centric Consistency, Replica Management, Consistency Protocols. Fault tolerance and recovery: basic concepts, fault models, agreement problems and its applications, commit protocols, voting protocols, check pointing and recovery. Distributed file systems: scalable performance, load balancing, and availability.
Case Studies: Dropbox, Google FS (GFS)/ Hadoop Distributed FS (HDFS), Bigtable/HBase MapReduce, RDDs, Apache Spark

Text Book(s)
Andrew S. Tannenbaum and Maarten van Steen, Distributed Systems: Principles and Paradigms, Third Edition, Prentice Hall, 2017.

Reference(s)
Ajay D. Kshemkalyani and Mukesh Singhal, Distributed Computing: Principles, Algorithms, and Systems, Cambridge University Press, 2011.

Garg VK, Garg VK. Elements of distributed computing. John Wiley & Sons; 2002.
George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair, Distributed Systems: Concepts and Design, Fifth Edition, Pearson Education, 2017.
Fokkink W. Distributed algorithms: an intuitive approach. Second Edition, MIT Press; 2018.

Evaluation Pattern:

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE442	PERVASIVE AND UBIQUITOUS SYSTEMS	L-T-P-C: 3-0-0-3

Pre-Requisite(s):19CSE301 Computer Networks

Course Objectives

- This course is an introduction to the fundamental concepts and theories in pervasive computing as well as the technologies and applications. The course also covers various aspects of design and implementation of pervasive middleware and real application systems.

Course Outcomes

CO1: Understand the foundations and design of pervasive computing systems and its applications.
CO2: Understand the design of middleware for pervasive systems and the different functionalities and algorithms in the middleware.
CO3: Understand the human computing paradigms in pervasive and ubiquitous systems and apply different technique for context awareness.
CO4: Analyze the pervasive system design and techniques in specific applications and real-world pervasive systems

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	3										3	2
CO2	3	2	3										3	2
CO 3	3	2	3	2		2	2	2					3	2
CO4	3	2	3	2	2	2	2	2					3	2

Syllabus

Unit 1
Introduction and Background: Perspectives of Pervasive Computing, Challenges, Technology, Introduction to ubiquitous computing, Modeling, Architectures. Disappearing Hardware: invisibility, evolving hardware, building ubiquitous systems, problems and limits. Wireless technologies for pervasive systems: Wireless Data Transmission, Bluetooth, WiFi, RFID, Lora, comparison of technologies.

Unit 2
Middleware for Pervasive Systems: Resource Management, User Tracking, Context Management, Service Management, Data Management, Security Management, Example middleware and applications. Context Collection, User Tracking, and Context Reasoning: context category, context collection framework, user tracking and localization, position identification, positioning systems and technologies, context reasoning, sensors and sensor networks.

Unit 3
HCI in Pervasive Environments: Wearable Computing, Basic concepts, Techniques, HCI Service and Interaction Migration, Context-Driven HCI Service Selection, Case Studies. Service Discovery: Data Transmission, Disk and Server Scheduling Algorithms, Pervasive Computing Applications - iCampus Prototype, iSensorium, IPSpace: An IPv6-Enabled Intelligent Space etc.

Text Book(s)
Genco, S. Sorce. Pervasive Systems and Ubiquitous Computing, WIT Press; 2010.

Reference(s)
Yao Shen, Feilong Tang, Jingyu Zhou, Minyi Guo. Pervasive Computing, CRC Press ;2016.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19ECE432	SOFTWARE DEFINED NETWORKS	L-T-P-C: 3-0-0-3

Pre Requisite(s): Computer Networks

Course Objectives

- To learn about Software Defined Networking (SDN) foundations and emerging Internet architectural framework
- To explore the SDN concepts, architectures, algorithms, protocols and applications related topics including Data Center Networks
- To study and experience about Network Function Virtualization (NFV) and SDN ECO systems

Course Outcomes

CO1: Able to understand Networking basics and necessity and genesis of Software defined Networking
CO2: Able to understand various SDN Architectures and Network Function Virtualization
CO3: Able to explore emerging SDN models
CO4: Able to implement simple SDN protocols using programming language

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	2	-	-	-	2	2	2	3	3
CO2	3	2	1	-	-	2	-	-	-	2	2	2	3	3
CO3	3	2	1	-	-	2	-	-	-	2	2	2	3	3
CO4	3	2	3	3	-	2	-	-	3	2	2	2	3	3

Syllabus

Unit 1
Networking Basics - Switching, Addressing, Routing - Switching Architecture – Data - Control, -and Management Planes -Forwarding Rules -Autonomous Switches and Routers - Why SDN? - Evolution of Switches and Control Planes - Cost -Data Center Innovation - Data Center Needs - Genesis of SDN - Forerunners of SDN - Open Source Contributions.

Unit 2
SDN Architecture - Fundamental Characteristics of SDN – Operation – Devices - SDN Controllers – Open Daylight and ONOS - SDN Applications - Northbound and Southbound APIs - Open Flow - Switch-Controller Interaction -Flow Table - Packet Matching - Actions and Packet Forwarding - Extensions and Limitations - Network Function Virtualization (NFV) - SDN vs. NFV – OPNFV - Inline Network Functions - NFV Orchestration.

Unit 3
Emerging SDN Models - Protocol Models - NETCONF, BGP, MPLS, Controller Models, Application Models – Proactive – Declarative – External - SDN in Datacenters – Multitenancy - Failure Recovery - SDN in Internet exchange Points (IXPs) - SDN Ecosystem - White-box switching - Open Sourcing SDN - Open Networking Foundation - Open Daylight – ONOS – OpenStack - OpenSwitch - Programming Assignments for implementing some of the theoretical concepts listed above.

Text Book(s)

Goransson P, Black C, Culver T, "Software Defined Networks: A Comprehensive Approaches", l: Elsevier Science; 2016.

Gray K, Nadeau TD, Amsterdam Boston Heidelberg, Morgan Kaufmann, "Network Function Virtualization" 2016.

Nadeau TD, Gray K. SDN: "Software Defined Networks ; [an Authoritative Review of Network Programmability *Technologies]", 1. ed. Beijing: O'Reilly; 2013.*

Reference(s)

Hu F, ed. "Network Innovation through OpenFlow and SDN: Principles and Design". Boca Raton London New York: CRC Press, Taylor & Francis Group, 2014.

Qi H, Li K. "Software Defined Networking Applications in Distributed Datacenters", Cham: Springer International Publishing; 2016. doi:10.1007/978-3-319-33135-5.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CSE458	COMPUTATIONAL INTELLIGENCE	L-T-P-C: 2-0-3-3

Pre-Requisite(s):19MAT111 Multivariable Calculus, 19MAT112 Linear Algebra, 19MAT205 Probability and Random Processes

Course Objectives

- This course covers practical adaptation and self-organization concepts, paradigms, algorithms and implementations that enable or facilitate appropriate actions (intelligent behavior) in complex and changing environments.
- The course includes mainly bottom-up approaches to solutions of (hard) problems based on various heuristics (soft computing), rather than exact approaches of traditional artificial intelligence based on logic (hard computing) mainly nature-inspired methods.

Course Outcomes

CO1: Understand conventional artificial intelligence approaches, algorithms and methods.
CO2: Apply conventional artificial intelligence algorithms and approaches to real-life problems.
CO3: Analyze Fuzzy and swarm optimization systems in application scenarios.
CO4: Understand hybridization of conventional artificial intelligence algorithms.
CO5: Apply improved algorithmic approaches to application scenarios.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	1	1						3	2
CO2	3	2	2	2	3	2	2						3	2
CO3	3	2	2	2	3	2	2						3	2
CO4	3	1	2	2	3	1	1						3	2
CO5	3	1	2	2	3	2	2						3	2

Syllabus
Unit 1
Fuzzy Systems, Fuzzy Sets, Fuzzy Logic, Fuzzy Relationships, Fuzzy Inference, Alternate fuzzy logic operations, Adaptation of fuzzy systems, Disjunctive versus conjunctive reasoning

Unit 2
Swarm Intelligence, Foundations Ants, Termites, Gnats, Birds Applications, Feedforward Neural Networks, Foundations of pattern classification & regression, Rosenblatt Perceptron, Training Neural networks

Unit 3
Smithing QwikNet, Software Applications, Evolutionary Computation, Genetic Algorithms, Boundary Marking, Particle Swarm, Search

Text Book(s)
Eberhart RC, Shi Y. Computational intelligence: concepts to implementations. Elsevier; 2007.

Reference(s)
Karray F, Karray FO, De Silva CW. Soft computing and intelligent systems design: theory, tools, and applications. Pearson Education; 2004.
Engelbrecht AP. Computational intelligence: an introduction. John Wiley & Sons; 2007.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	10	
Continuous Assessment (Lab) (CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE444	REAL-TIME SYSTEMS	L-T-P-C: 3-0-0-3

Pre-Requisite(s):19CSE213 Operating Systems, 19CSE303 Embedded Systems

Course Objectives

- This course introduces the student to real-time systems, its foundations, models, and design with respect to real-time operating systems.
- The course also aims to provide a practical exposure into design and functioning of state-of-the-art real-time systems.

Course Outcomes

CO1: Understand the foundation of real-time systems and apply the concept of time and time synchronization in their modelling.
CO2: Apply the concepts of temporal relations and determinism in RTSs, and design and functionalities of RTOSs.
CO3: Analyze different algorithms for real-time scheduling, resource sharing and fault tolerance in RTSs.
CO4: Analyze the design and functioning of existing real-time systems and real-time operating systems.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	3										3	2
CO2	3	2	3										3	2
CO3	3	2	3	2									3	2
CO4	3	2	3	2	2	2							3	2

Syllabus

Unit 1
Introduction: What is real-time?, applications, models of real-time systems (RTS), characteristics, safety and reliability, types, timing constraints, examples of RTSs. Global Times: time and order, time measurement, dense time vs sparse time, internal clock synchronization, external clock synchronization. Real-time model: components and messages, component state, gateway component, linking interface specification, component integration.

