AMRITA VISHWA VIDYAPEETHAM
DEEMED TO BE UNIVERSITY
School of Engineering

(AMRITAPURI, BANGALORE, COIMBATORE, CHENNAI)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

B.Tech. in ELECTRONICS AND COMMUNICATION ENGINEERING

(BTC-ECE)

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.

Program educational objectives are the envisioned career/professional/personal growth that the graduates should achieve in a short span of time (3-5 years) after graduating from the course.

- **PEO1**: To develop an ability to integrate fundamental knowledge of basic science, mathematics and engineering to work on complex problems in the field of Electronics and Communication Engineering.
- **PEO2**: To promote an independent research mindset and inculcate a thirst for continuous learning by providing hands-on experience with simulation and modelling tools for electronics, signal processing and communication-based applications.
- **PEO3**: To provide a platform to explore and pursue their interests in diversified fields for a successful career in both public and private sectors specializing in electronics and communication.
- **PEO4:** To nurture team spirit and leadership qualities together with a sense of social responsibility by outreach programs and produce electronics and communication engineers with an ability to integrate engineering and society.

Program Specific Objectives (PSOs)

- **PSO1**: Able to design, develop and analyze systems in signal processing, electronics, communication and computing.
- **PSO2**: Able to demonstrate competency in research and innovations.

SEMESTER I

Cat.	Code	Title	Credit
SCI	19BIO101	Biology for Engineers -A	3
SCI	19MAT101	Single Variable Calculus	1
SCI	19MAT102	Matrix Algebra	2
ENGG	19CSE100	Problem Solving and Algorithmic Thinking	4
SCI	19PHY103	Physics of Electronic Materials	3
ENGG	19MEE100	Engineering Graphics - CAD	3
ENGG	19EEE100	Basic Electrical and Electronics Engineering	3
ENGG	19EEE181	Basic Electrical and Electronics Engineering Lab	1
ENGG	19ECE101	Introduction to Internet of Things	1
HUM	19CUL101	Cultural Education - I	2
		TOTAL	23

SEMESTER II

Cat.	Code	Title	Credit
HUM	19ENG111	Technical Communication	3
SCI	19MAT111	Multivariable Calculus	2
SCI	19MAT112	Linear Algebra	3
SCI	19CHY102	Engineering Chemistry - B	3
SCI	19CHY182	Engineering Chemistry Lab - B	1
ENGG	19CSE102	Computer Programming	4
ENGG	19ECE112	Electronic Devices and Circuits	3
ENGG	19ECE181	Electronic Systems Lab	1
ENGG	19MEE181	Manufacturing Practice	1
ENGG	19ECE111	Circuit Theory	3
HUM	19CUL111	Cultural Education - II	2
		TOTAL	26

SEMESTER III

Cat.	Code	Title	Credit
ENGG	19ECE201	Analog Electronic Circuits	3
ENGG	19ECE202	Applied Electromagnetics	4
ENGG	19ECE204	Digital Electronics and Systems	4
ENGG	19ECE203	Signals and Systems	4
SCI	19MAT205	Probability and Random Processes	4
ENGG	19ECE282	Digital Electronics and Systems Lab	1
ENGG	19ECE281	Analog Electronics Lab	1
HUM	19AVP201	Amrita Values Program I	1
HUM	19ENV300	Environmental Science	P/F
		TOTAL	22

SEMESTER IV

Cat.	Code	Title	Credit
ENGG	19ECE213	Transmission Lines and Radiating Systems	4
ENGG	19ECE211	Digital Signal Processing	3
ENGG	19ECE212	Linear Integrated Circuits	3
ENGG	19ECE214	Communication Theory	4
SCI	19MAT213	Optimization Techniques	3
ENGG	19ECE284	Digital Signal Processing Lab	1
HUM	19AVP211	Amrita Values Program II	1
ENGG	19ECE283	Linear Integrated Circuits Lab	1
HUM	19SSK211	Soft Skills I	2
HUM	19LAW300	Indian Constitution	P/F
		TOTAL	22

SEMESTER V

Cat.	Code	Title	Credit
ENGG	19ECE304	Microcontrollers and Interfacing	4
ENGG	19ECE303	Radio Frequency Engineering	3
ENGG	19ECE302	Digital Communication	3
ENGG	19ECE301	Control Theory	4
ENGG		Professional Elective I*	3
ENGG	19ECE381	RF and Simulation lab	1
ENGG	19ECE382	Communication Systems lab	1
HUM	19SSK301	Soft Skills II	2
ENGG	19LIV390	Live-in –Labs***	[3]
		TOTAL	21+[3]

SEMESTER VI

Cat.	Code	Title	Credit
ENGG	19ECE313	VLSI Design	3
ENGG	19ECE311	Computer Networks	4
ENGG	19ECE312	Information Theory and Coding	3
ENGG		Professional Elective II*	3
ENGG		Professional Elective III*	3
ENGG	19ECE383	VLSI Design Lab	1
HUM	19SSK311	Soft Skills III	2
ENGG	19ECE391	Seminar	1
ENGG	19ECE384	Open Lab	1
HUM	19MNG300	Disaster Management	P/F
ENGG	19LIV490	Live-in –Labs***	[3]
		TOTAL	21+[3]

SEMESTER VII

Cat.	Code	Title	Credit
ENGG		Professional Elective IV*	3
ENGG		Professional Elective V*	3
ENGG		Professional Elective VI*	3
HUM		Free Elective**	2
HUM		Free Elective**	2
PRJ	19ECE495	Project Phase I	2
		TOTAL	15

SEMESTER VIII

Cat.	Code	Title	Credit
ENGG		Professional Elective VII*	3
PRJ	19ECE499	Project Phase II	10
		TOTAL	13

		TOTAL CREDITS		163

***Professional Elective -** Electives categorized 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 ELECTIVE

Cat.	Code	Title	Credit
Analog and Mixed Signal Systems			
ENGG	19ECE331	Biomedical Instrumentation	3
ENGG