Unit 2
Temporal relations: real-time entities, observations (untimed, indirect, state and event), real-time images and objects, temporal accuracy, permanence and idempotency, determinism. Real-time task scheduling : types of real-time tasks, task scheduling, concepts and classification, algorithms – clock driven scheduling, hybrid schedulers, event driven scheduling, EDF scheduling, rate monotonic algorithm, multiprocessor task allocation, dynamic allocation of tasks. Resource sharing and Dependencies: resource sharing, priority inversion, basic concepts of faults, errors, failures, anomaly detection, fault tolerance, robustness.

Unit 3
Real-time communication: requirements, design issues, communication model, flow control, event triggered communication, rate constrained communication, time-triggered communication. Real-time operating systems: features, inter-component communication, task management, time as data, inter-task interactions, Process I/O, error detection, Unix as a RTOS, POSIX, Contemporary RTOSs like PSOS, RT Linux et, benchmarking realtime systems.

Text Book(s)

Kopetz H. Real-time Systems: Design Principles for Distributed Embedded Applications. Springer Science & Business Media; 2011 Apr 15.

Reference(s)

Rajib Mall. Real-Time Systems: Theory and Practice, Pearson, First Edition; 2006.

Laplante PA. Real-time Systems Design and Analysis: An Engineer's Handbook. Wiley-IEEE Press; 1996 Nov 1.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE453	NATURAL LANGUAGE PROCESSING	L-T-P-C: 2-0-3-3

Pre-Requisite(s):19MAT111 Multivariable Calculus, 19MAT112 Linear Algebra, 19MAT205 Probability and Random processes

Course Objectives

- This course is devoted to the study of phonological, morphological and syntactic processing. These areas will be approached from both a linguistic and an algorithmic perspective.
- The course will focus on the computational properties of natural languages and of the algorithms used to process them, as well as the match between grammar formalisms and the linguistic data that needs to be covered.

Course Outcomes

CO1: Understand the models, methods, and algorithms of statistical Natural Language Processing (NLP) for common NLP tasks.
CO2: Understand mathematical and statistical models for NLP.
CO3: Understand linguistic phenomena and linguistic features relevant to each NLP task.
CO4: Apply probabilistic models in code.
CO5: Apply learning models to NLP tasks such as speech recognition, machine translation, spam filtering, text classification, and spell checking

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3									3	2
CO2	3	2	3	2									3	2
CO3	3	2	3	2									3	2
CO4	3	1	2	2	3								3	2
CO5	3	1	2	2	3								3	2

Syllabus

Unit 1
Introduction- Human languages, models, ambiguity, processing paradigms; Phases in natural language processing, applications. Text representation in computers, encoding schemes. Linguistics resources- Introduction to corpus, elements in balanced corpus, TreeBank, PropBank, WordNet, VerbNet etc. Resource management with XML, Management of linguistic data with the help of GATE, NLTK. Regular expressions, Finite State Automata, word recognition, lexicon. Morphology, acquisition models, Finite State Transducer, N-grams, smoothing, entropy, HMM, ME, SVM, CRF.

Unit 2
Part of Speech tagging- Stochastic POS tagging, HMM, Transformation based tagging (TBL), Handling of unknown words, named entities, multi word expressions. A survey on natural language grammars, lexeme, phonemes, phrases and idioms, word order, agreement, tense, aspect and mood and agreement, Context Free Grammar, spoken language syntax. Parsing- Unification, probabilistic parsing, TreeBank. Semantics- Meaning representation, semantic analysis, lexical semantics, WordNet Word Sense Disambiguation- Selectional restriction, machine learning approaches, dictionary based approaches.

Unit 3

Discourse- Reference resolution, constraints on co-reference, algorithm for pronoun resolution, text coherence, discourse structure. Applications of NLP- Spell-checking, Summarization Information Retrieval- Vector space model, term weighting, homonymy, polysemy, synonymy, improving user queries. Machine Translation–EM algorithm - Discriminative learning - Deep representation learning - Generative learning.

Text Book(s)

Martin JH, Jurafsky D. Speech and language processing: An introduction to natural language processing, computational linguistics, and speech recognition. Upper Saddle River: Pearson/Prentice Hall; 2009.

Reference(s)

James A.. Natural language Understanding,Second Edition, Pearson Education;1994.
Bharati A., Sangal R., Chaitanya V.. Natural language processing: a Paninian perspective, PHI; 2000.
Tiwary U S, Siddiqui T. Natural language processing and information retrieval. Oxford University Press, Inc.; 2008.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	10	
Continuous Assessment (Lab) (CAL)	40	
End Semester		30

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE440	BIOMETRICS	L-T-P-C: 3-0-0-3

Course Objectives

- This course covers fundamental concepts, characteristics and processes of biometrics including identity management system and performance of traits for verification recognition.
- It helps students explore software tools for verification and recognition of biometrics standards

Course Outcomes

CO1: Understand the fundamental concepts, characteristics and processes of biometrics.
CO2: Apply physiological and behavioural modalities for real world problems towards identity management system.
CO3: Analyze the performance of various traits / indicators or identifiers for verification and recognition.
CO4: Design a pattern recognition system based on multibiometric system by applying various fusion techniques and evaluate the performance.
CO5: Explore software tools for verification and recognition with biometric standards

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												3	2
CO2							1	1					3	2
CO3		2		2									3	2
CO4			3			1							3	2
CO5					1				1	1			3	2

Syllabus

Unit 1
Introduction - Biometric fundamentals – Biometric technologies – Biometrics vs traditional techniques – Characteristics of a good biometric system – Benefits of biometrics – Key biometric processes: verification, identification and biometric matching – Performance measures in biometric systems. Basics in biometric errors estimation. Enrollment, verification and identification.

Unit 2
Physiological Biometrics - Leading technologies: Finger-scan – Face Recognition – face detection, alignment, feature extraction, matching. Classic subspace methods. Hand-tuned feature descriptors. Iris-scan Eye and iris morphogenesis, genetic penetrance. Iris image preprocessing, segmentation, formatting and filtering. Daugman's method, iris code, statistical properties of the iris code. Behavioural Biometrics: Leading technologies: Signature-scan – Keystroke scan – components, working principles, strengths and weaknesses.

Unit 3
Multi-Biometric Fusion. Levels of fusion: sensor, feature, rank, decision. Score normalization and fusion rules. Quality-based fusion and failure prediction.
Standards in Biometrics - Assessing the Privacy Risks of Biometrics – Designing Privacy - Sympathetic Biometric Systems – Need for standards – different biometric standards - Categorizing biometric applications. Secure transfer of biometric data. Secure storage, use of smart cards, principles of match-off-card and match-on-card techniques.Biometrics in the cloud.Points of attack.Privacy models.

Text Book(s)
Flynn PJ, Jain AK, Ross AA, editors. Handbook of biometrics. Springer; 2008.

Reference(s)

Paul Reid, Samir Nanavati, Michael Thieme and Raj Nanavati. Biometrics – Identity Verification in a Networked World, Wiley-dreamtech India Private Limited, New Delhi; 2003.
John R Vacca. Biometric Technologies and Verification Systems, Elsevier Inc;2007.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

ANALOG ELECTRONICS

19ECE332	MIXED SIGNAL DESIGN	L-T-P-C: 3-0-0-3

Pre Requisite(s): Linear Integrated Circuits

Course Objectives

- To understand the sampling and its limitation in mixed signal environment
- To provide a design platform in Verilog AMS
- To design active filters, data converters and PLL

Course Outcomes

CO1: Ability to understand the operation of active filters
CO2: Ability to design data converters
CO3: Ability to design a MOS based PLL
CO4: Ability to model mixed signal circuits in Verilog – AMS

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	3	3	-	-	-	-	-	-	-	-	-	2	-
CO3	2	3	3	-	-	-	-	-	-	-	-	-	2	2
CO4	2	3	3	-	-	-	-	-	-	-	-	-	2	2

Syllabus

Unit 1
Continuous Time Signals – Discrete Time Signals – Laplace Transform – Z Transform – Nyquist Sampling theorem, Sample and Hold Circuits – Top & Bottom Plate Sampling - Analog Continuous Time Filters –Passive and Active Filters –Switched Capacitor Filters– The gm-C filter. Introduction to Verilog A and Verilog AMS.

Unit 2
Ideal D/A and A/D Converters – Quantization Noise and SNR – Nyquist Rate A/D Converters – Flash ADC- Successive Approximation Register (SAR) ADC- Pipelined ADC- Capacitor array DAC- Matching of capacitors- Choice of unit capacitance-Split capacitor array-Techniques for improving SNR.

Unit 3
Introduction to PLLs-Linearized PLL models- Mixed Signal Current Mode and Voltage Mode converters.

Text Book(s)
B. Razavi, "Principles of Data Conversion System Design", John Wiley and Sons, 1995.
B. Razavi, "Design of Analog CMOS Integrated Circuits", McGraw Hill, 2001.

Reference(s)
B. Razavi, "RF Microelectronics", Prentice Hall, 2011.
R. Jacob Baker, "CMOS Mixed Signal Circuit Design", Wiley India Pvt. Ltd, 2008.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE334	ANALOG IC DESIGN	L-T-P-C: 3-0-0-3

Pre Requisite(s): Analog Electronic Circuits

Course Objectives

- To understand the importance of biasing in analog circuits
- To develop small signal model parameters for amplifier circuits based on small signal equivalents of MOS device
- To design CMOS operational amplifiers

Course Outcomes

CO1: Able to understand the small signal operation of MOSFETs
CO2: Ability to understand the amplifier characteristics
CO3: Ability to design and analyze CMOS amplifiers
CO4: Ability to model, design and analyze circuits using simulation tools

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-	2	-
CO3	2	3	3	-	-	-	-	-	-	-	-	-	2	-
CO4	2	3	3	-	-	-	-	-	-	-	-	-	2	2

Syllabus

Unit 1
Introduction to Analog Integrated Circuits - Notation, Symbols and Terminology, Example of Analog and mixed signal circuits - CMOS Technology - Basic MOS semiconductor fabrication process -PN junction - The MOS Transistor - CMOS Device Modeling, Large Signal Model - Small Signal Model - Sub threshold MOS model - SPICE Simulation.

Unit 2
Analog CMOS Sub circuits - MOS Switch, MOS Diode / Active Resistor, Current sinks and sources, supply independent biasing - cascode current mirrors - sensitivity - Frequency response of active loaded MOS amplifiers - Differential amplifiers - Large signal and small signal analysis of Differential amplifier - active loaded Differential amplifiers - CMRR.

Unit 3
CMOS Operational Amplifier - Design and analysis of two stage CMOS op-amps - Biasing circuits - Frequency response - Design problems of Cascode Amplifier and Telescopic Cascode Amplifier.

Text Book(s)
P. Allen and D. Holberg, "CMOS Analog Circuit Design", Oxford University Press, Second Edition, 2012.
B. Razavi, "Design of Analog CMOS Integrated Circuits", McGraw Hill, 2001.

Reference(s)
Sedra/Smith, "Microelectronic circuits", 7th edition, Oxford University Press, 2015.
P. Gray, P. Hurst, S. Lewis, and R.G. Meyer, "Analysis and Design of Analog Integrated Circuits", John Wiley and Sons, Fourth Edition, 2001.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE335	APPLICATIONS OF LINEAR INTEGRATED CIRCUITS	L-T-P-C: 3-0-0-3

Pre Requisite(s): Analog Electronic Circuits

Course Objectives

- To understand how to choose the right operational amplifier
- To understand operation of various op-amp based circuits
- To understand the concept and operation of operational transconductance amplifiers
- To be able to design various circuits using operational amplifiers

Course Outcomes

CO1: Ability to choose the operation of various high level circuits, using opamps
CO2: Ability to understand the operation of operational transconductance amplifiers
CO3: Ability to design circuits to given specifications, using op-amps
CO4: Ability to use simulation tools (PSpice) to understand and analyse circuits

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	2
CO2	3	-	-	-	-	-	-	-	-	-	-	-	2	2
CO3	3	-	3	-	-	-	-	-	-	-	-	-	2	2
CO4	-	3	-	-	-	-	-	-	-	-	-	-	2	2

Syllabus

Unit 1
Op-amp Basics - OA741 – Internal Schematic - Parameters - Frequency Compensation of voltage and current feedback amplifiers - OP07.

Unit 2
Instrumentation Amplifiers - Current Sources using opamps - Isolation Amplifiers - Operational Transconductance Amplifiers (OTA) - Log and Anti-Log amplifiers – Multipliers - Voltage to Frequency and Frequency to Voltage Converters - Phase Sensitive Detectors (PSD) - Phase Locked Loops (PLL).

Unit 3
Voltage References - Low Noise Current Differencing and Low power operational amplifiers - Voltage regulators - IC Protection Circuits - Analog to Digital Converters - Σ- ADC.

Text Book(s)
Sedra A and Smith K C, "Microelectronic Circuits", Sixth Edition, New York: Oxford University Press, 2010.
Franco S., "Design with operational amplifiers and analog integrated circuits", Fourth edition. New York, NY, McGraw-Hill Education, 2015.

Reference(s)
Gray P R, Hurst P J, Lewis S H, and Meyer R G, "Analysis and design of analog integrated circuits", Fifth edition, New York: Wiley, 2009.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE331	BIOMEDICAL INSTRUMENTATION	L-T-P-C: 3-0-0-3

Pre Requisite(s): Electronic Devices and Circuits

Course Objectives

- To introduce the principles of bio potentials and the characteristics of various biomedical signals
- To provide the deep understanding about the types of electrodes and amplifiers used for ECG, EMG, EEG, ERG and EOG measurement systems
- To familiarize the students about the principles of diagnostic and therapeutic equipment's
- To bring out the importance of imaging techniques

Course Outcomes

CO1: Able to understand the principles of bio potentials and the characteristics of various biomedical signals
CO2: Able to understand the types of electrodes and amplifiers used for ECG, EMG, EEG, ERG and EOG measurement systems
CO3: Able to familiarize the fundamental principles of diagnostic and therapeutic equipment's.
CO4: Able to understand various medical imaging techniques

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	2	2	-	-	-	-	-	-	-	-	-	2	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-	2	-

Syllabus

Unit 1
Cell resting potential and action potentials - Origin of bio potentials - characteristics - Frequency and amplitude ranges. ECG - Einthoven's triangle - 3 lead ECG system. EEG – electrode system - Origin and characteristics of EMG - EOG - ERG electrodes and transducers - Electrode-electrolyte interface - Electrode-skin interface - Half cell potential - Impedance - Polarization effects of electrode - Nonpolarizable electrodes - Types of electrodes - Surface - needle and micro electrodes - ECG - EMG - EEG Electrodes.

Unit 2
Diagnostic and Therapeutic Equipments - Blood pressure monitors - Electrocardioscope - Pulse Oximeter - pH meter - Auto analyzer-Pacemakers-Defibrillator - Heart lung machine - Nerve and muscle stimulators - Dialysis machines - Surgical diathermy equipments – Nebulizer - Inhalator - Aspirator - Humidifier - Ventilator and Spirometer.

Unit 3
Medical imaging techniques - Basics of diagnostic radiology - Production - Nature and properties of X rays - X-ray machine block diagram - Digital radiography - CT basic Principle and block diagram - Radioisotopes in medical diagnosis - Physics of radioactivity - Gamma Camera - SPECT Scanner - PET Scanner - Principles of NMR Imaging systems. Ultrasonic Imaging Systems - Physics of Ultrasound waves - Doppler effect - Medical Ultrasound. Electrical safety - Physiological effects of electricity - Micro and macro shock hazards - Electrical Safety codes and standards - Protection of patients.

Text Book(s)

R S Khandpur, "Handbook of Biomedical Instrumentation", Third Edition, Tata McGraw Hill Publishing Company Limited, 2014.

John G Webster, "Medical Instrumentation - Application and Design", Fourth Edition, John Wiley and Sons, 2009.

Reference(s)

Leslie Cromwell, Fred. J. Weibell, Erich. A. Pfeiffer, "Biomedical Instrumentation & Measurements", Second Edition, Pearson Education., 2011.

Mandeep Singh, "Introduction to Biomedical Instrumentation", Second Edition, Prentice-Hall of India Pvt. Ltd, 2014.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE432	SOFTWARE DEFINED NETWORKS	L-T-P-C: 3-0-0-3

Pre Requisite(s): Computer Networks

Course Objectives

- To learn about Software Defined Networking (SDN) foundations and emerging Internet architectural framework
- To explore the SDN concepts, architectures, algorithms, protocols and applications related topics including Data Center Networks
- To study and experience about Network Function Virtualization (NFV) and SDN ECO systems

Course Outcomes

CO1: Able to understand Networking basics and necessity and genesis of Software defined Networking
CO2: Able to understand various SDN Architectures and Network Function Virtualization
CO3: Able to explore emerging SDN models
CO4: Able to implement simple SDN protocols using programming language

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	2	-	-	-	2	2	2	3	3
CO2	3	2	1	-	-	2	-	-	-	2	2	2	3	3
CO3	3	2	1	-	-	2	-	-	-	2	2	2	3	3
CO4	3	2	3	3	-	2	-	-	3	2	2	2	3	3

Syllabus

Unit 1
Networking Basics - Switching, Addressing, Routing - Switching Architecture – Data - Control, -and Management Planes -Forwarding Rules -Autonomous Switches and Routers - Why SDN? - Evolution of Switches and Control Planes - Cost -Data Center Innovation - Data Center Needs - Genesis of SDN - Forerunners of SDN - Open Source Contributions.

Unit 2
SDN Architecture - Fundamental Characteristics of SDN – Operation – Devices - SDN Controllers – Open Daylight and ONOS - SDN Applications - Northbound and Southbound APIs - Open Flow - Switch-Controller Interaction -Flow Table - Packet Matching - Actions and Packet Forwarding - Extensions and Limitations - Network Function Virtualization (NFV) - SDN vs. NFV – OPNFV - Inline Network Functions - NFV Orchestration.

Unit 3
Emerging SDN Models - Protocol Models - NETCONF, BGP, MPLS, Controller Models, Application Models – Proactive – Declarative – External - SDN in Datacenters – Multitenancy - Failure Recovery - SDN in Internet exchange Points (IXPs) - SDN Ecosystem - White-box switching - Open Sourcing SDN - Open Networking Foundation - Open Daylight – ONOS – OpenStack - OpenSwitch - Programming Assignments for implementing some of the theoretical concepts listed above.

Text Book(s)

Goransson P, Black C, Culver T, "Software Defined Networks: A Comprehensive Approaches", l: Elsevier Science; 2016.

Gray K, Nadeau TD, Amsterdam Boston Heidelberg, Morgan Kaufmann, "Network Function Virtualization" 2016.

Nadeau TD, Gray K. SDN: "Software Defined Networks ; [an Authoritative Review of Network Programmability *Technologies]", 1. ed. Beijing: O'Reilly; 2013.*

Reference(s)

Hu F, ed. "Network Innovation through OpenFlow and SDN: Principles and Design". Boca Raton London New York: CRC Press, Taylor & Francis Group, 2014.

Qi H, Li K. "Software Defined Networking Applications in Distributed Datacenters", Cham: Springer International Publishing; 2016. doi:10.1007/978-3-319-33135-5.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

Signal Processing

19ECE458	ADAPTIVE SIGNAL PROCESSING	L-T-P-C: 3-0-0-3

Pre Requisite(s): Signals and Systems

Course Objectives

- To introduce the adaptive filter for estimation and tracking
- To develop various adaptive algorithms for communication systems
- To apply the adaptive theory to a variety of practical problems

.

Course Outcomes

CO1: Able to analyze the filtering tasks and identify the need for adaptation in filtering
CO2: Able to design filter to meet performance requirements derived from various real life applications
CO3: Able to develop algorithms for the design of filters to track variations of non-stationary random process
CO4: Able to evaluate the performance of the developed filter in terms of computational complexity convergence time and stability

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	-	2	-
CO2	2	2	3	-	-	-	-	-	-	-	-	-	2	-
CO3	2	3	3	2	-	-	-	-	-	-	-	2	3	2
CO4	3	2	3	2	-	-	-	-	-	-	-	2	3	2

Syllabus

Unit 1
Discrete time stochastic processes - Re-visiting probability and random variables - Discrete time random processes- Power spectral density – properties- Autocorrelation and covariance structures of discrete time random processes- Eigen-analysis of autocorrelation matrices-Spectrum Estimation - Non-parametric methods - Estimators and its performance analysis - periodogram estimators - signal modeling - parameter estimation using Yule- Walker Method.

Unit 2
LMS Algorithm - Need for adaptive filtering - Wiener FIR adaptive filters – Newton's method - Steepest descent method –Convergence analysis - Performance surface – Least Mean Square (LMS) adaption algorithms– Convergence – Excess mean square error -Leaky LMS - Normalized LMS – Block LMS-Least Squares Algorithm: Recursive least squares (RLS) algorithm for adaptive filtering of stationary process- Matrix inversion – Comparison with LMS – RLS for quasi-stationary signals- Exponentially weighted RLS- Sliding window RLS – RLS algorithm for array processing – Adaptive beam forming – Other applications of adaptive filters – Echo cancellation – Channel Equalization.

Unit 3
Kalman Filtering - Statistical filtering for non-stationary signals – Kalman filtering- Principles – Initialization and tracking – Scalar and vector Kalman filter – Applications in signal processing – Time varying channel estimation – Radar tracking

Text Book(s)

Simon O. Haykin, "Adaptive Filter Theory", 5 th Edition, Pearson Education Limited, 2014.

Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon, "Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering, and Array Processing", McGraw-Hill, 2005.

Reference(s)

Monson H.Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons, Inc., Singapore, 2002.

Sopocles J. Orfanidis, "Optimum Signal Processing", McGraw Hill, 2007.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE441	AVIONICS	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce concept of engineering design for avionics systems
- To impart knowledge in Fault Detection methodologies
- To make aware the various generations of avionics evolution
- To help understand the physical principles behind the functioning of manifold avionics sensor systems

.

Course Outcomes

CO1: Able to understand Concept of avionics systems engineering design
CO2: Able to understand Fault Detection methodologies
CO3: Able to understand the principles in various generations of avionics evolution
CO4: Able to understand physical principles of avionics sensor systems

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	2	-	2	-
CO2	3	3	-	3	-	-	-	-	-	-	-	-	2	-
CO3	2	3	-	-	-	-	-	-	-	-	-	2	3	-
CO4	3	3	-	2	-	-	-	-	-	-	-	-	3	-

Syllabus

Unit 1

Introduction to avionics - Component specifications - Packaging standards - LRU - LRM - IMA - Backplanes - PXIe, VME - System design parameters - Traceability - Ilities - Fault tolerance and recovery - FMEA – FTA.

Unit 2

Avionics architecture - PAVE PILLAR - PAVE PACE - JIAWG - Systems Integration - Databus topologies & Word formats - MIL-STD 1553B - ARINC 429 - ARINC 629.

Unit 3

Cockpit instruments - Flightdeck UI - GNC - Sensors - SMS - Data communications - Spectrum Warfare.

Text Book(s)

Moir I. and Allan G Seabridge A. G., "Civil Avionics Systems", Professional Engineering Publishing Limited (London), 2003.
Helfrick A., "Principles of Avionics, Airline Avionics", 4 ed., Avionics Communications Inc., 2007.

Reference(s)

Clifford M., "Aeronautical Engineer's Data Book", Butterworth-Heineman (Oxford), 2002.
Spitzer C. R., "The Avionics Handbook", CRC Press LLC, 2001.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE455	BIOMEDICAL SIGNAL PROCESSING	L-T-P-C: 3-0-0-3

Pre Requisite(s): Digital Signal Processing

Course Objectives

- To introduce origin and characteristics of biomedical signals
- To provide an understanding on the application of signal processing concepts in analyzing biomedical signals
- To implement algorithms for various biomedical signal processing tasks

Course Outcomes

CO1: Able to understand techniques for various levels of tasks in biomedical signal analysis
CO2: Able to adopt appropriate algorithms according to nature of the signal and acquisition characteristics
CO3: Able to develop contemporary algorithms to address complex problems
CO4: Able to implement biomedical signal processing algorithms using appropriate tools

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	2	2	-
CO2	2	3	2	2	-	-	-	-	-	-	-	-	2	2
CO3	2	-	3	3	-	-	-	-	-	-	-	-	3	3
CO4	2	-	-	-	-	-	-	2	-	-	-	-	2	2

Syllabus

Unit 1
Review of Signal Processing – LTI systems – Convolution – Transform Analysis – Fourier Spectrum – Power Spectral Density – Time and Frequency Domain filters – Introduction to Biomedical signals – Origin and Characteristics.

Unit 2
Filtering for Removal of Artifacts in ECG – Algorithms for QRS Detection – Morphological Analysis of ECG Waves – EEG Rhythms - Waves and Transients – Correlation Analysis of EEG Channels.

Unit 3
Image Artifact Removal – Mask Processing – Contrast Enhancement – Histogram Equalization – Histogram Matching – Detection of Regions of Interest – Thresholding – Region Growing – Application in Selected Biomedical Image.

Text Book(s)
Oppenheim A V, Schafer R W and Buck J R, "Discrete-Time Signal Processing", Third Edition, Prentice Hall, 2009.
Rangayyan R M, "Biomedical Signal Analysis-A Case- Study Approach", Second Edition, Wiley -IEEE Press, 2015.

Reference(s)
Kay S M, "Fundamentals of Statistical Signal Processing; Practical Algorithm Development", Vol . III, Prentice Hall, 2013.
Begg R, Palaniswami M and Lai D T H, "Computational Intelligence in Biomedical Engineering", CRC Press, 2007.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Report

19ECE456	HYPERSPECTRAL IMAGE ANALYSIS	L-T-P-C: 3-0-0-3

Pre Requisite(s): Signals and Systems

Course Objectives

- To introduce the acquisition of hyperspectral imaging using various sensors
- To provide the students with concepts, methodologies and applications of hyper spectral Imaging technology
- To address the challenges of hyper spectral imaging in various fields

Course Outcomes

CO1: Able to understand various hyperspectral image acquisition techniques
CO2: Able to analyze the pre-processing techniques used for hyperspectral image analysis
CO3: Able to apply the machine learning algorithms used for hyperspectral image classification
CO4: Able to implement the pre-processing and classification techniques for various applications

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	3	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-	3	-
CO4	3	3	3	3	-	-	-	-	-	-	-	-	3	2

Syllabus

Unit 1
Hyperspectral Imaging - Background and Equipment - Digital Images - Multivariate images and hyperspectral images - Study of hyperspectral sensors- Hyperspectral image generation – Essentials of hyperspectral image analysis - Principles of hyperspectral Image Analysis in remote sensing, -Technology and industry - Pre-processing of hyper spectral imagery - atmospheric calibration/correction - spectral correlation and data redundancy - dimensionality reduction and feature selection - end member extraction.

Unit 2
Clustering and classification in hyperspectral Imaging - Supervised and unsupervised classification of hyperspectral Imaging – Visualization and colouring of segmented images and graphs- Hyperspectral image data conditioning and regression analysis – Principles of image cross validation-Detection, Classification and quantification in hyperspectral imaging – Resolution and calibration in hyperspectral images.

Unit 3
Applications of hyper spectral remote sensing - vegetation biophysical and biochemical parameters - soil properties - mineral identification - water quality assessment - material identification and mapping - anomaly detection - reference spectral libraries- USGS - and ASTER spectral libraries.

Text Book(s)
Hans F. Grahn and Paul Geladi, "Techniques and Applications of Hyperspectral Image Analysis", First Edition, John Wiley & Sons, Ltd, 2007.
Wang. L and Zhao. C, "Hyperspectral Image Processing", First Edition, Springer, 2016.

Reference(s)

Marcus Borengasser, William S. Hungate, and Russell Watkins, Hyper spectral Remote Sensing: Principles and Applications, First Edition, CRC Press, 2007.Pramod K. Varshney and Manoj K. Arora, Advanced Image Processing Techniques for Remotely Sensed Hyperspectral Data, First Edition, Springer-Verlag Berlin Heidelberg, 2004.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE454	IMAGE PROCESSING	L-T-P-C: 3-0-0-3

Pre Requisite(s): Signals and Systems

Course Objectives

- To introduce the fundamental concepts and techniques in basic digital image processing
- To familiarize mathematical transforms necessary for image processing
- To get sufficient expertise in both the theory of two-dimensional signal processing and its wide range of applications such as image enhancement, image compression, and image segmentation
- To apply various image processing algorithms to solve problems in different domains

Course Outcomes

CO1: Able to analyze the necessity for various image transforms and their properties
CO2: Able to understand the different techniques adapted for image enhancement in spatial and frequency domain
CO3: Able to evaluate the image compression techniques in spatial and frequency domain
CO4: Able to pursue research in image analysis and applications

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	2	2	-
CO2	2	2	-	-	-	-	-	-	-	-	-	2	2	-
CO3	2	3	3	2	-	-	-	-	-	-	-	2	3	2
CO4	3	2	3	2	-	-	-	-	-	-	-	2	3	3

Syllabus

Unit 1
Digitization & Sampling - Elements of visual perception Brightness & contrast - Image sensing & Acquisition- Image sampling & Quantization-some basic relationships between pixels - Distance measures - 2-D transforms and properties - Image Enhancement in spatial and frequency domain - smoothing spatial filters-sharpening spatial filters-Review of sampling and discrete Fourier Transform - Homomorphic filtering.

Unit 2
Image analysis – applications - Spatial and transform features - Edge detection, boundary extraction - AR models and region representation -Moments as features - Image structure - Morphological operations and transforms - Texture - Scene matching and detection - Segmentation and classification.

Unit 3
Image data compression-sub sampling - Coarse quantization and frame repetition - Pixel coding – PCM - entropy coding - run length coding Bit-plane coding. Predictive coding - Transform coding of images Hybrid coding and vector DPCM. Inter frame hybrid coding.

Text Book(s)
Rafael C Gonzalez and Richard E Woods, "Digital Image Processing", Pearson Education, New Delhi, 2009.
Anil K Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India, New Delhi, 2010.

Reference(s)

William K Pratt, "Digital Image Processing", Wiley, 2010.
John W. Woods, "Multidimensional Signal, Image, and Video Processing and Coding", Academic Publisher, 2012.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE357	PATTERN RECOGNITION	L-T-P-C: 3-0-0-3

Pre Requisite(s): Probability Theory and Random Processes

Course Objectives

- To understand the concept of pattern and the basic approach in developing pattern recognition algorithms
- To develop prototype pattern recognition algorithms that can be applied against real-world multivariate data
- To effectively implement pattern recognition algorithms for specific applications using simulation tools

Course Outcomes

CO1: Able to apply the knowledge of mathematics for obtaining solutions in pattern recognition domain
CO2: Able to apply various algorithms for pattern recognition
CO3: Able to map the pattern recognition concepts for solving real life problems
CO4: Able to carry out implementation of algorithms using different simulation tools

CO – PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	3	2	2	-	-	-	-	2	-	-	-	2	2
CO4	3	2	3	-	-	-	-	-	2	-	-	-	2	-

Syllabus

Unit 1
Introduction - Applications of pattern recognition - Probability distribution basics - Discrete distributions and Continuous distributions - Conditional probability distribution and Joint probability distribution - Statistical decision making –Introduction - Bayes' theorem - conditionally independent features - Naïve bayes classifier - Decision boundaries - Unequal costs of error - Estimation of error rates.

Unit 2
Nonparametric decision making – Introduction – histograms - K nearest neighbor method - adaptive decision boundaries adaptive discriminant functions - minimum squared error discriminant functions.

Unit 3
Artificial neural networks - Logistic regression, Perceptron, -Multilayer feed forward neural network – Gradient descent method - back propagation. Dimensionality Reduction Techniques - Principal component analysis - Fisher discriminant analysis.

Text Book(s)
Earl Gose, Richard Johnsonbaugh, Steve Jost, "Pattern Recognition and Image Analysis", Prentice Hall India Private Limited, 2003.
Bishop, Christopher M. "Pattern recognition and machine learning", Springer, 2006.

Reference(s)

Duda, Richard O., Peter E. Hart, and David G. "Stork. Pattern classification", John Wiley & Sons, 2012.
Fausett, Laurene V. "Fundamentals of neural networks: architectures, algorithms, and applications", Vol. 3. Englewood Cliffs: Prentice-Hall, 1994.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Report

19ECE451	SPOKEN LANGUAGE PROCESSING	L-T-P-C: 3-0-0-3

Pre Requisite(s): Digital Signal Processing

Course Objectives

- To introduce the mathematical basics of speech modelling, and its applications
- To help understand the various applications of speech modelling
- To understand the components for developing a natural language processing system
- To comprehend the computational concepts learned in the lecture classes through numerical simulations and programming

Course Outcomes

CO1: Able to understand the mathematical methods required for speech modelling
CO2: Able to understand the various applications of speech modelling theory
CO3: Able to understand the selected machine learning algorithms used in spoken language processing
CO4: Able to carry out implementation of selected speech modelling algorithms, and understand the characteristics of the different types of speech signals
CO5: Develop an insight into the working of the machine learning algorithms used in spoken language processing

CO-PO mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	2	3	-
CO2	2	2	-	-	-	-	-	-	-	-	-	2	2	-
CO3	3	3	-	3	-	-	-	-	-	-	-	-	2	3
CO4	3	2	3	-	-	-	-	-	-	-	-	-	2	3
CO5	3	2	3	-	-	-	-	-	-	-	-	3	3	3

Syllabus

Unit 1

Speech analysis - source filter modeling - Speech sounds - Lip radiation - Linear prediction - Lattice filters - Levisnon-Durbin recursion. Feature extraction for speech processing: Short term Fourier transform –Mel frequency cepstral coefficients (MFCC) - Perceptual linear prediction (PLP) - Mel filter bank energies.

Unit 2

Principles of speech coding - Main characteristics of a speech coder - Key components of a speech coder - From predictive coding to CELP - Improved CELP coders - Wide band speech coding - Audio-visual speech coding. Speech synthesis: Linguistic processing - Acoustic processing - Training models automatically - Text pre-processing - Grapheme to phoneme conversion – Rule based and decision tree approaches - Syntactic prosodic analysis - Prosodic analysis - Speech signal modeling – Introduction to text to speech synthesis (TTS) - popular techniques used in TTS.

Unit 3

Principles of speech recognition - Hidden Markov models (HMM) for acoustic modelling, Observation probability and model parameters - HMM as probabilistic automata - Viterbi algorithm - Language models - n-gram language modelling and difficulties with the evaluation of higher order n-grams and solutions. Spoken keyword spotting approaches - Evaluation metric - Spoken language identification – Approaches – Acoustic – Phonotactic - LVCSR based. Introduction to speaker recognition – popular approaches – introduction to speech understanding – challenges ahead in developing state-of-the-art natural language processing systems.

Text Book(s)

Joseph Mariani (Ed), "Spoken Language Processing", John Wiley & Sons, 2009.
Xuedong Huang, Alex Acero, Hsiao-Wuen Hon, "Spoken Language Processing, A guide to theory, algorithm and system development", Prentice Hall, Inc, New Joursey, USA, 2001.

Reference(s)

J Benesty, M MSondhi, Y. Huang (Eds.), "Springer Handbook on Speech Processing", Springer-Verlag Berlin, Heidenberg, 2008.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE463	SMART SENSORS	L-T-P-C: 3-0-0-3

Pre Requisite(s): Nil

Course Objectives

- To understand various physical phenomena behind the operation of different types of sensors and micro systems
- To design sensors with appropriate electronic interface as a complete system
- To appreciate and understand the applications of sensors

Course Outcomes

CO1: Able understand various physical phenomena behind the operation of different types of sensors and micro systems
CO2: Able to design sensors with appropriate electronic interface as a complete system
CO3: Able to appreciate and understand the applications of sensors
CO4: Able to understand the process of MEMS fabrication

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	2	-	-	-	-	-	-	-	-	2	2	-
CO2	3	-	2	-	-	-	-	-	-	-	-	2	2	2
CO3	3	3	2	-	-	-	-	-	-	-	-	2	2	2
CO4	3	2	2	-	-	-	-	-	-	-	-	2	2	-

Syllabus

Unit 1
Sensor Characteristics and Physical Principles of Sensing - Example of Smart Sensors in nature (Vision –Hearing –touch -and smell) - Classification and Terminology of sensors – Measurands - Physical principles of sensing - electric charges – fields - and potentials Capacitance - magnetism - Induction – resistance - Piezoelectric effect - pyroelectric effect - Hall effect - Seebeck and Peltier effects.

Unit 2
Acoustic Sensors - Magnetic Sensors and Mechanical Sensors - Acoustic waves, piezoelectric materials - Acoustic sensing, -saw sensor - Sensor applications and future trends - Magnetic sensors - effects and materials -Integrated Hall sensors – Magnetotransistors - other magnetics transistor and future trends, Mechanical sensors - piezoresistivity - Piezoresistive sensors - Capacitive sensors. Radiation Sensors Thermal Sensors and Chemical Sensors - Radiation basics - HgCdTe infrared sensors - Visible-light color sensors - high-energy photodiodes - Heat transfer - thermal structures – Thermal sensing elements - Thermal and temperature sensors - Interaction of gaseous species at semiconductor Surfaces - Catalysis - the acceleration of chemical reactions - Thin-film sensors - FET devices for gas and ion sensing.

Unit 3
Micro-and Nanotechnologies or Sensors - Fundamentals of MEMS fabrication - introduction and description of basic processes - MEMS fabrication technologies - bulk micromachining - Surface micromachining - High-aspect-ratio (LIGA and LIGA-Like) technology microfluidics microsystem components Microfluidics microsystem components Nanotechnology - product prospects - application trends Procedures and techniques - the making of

ultrathin films Creation of lateral nanostructures - clusters and Nano crystalline materials and principles of self-organization and Future trends.

Text Book(s)

Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs, and Applications", Springer; 4th ed. 2010.
S. M. Sze, "Semiconductor Sensors", Wiley-Interscience, 1994.

Reference(s)

Gerard Meijer, "Smart sensor systems", Wiley, 2008.
W Gopel, J. Hesse, J. N. Zemel, "Sensors A Comprehensive Survey", Vol. 9, Wiley-VCH, 1995.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE457	WAVELETS AND APPLICATION	L-T-P-C: 3-0-0-3

Pre Requisite(s): Digital Signal Processing

Course Objectives

- To understand the analysis, design and applications of filter banks
- To analyze the conditions to be satisfied for scaling and wavelet function to be a wavelet
- To design wavelets and understanding different types of wavelets

Course Outcomes

CO1: Able to understand the design and application of filter banks
CO2: Able to analyze the properties of wavelets
CO3: Able to design Wavelets and analysis on different types of wavelet
CO4: Able to apply wavelets for various applications

CO – PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO3	2	3	3	2	-	-	-	-	-	-	-	-	-	2
CO4	2	2	-	2	-	-	-	-	-	-	-	-	-	-

Syllabus

Unit 1
Introduction to wavelets-Vector Space-Functions and function spaces- Continuous time Fourier Transforms-Short time Fourier transforms-The uncertainty principle and time-frequency tiling-Discrete wavelet transforms-Scaling and Wavelet Functions – Filter Banks.

Unit 2
Legendre Polynomials – Recurrence Formula – Laplace's Integral Formula – Design of Orthogonal Wavelet Systems – Bi-orthogonal Wavelet – Introduction to Lifting Scheme – Dealing with Signal Boundaries – Multi Wavelet – Frequency Domain Approach – Design of Wavelet.

Unit 3
Wavelet in Image Processing – Biomedical Applications – Data Compression – EZW Algorithm – De-noising – Edge Detection – Object Isolation – Audio Coding – Communication Applications – Channel Coding – Speckle Removal – Image Fusion–Filter Design – Signal Analysis – Image Compression– PDEs –Wavelet Transforms on Complex Geometrical Shapes.

Text Book(s)
SomanK. P. and Ramachandran K. I., "Insight into Wavelets from Theory to Practice", Prentice Hall, third edition, 2010.
StephaneMallat , "A Wavelet Tour of *Signal Processing", The Sparse Way, Academic Press Elsevier 2009.*

Reference(s)
Howard L. Resnikoff and Raymond O. Wells, "Wavelets Analysis the Scalable Structure of Information", Springer, 1998.
Strang G. and Nguyen T. Q., "Wavelets and Filter Banks", Wellesley Cambridge Press, 1998.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Report

19ECE436	WIRELESS SENSOR NETWORKS	L-T-P-C: 3-0-0-3

Pre Requisite(s): Computer Networks

Couse Objectives

- To understand the characteristics and architecture of wireless sensor network
- To understand Physical and MAC layers in protocol stack and analyze various design considerations
- To attain a knowledge of Routing techniques and Data gathering Protocols
- To analyze and interpret wireless sensor network design in different applications scenario

Course Outcomes

CO1: Able to understand characteristics and architecture of wireless sensor network
CO2: Able to understand Physical and MAC layers in protocol stack and analyze its various design considerations
CO3: Able to understand various routing techniques in wireless sensor networks
CO4: Able to analyze and interpret wireless sensor network design in different applications scenario

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	-	-
CO3	3	1	1	-	-	-	-	-	-	-	-	-	-	-
CO4	2	2	2	-	-	-	-	-	1	-	-	-	-	-

Syllabus

Unit 1
Introduction to WSN - Characteristic requirements for WSN - Challenges for WSNs – WSN vs Adhoc Networks - Sensor node architecture – Commercially available sensor nodes – Imote - IRIS, Mica Mote, EYES nodes – Btnodes - TelosB, Sunspot -Physical layer and transceiver design considerations in WSNs - Energy usage profile - Choice of modulation scheme - Dynamic modulation scaling -Antenna considerations - Medium Access Control Protocols - Fundamentals of MAC protocols - Low duty cycle protocols and wakeup concepts – Contention based protocols - Schedule-based protocols - SMAC - BMAC - Traffic-adaptive medium access protocol (TRAMA) - The IEEE 802.15.4 MAC protocol.

Unit 2
Routing And Data Gathering Protocols - Routing Challenges and Design Issues in Wireless Sensor Networks, Flooding and gossiping – Data centric Routing – SPIN – Directed Diffusion – Energy aware routing - Gradient-based routing - Rumor Routing – COUGAR – ACQUIRE – Hierarchical Routing - LEACH, PEGASIS – Location Based Routing - GF - GAF - GEAR - GPSR – Real Time routing Protocols – TEEN – APTEEN – SPEED - RAP - Data aggregation - data aggregation operations - Aggregate Queries in Sensor Networks - Aggregation Techniques – TAG - Tiny DB.

Unit 3
Embedded Operating Systems - Operating Systems for Wireless Sensor Networks – Introduction - Operating System Design Issues - Examples of Operating Systems – Tiny OS – Mate – Magnet OS – MANTIS - OSPM - EYES OS – Sen OS – EMERALDS – Pic OS Applications Of WSN: WSN Applications - Home Control – Building Automation - Industrial Automation - Medical Applications - Reconfigurable Sensor Networks - Highway Monitoring - Military Applications - Civil and Environmental Engineering Applications - Wildfire Instrumentation - Habitat Monitoring - Nanoscopic Sensor Applications – Case Study: IEEE 802.15.4 LR-WPANs Standard - Target detection and tracking - Contour/edge detection - Field sampling.

Text Book(s)

Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, Ltd, 2005.

Kazem Sohraby, Daniel Minoli and Taieb Znati, "Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley & Sons, 2007.

Reference(s)

K. Akkaya And M. Younis, "A Survey Of Routing Protocols In Wireless Sensor Networks", Elsevier Ad-Hoc Network Journal, Vol. 3, No. 3, Pp. 325—349.

Anna Ha´C, "Wireless Sensor Network Designs", John Wiley & Sons Ltd.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE346	DIGITAL IC DESIGN	L-T-P-C: 3-0-0-3

Pre Requisite(s): Digital Design

Course Objectives

- To introduce the concept of mixed logic as applicable to arithmetic and non-arithmetic combinational logic circuits
- To develop contemporary skills for logic optimization using entered variable K-maps
- To develop design skills for the analysis and design of state machines

Course Outcomes

CO1: Able to design combinational logic circuit using mixed logic
CO2: Able to understand and analyze arithmetic subsystems
CO3: Able to carry out advanced logic optimization
CO4: Able to analyze and design state machines

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	3	-	-	-	-	-	-	-	-	-	2	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	3	3	3	-	-	-	-	-	-	-	-	2	2
CO4	3	3	3	-	-	-	-	-	-	-	-	-	2	-

Syllabus

Unit 1
Mixed logic circuits - Entered variable K-map Minimization - Multiple output Minimization, Resubstitution – Decomposition – Factorization - Non-arithmetic combinational Logic with EVK-maps - Arithmetic logic with EVK-maps.

Unit 2
Fast Adders - Hybrid adders - Carry Look Ahead adder - Carry Save adder - Multilevel Minimization and Optimization - Propagation delay & Timing defects in combinational logic - Lumped Path Delay Diagram - Binary Decision Diagram (BDD).

Unit 3
Synchronous State Machines - Design & analysis of simple state machines - state assignment - state reduction techniques - Asynchronous State Machine - Analysis of simple state machines - Detection and elimination of output races – glitches - static hazards.

Text Book(s)
Richard F. Tinder, "Engineering Digital Design", Academic Press, 2000.
Eugene Fabricius, "Modern Digital Design & Switching Theory", CRC Press, 1992.

Reference(s)
Samuel C. Lee, "Digital Circuits and Logic Design", Prentice Hall India Private Limited, 2006.
Zvi Kohavi and Niraj K Jha, "Switching and Finite Automata Theory", Third Edition, Cambridge University Press, 2009.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE347	ELECTRONIC SYSTEM LEVEL DESIGN AND VERIFICATION	L-T-P-C: 3-0-0-3

Pre Requisite(s): Digital Design

Course Objectives

- To introduce the concept of system level design and transaction level modelling
- To familiarize with function verification and understand the basics of System Verilog
- To design test environments for performing system level verification

Course Outcomes

CO1: Able to understand the concept of Design at the system level
CO2: Able to explore hardware and software partitioning and understand basics of Transaction Level Modelling
CO3: Able to understand the concept of design verification and familiarize with System Verilog
CO4: Able to use system Verilog for designing basic test environments
CO5: Able to design advanced test environments employing Constraint Random Generation, Assertion Based verification and coverage driven verification

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	2	2	-
CO2	3	3	3	-	-	-	-	-	-	-	-	2	2	-
CO3	3	3	2	-	-	-	-	-	-	-	-	2	2	-
CO4	3	-	-	-	-	-	-	-	-	-	-	2	3	2
CO5	3	2	3	-	-	-	-	-	-	-	-	2	3	2

Syllabus

Unit 1
Introduction to Electronic System level design - Hybrid Design - ESLD flows and methodologies - Architecture and design exploration – hardware software partitioning - models for ESL Design - Transaction Level Modeling - Introduction to System Verilog.

Unit 2
Data types in system Verilog- fixed arrays (packed/unpacked) - dynamic arrays – queues- associative arrays - System Verilog operators - tasks and functions -Object oriented programming – introduction – classes – inheritance - polymorphism- introduction to layered test bench.

Unit 3
Verification features and environment – stimulus generation - class based randomization - clocking block – interfaces - virtual interfaces - program block - mail boxes – assertions – coverage - layered test bench design.

Text Book(s)
Sandro Rigo, Rodolfo Azevedo and Luiz santos, "Electronic System Level Design – An Open Source Approach", First Edition, Springer, 2011.
Spear, Chris. "SystemVerilog for verification: a guide to learning the test bench language features", Springer Science & Business Media, Third Edition, 2012.

Reference(s)

Sutherland, Stuart, Simon Davidmann, and Peter Flake. "System Verilog for Design Second Edition: A Guide to Using System Verilog for Hardware Design and Modeling", Springer Science & Business Media, Second Edition, 2006.

Brian Bailey and Grant Martin, "ESL Models and their Application in Electronic System level Design and Verification in Practice", Springer, First Edition, 2010.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE342	HARDWARE SECURITY AND TRUST	L-T-P-C: 3-0-0-3

Pre Requisite(s): VLSI Design

Course Objectives

- To introduce Hardware Trojan taxonomy
- To familiarize Trojan insertion methods and detection approaches at various level of abstraction
- To introduce VLSI design flow incorporating trust at different levels

.

Course Outcomes

CO1: Able to describe and identify typical hardware security vulnerabilities at various phases of VLSI Design flow
CO2: Able to understand fundamental approaches used in Trojan insertion
CO3: Able to understand different approaches for Trojan and Piracy detection and analysis
CO4: Able to identify ways in which trust can be incorporated in VLSI Design flow

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO4	3	2	-	-	-	-	-	-	-	-	-	2	2	-

Syllabus

Unit 1
Review of VLSI Design Flow - Hardware Trojan –Trojan taxonomy - Case study - Trojan detection – Classification of Trojan detection - Challenges in Trojan detection.

Unit 2
Design for hardware trust – Delay based methods – Shadow registers – Ring oscillators - Dummy scan Flip-Flop insertion - Trojan activation time analysis - Trojan detection and isolation flow – Architectural approaches.

Unit 3
Security and testing – Scan-based testing – Scan-based attacks and counter measures - System-on-chip test infrastructure - Emerging areas of test security. Trojan prevention: Built-in self authentication - BISA structure and insertion flow - Analyzing BISA structure - Trusted design in FPGAs.

Text Book(s)
Mohammad Tehranipoor and Cliff Wang (Eds.), "Introduction to Hardware Security and Trust", Springer, New York, 2012.
Mohammad Tehranipoor, Hassan Salmani and Xuehui Zhang, "Integrated Circuit Authentication - Hardware Trojans and Counterfeit Detection", Springer International Publishing, Switzerland 2014.

Reference(s)
Nicolas Sklavos, Ricardo Chaves, Giorgio De Natale, Francesco Regazzoni (Eds), "Hardware Security and Trust: Design and Deployment of Integrated Circuits in a Threatened Environment", Springer, 2017.
Prabhat Mishra, Swarup Bhunia, Mark Teharanipoor (Eds), "Hardware IP Security and Trust", Springer, 2017.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

Instrumentation and Control

19ECE461	INTELLIGENT CONTROL SYSTEMS	L-T-P-C: 3-0-0-3

Pre Requisite(s): Control Theory

Course Objectives

- To equip the student with knowledge of various soft computing tools
- To impart knowledge regarding the theory and application of fuzzy logic controller design
- To impart understanding of various Nonlinear controller strategies

Course Outcomes

CO1: Understand principles of soft computing tools like neural networks and fuzzy logic
CO2: Apply neural networks and fuzzy logic for system identification
CO3: Develop understanding of various non-linear control strategies
CO4: Design fuzzy logic controllers

CO – PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	2	2	-
CO2	3	2	-	-	-	-	-	-	-	-	-	2	2	2
CO3	3	2	-	2	-	-	-	-	-	-	-	2	2	-
CO4	3	2	2	2	-	-	-	-	-	-	-	2	2	2

Syllabus

Unit 1
Basic Concepts for Intelligent Systems - Artificial Neural Networks - Perceptral Networks - Radial Basis Function Networks - Back-propagation Networks and Recurrent Networks - System Identification Using Neural Networks - Fuzzy logic - Knowledge Representation - Fuzzy Sets - Fuzzy Rules and Reasoning - Fuzzy Logic Control - Mamdani Model - Takagi-Sugeno Model - System Identification using T-S Fuzzy Models.

Unit 2
Nonlinear Control - Nonlinear State-space Model - Lyapunov Stability Theory - Lyapunov's Indirect Method - Nonlinear Control Strategies Direct Adaptive Control Using Neural Networks - Direct Adaptive Control - SISO and MIMO Systems - Back-stepping Control.

Unit 3
Fuzzy Model Based Control - T-S Fuzzy model - Linear Matrix Inequality (LMI) Technique - Fixed Gain state Feedback Controller Design Technique - Variable Gain Controller Design using Single Linear Nominal Plant and each Linear Subsystem as Nominal Plant - Controller Design using Discrete T-S Fuzzy System.

Text Book(s)
Behera L., Kar I., "Intelligent Systems and Control: Principles and Applications", Oxford University Press, 2009.
Gopal M., "Digital Control and State Variable Methods", Tata McGraw Hill, third Edition, 2008.

Reference(s)

Zi-Xing C., "Intelligent Control: Principles, Techniques and Applications", World Scientific Publishing Co. Pvt. Ltd., 1997.

Jang J. S. R., Sun C. T., Mizutzni E., "Neuro-Fuzzy and Soft Computing", Prentice Hall India Private Limited, 2002.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE348	VLSI TESTING AND TESTABILITY	L-T-P-C: 3-0-0-3

Pre Requisite(s): VLSI Design

Course Objectives

- To introduce the concept of VLSI Testing and fault modeling
- To understand and analyse for automatic test pattern generation algorithms
- To learn and understand the challenges involved in scan design and design for test

Course Outcomes

CO1: Able to understand the concepts of digital testing and Fault models
CO2: Able to apply fault equivalence and dominance collapsing
CO3: Able to apply fault simulation algorithms on digital circuits
CO4: Able to understand and analyze combinational ATPG algorithms
CO5: Able to design testable combinational & sequential circuits

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	2	3	2
CO2	3	2	-	2	-	-	-	-	-	-	-	2	3	2
CO3	3	3	-	2	-	-	-	-	-	-	-	2	3	2
CO4	3	3	-	2	-	-	-	-	-	-	-	2	3	2
CO5	3	3	3	2	-	-	-	-	-	-	-	2	3	2

Syllabus

Unit 1
Introduction - Need for testing - Testing of VLSI Circuits– Fault Modeling - Glossary of fault models - Single stuck-at fault – Equivalence and Dominance - Checkpoint theorem.

Unit 2
Logic and fault simulation - Modeling circuits for simulation - Algorithms for true value simulation and fault simulation - Testability Measures – Combinational ATPG - Roth's D-algorithm – PODEM Algorithm.

Unit 3
Design for Testability– Scan Architectures and Testing – Testable Combinational Logic Circuit Design – Design of Testable Sequential Circuits.

Text Book(s)
Vishwani D. Agrawal and Michael L. Bushnell, "Essentials of Electronic Testing for Digital Memory and Mixed Signal VLSI Circuits", Kluwer Academic Publishers, 2005.
Parag K. Lala, "An Introduction to Logic Circuit Testing", Morgan &Claypool Publishers, 2009.

Reference(s)
LaungTerng Wang, Cheng Wen Wu and Xiaoqing Wen, "VLSI Test Principles and Architectures – Design for Testability", First Edition, Morgan Kaufmann Publishers, 2006.
Parag K. Lala, "Digital Circuit Testing and Testability", Academic Press, 1997.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE349	RISC PROCESSOR DESIGN USING HDL	L-T-P-C: 3-0-0-3

Pre Requisite(s): Digital Design

Course Objectives

- To understand principles of processor architectures
- To familiarize with RISC design principles
- To design a pipelined processor using Verilog HDL

Course Outcomes

CO1: Able to understand the concepts of pipelined computer architecture
CO2: Able to design circuits using Verilog and understand concept of timing analysis
CO3: Able to understand and design a MIPS based processor
CO4: Able to implement a pipelined architecture of MIPS
CO5: Able to understand memory hierarchy and design of cache memories

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	2	2	-
CO2	3	3	3	-	-	-	-	-	-	-	-	2	3	-
CO3	2	-	2	-	-	-	-	-	-	-	-	2	2	-
CO4	2	-	2	-	-	-	-	-	-	-	-	2	3	-
CO5	2	3	3	-	-	-	-	-	-	-	-	2	3	-

Syllabus

Unit 1
Fundamental techniques of computer design – RISC and CISC architectures - computer arithmetic, - comparison of RISC and CISC architectures - Introduction to superscalar and super pipelined architectures - Verilog- Introduction and review of basic designs using Verilog - Static timing analysis – Introduction - setup and hold time constraints - processor timing issues - design examples.

Unit 2
MIPS Processor- Introduction to MIPS features and MIPS instruction set, logical design of MIPS datapath - control unit and instruction decode - Design of single cycle - multi-cycle and pipelined architectures of MIPS - Hazards- data and control hazards - Verilog designs of single cycle and multi-cycle MIPS processor.

Unit 3
Verilog design of pipelined MIPS processor - Introduction to memory hierarchy cache memory fundamentals - memory systems for superscalar processors.

Text Book(s)
Patterson, David A., and John L. Hennessy, "Computer Organization and Design: The Hardware Software Interface", Morgan kaufmann, First edition 2005.
Palnitkar, Samir. "Verilog HDL: a guide to digital design and synthesis", Edition 1, Prentice Hall Professional, 2003.

Reference(s)

Hamacher, V. Carl, et al. "Computer organization", Fifth edition. New York et al. McGraw-Hill, 1984.
Dandamudi, Sivarama P, "Guide to RISC processors: for programmers and engineers", First edition, Springer Science & Business Media, 2005.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE337	VLSI FABRICATION TECHNOLOGY	L-T-P-C: 3-0-0-3

Pre Requisite(s): Electronic Devices and Circuits

Course Objectives

- To get acquainted with basic principles and processes on semiconductor fabrication technologies
- Explore principles and theory of micro- and nanofabrication
- Understand the science and technology involved in fabrication and be able to apply to future research and processes

Course Outcomes

CO1: Understand the fundamentals of crystal growth methods of Silicon and GaAs
CO2: Describe the optical and nanolithographic methods
CO3: Visualize and understand concepts related to Diffusion and Ion Implantation
CO4: Understand, apply and analyze the fabrication processes implemented in a sequential manner
CO5: Comprehend and apply concepts related to metallization, low K and high K Dielectrics and integration with CMOS Technology

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	2	-	-	-	-	-	-	-	2	2	-
CO4	2	2	-	2	-	-	-	-	-	-	-	2	2	-
CO5	2	2	-	2	-	-	-	-	-	-	-	2	2	2

Syllabus

Unit 1

Introduction to VLSI Fabrication; Crystal growth and Wafer manufacturing - Crystal structure, Czochralski - Bridgman and Float Zone (FZ) growth methods - Wafer preparation and specifications - SOI Wafer manufacturing; Clean rooms - wafer cleaning and gettering - Basic concepts; Photolithography – Light sources - Wafer exposure systems – Photoresists - Baking and development - Mask making - Measurement of mask features and defects - resist patterns and etched features - Overview of Nanolithography techniques – nanoimprint lithography and electron beam lithography.

Unit 2

Oxidation - Wet and Dry oxidation, growth kinetics and models - defects, measurement methods and characterization - Diffusion - Models for diffused layers - Characterization methods – Segregation - Interfacial dopant pileup - oxidation enhanced diffusion - dopant-defect interaction - Ion-implantation - Basic concepts - High energy and ultralow energy implantation - shallow junction formation & modeling - Electronic stopping Damage production and annealing - RTA Process & dopant activation.

Unit 3

Thin Film Deposition - Chemical and Physical Vapor Deposition, Epitaxial Growth, Manufacturing Methods And Systems, Deposition of Dielectrics and Metals Commonly used in VLSI - Wet Etching and Plasma Etching – RIE - Etching of Materials used in VLSI - Interconnect Technology – Copper Contacts - Dielectrics; Vias, Multi-Level Interconnects - Silicided Gates and S/D Regions - Reflow & Planarization - Multi-Chip Modules and Packaging. -IC BJT - Fabrication and Realization; CMOS and BICMOS Technology.

Text Book(s)

Peter Van Zant, "Microchip Fabrication: A Practical Guide to Semiconductor Processing", McGraw-Hill Professional, Sixth Edition, 2014.

Gary. S. May and S. M. Sze, "Fundamentals of semiconductor fabrication", John Wiley, First Edition, 2003.

Reference(s)

Marc J. Madou, "Fundamentals of Microfabrication and Nanotechnology - Volume II", CRC Press, Third Edition, 2011.

Stephen Campbell, "Science of Microelectronic Fabrication", Oxford University Press, 2001.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE343	FPGA BASED SYSTEM DESIGN	L-T-P-C: 3-0-0-3

Pre Requisite(s): Digital Design

Course Objectives

- To introduce advanced system description and analysis of digital circuits with HDL
- To understand the organization and implementation of an FPGA based digital system
- To familiarize the design of advanced digital hardware systems targeting FPGAs and Synthesis tools

Course Outcomes

CO1: Able to write Verilog models for basic digital building blocks
CO2: Able to write synthesizable Verilog codes for VLSI subsystems
CO3: Able to comprehend the different phases of FPGA design flow
CO4: Able to understand FPGA Architectures and advanced technologies

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	3	2	-
CO2	3	2	3	-	-	-	-	-	-	-	-	3	3	2
CO3	3	2	3	-	-	-	-	-	-	-	-	2	2	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	2	-

Syllabus

Unit 1
Hierarchical Modeling Concepts - Verilog HDL Coding Style- Lexical Conventions- Ports and Modules– Operators-Gate Level Modeling - Compiler Directives-Test Bench- Tasks & Functions - Procedural continuous assignments- Synthesis of Combinational Circuits: Behavioral, Data Flow and Structural Realization–Adders– Multipliers-Comparators.

Unit 2
FPGA Design Flow - Modeling and Synthesis of Flip Flops-Realization of Shift Register, Counter-Synchronous and Asynchronous FIFO – Single port and Dual port RAM–Pseudo Random LFSR - Modeling and FPGA implementation of Mealy and Moore state machines, Sequence detection, Design of vending machine using One Hot Controller.

Unit 3
FPGA and its Architecture - Migrating ASIC Design to FPGAs - PLA & PAL –FPGA Generic Architecture – FPGA Fabrics- ALTERA Cyclone II Architecture–System Design Examples and Synthesis using Xilinx FPGAs– Intellectual Property - Partial Reconfiguration Design- High-Level Synthesis for Reconfigurable Devices.

Text Book(s)
Samir Palnitkar, Verilog HDL: "A Guide to Digital Design and Synthesis", Prentice Hall, Second Edition, 2003.
Christophe Bobda, "Introduction to Reconfigurable Computing: Architectures, Algorithms and Applications", Springer, 2007.

Reference(s)

Wayne Wolf, "FPGA-based System Design", Prentice-Hall, 2004.
Clive Maxfield, "The Design Warrior's Guide to FPGAs", Newnes, 2004.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE434	MIMO AND MULTICARRIER SYSTEMS	L-T-P-C: 3-0-0-3

Pre Requisite(s): Digital Communication

Course Objectives

- To introduce the concepts of crowded spectrum and need for high data rates
- To understand the design of spectral efficient and reliable spatial diversity techniques
- To comprehend the design of broadband wireless systems

Course Outcomes

CO1: Able to understand the spectral limitations in the design of reliable and high data rate communication systems
CO2: Able to analyze the spectrally efficient communication techniques to proposed design solutions for high date rate wireless systems and principles to propose design solutions for high date rate wireless system
CO3: Able to conduct investigations and provide viable solutions in the field of communication
CO4: Able to apply the contextual knowledge in design, development of solutions of complex engineering problems
CO5: Able to learn the emerging wireless communication standards

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	-	-	-	-	-	-	-	-	2	2
CO3	-	3	3	3	-	-	-	-	-	-	-	-	2	-
CO4	3	3	3	3	-	-	-	-	-	-	-	-	3	2
CO5	3	-	-	-	-	-	-	-	-	-	-	3	-	-

Syllabus

Unit 1
Introduction - Crowded spectrum - Need for high data rates – Multiple input multiple output systems – Multi antenna systems and concepts - Spatial multiplexing - MIMO system model- MIMO system capacity- Channel known to the transmitter - Channel unknown to the transmitter - Water-pouring principle – Capacity calculation – SIMO - MISO - Ergodic capacity - Outage capacity – Influence of fading Correlation on MIMO capacity - Influence of LOS on MIMO capacity.

Unit 2
Delay diversity scheme- Alamouti space - time code - Maximum likelihood decoding - Maximum ratio combining - Transmit diversity - Space-time block codes - STBC for real signal constellations - Decoding of STBC-OSTBC - Capacity of OSTBC channels - Space-time code Word design criteria – Multiplexing architecture - VBLAST architecture.

Unit 3
Data transmission over multipath channels - Single carrier approach - Multicarrier approach - OFDM - OFDM generation - Cyclic prefix - Performance of space - Time coding on frequency-Selective fading channels- Capacity of MIMO - OFDM systems - Performance analysis of MIMO-OFDM systems.

Text Book(s)

Mohinder Janakiram, "Space time Processing and MIMO systems", Artech House, First Edition, 2004.
Arogyaswami Paulraj, Rohit Nabar, Dhananjay Gore, "Introduction to Space-Time Wireless Communications", Cambridge University Press, 2008.

Reference(s)
Hamid Jafarkhani, "Space Time coding-Theory and Practice", Cambridge University Press, First Edition, 2005.
David Tse, Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2005.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE350	VLSI SIGNAL PROCESSING	L-T-P-C: 3-0-0-3

Pre Requisite(s): Digital Signal Processing

Course Objectives

- To provide a unified applied treatment of fundamental mathematics, illustrate with demonstrations using high level synthesis tools
- To use graph and architectural transformation techniques for applications' architecture development and analyze for trade off studies
- To comprehend the programming for filter designs and applications based on different architecture schemes

Course Outcomes

CO1: Able to design fundamental architectures of basic filter and digital units in signal processing and communication
CO2: Able to understand the mathematical methods in graph theory and architectural transformations
CO3: Able to apply transformation techniques to practical design of signal processing architectures
CO4: Able to analyze mathematical models for new designs in signal processing
CO5: Able to carry out implementation of algorithm using high level synthesis techniques and tools

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	2	-	-	-	-	-	-	-	-	-	2	-
CO2	3	-	3	-	-	-	-	-	-	-	-	2	2	-
CO3	3	-	3	-	-	-	-	-	-	-	-	-	2	2
CO4	3	3	3	-	-	-	-	-	-	-	-	2	2	2
CO5	3	3	2	2	-	-	-	-	-	-	-	2	2	2

Syllabus

Unit 1
Algorithms - Introduction to DSP systems - Pipelined and parallel processing - Iteration Bound – Retiming- unfolding- algorithmic strength reduction in filters- Systolic architecture design - fast convolution- pipelined and parallel recursive and adaptive filters- Scaling and round off noise.

Unit 2
Architecture – Implementations- Digital lattice filter structures - bit level arithmetic- architecture- redundant arithmetic - DSP core algorithms (FIR – IIR – Convolution – Correlation - FFT) - IEEE standard for Fixed and Floating Point Computations.

Unit 3
Programmable digit signal processors &FPGAs - rogrammable DSP Hardware - Special Architectures Modules used in Digital Signal Processors (like MAC unit, Barrel shifters) - On-Chip peripherals - DSP benchmarking Processing Architectures (von Neumann, Harvard) - VLIW Architecture - Current DSP Architectures. FPGA based DSP Systems - Limitations of P-DSPs - Requirements of Signal processing for Cognitive Radio (SDR) - FPGA based signal processing design-case study of a complete design of DSP processor.

Text Book(s)

K.K. Parhi, "VLSI Digital Signal Processing Systems: Design and Implementation", John Wiley & Sons, 1999.

Peter Pirsch, "Architectures for Digital Signal Processing", Wiley, 2009.

Reference(s)

Wayne Wolf, "High Performance Embedded Computing: Architectures, Applications and Methodologies", 1st Edition, Morgan Kaufman, 2006.

E.S.Gopi, "Algorithmic Collections for Digital Signal Processing Applications Using MATLAB", 1st Edition, Springer Netherlands, 2007.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19ECE313	VLSI DESIGN	L-T-P-C: 3-0-0-3

Pre Requisite(s): Digital Design

Course Objectives

- To develop understanding of MOSFETs and its characteristics to enable designing digital logic circuits
- Provides the fundamental knowledge to analyze static, transient and dynamic response of CMOS digital logic design
- Delivers a comprehensive foundation about CMOS physical design

.

Course Outcomes

CO1: Able to understand and implement simple logic circuits using CMOS
CO2: Able to analyze different CMOS gate realizations
CO3: Able to understand and analyze performance trade-offs in CMOS VLSI systems
CO4: Able to implement layouts of simple CMOS circuits

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	-	-	-	-	-	-	-	-	-	2	2
CO2	3	3	-	-	-	-	-	-	-	-	-	-	2	2
CO3	3	3	-	-	-	-	-	-	-	-	-	2	2	2
CO4	3	-	3	-	-	-	-	-	-	-	-	2	2	2

Syllabus

Unit 1
Issues in Digital Integrated Circuit Design - From Custom to Semicustom and Structured Array Design Approaches -MOSFETs as switches –Device characteristics - Non ideal I-V effects. NMOS and CMOS physical layouts and stick diagrams - Design Rules - Physical Design - NMOS and CMOS layers - Designing FET arrays - FET sizing and unit transistor - Physical design of logic gates and design hierarchies.

Unit 2
Analysis of MOS logic gates - DC switching characteristics of NMOS and CMOS inverters - DC characteristics of NAND and NOR gates - Transient response - Gate design for transient performance - Transmission gates and pass transistors.

Unit 3
Designing high speed CMOS logic networks - Gate delays - Driving large capacitive loads - BiCMOS drivers - Clocking and data flow control - Advanced techniques in CMOS logic circuits - Mirror circuits - Pseudo-NMOS - Tristate circuits - Clocked CMOS - Dynamic CMOS logic circuits- Static Latches and Registers- Dynamic Latches and Registers.

Text Book(s)

J. P. Uyemura, "Introduction to VLSI Circuits and Systems", John Wiley and Sons, Second Edition, 2002.
Jan M. Rabey, Anantha Chandrakasan, and Borivoje Nikolic, "Digital Integrated Circuits-A Design Perspective", Second Edition, Prentice Hall/Pearson, 2003.

Reference(s)

Neil Weste, David Harris, Ayan Banerjee, "CMOS VLSI Design: A Circuits and Systems Perspective", Pearson Education, 4th Edition, 2011.

Sung-Mo Kang, Yusuf Leblechi, "CMOS Digital Integrated Circuits - Analysis and Design", Tata McGraw Hill Publishing Company Limited, Third Edition, 2003.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports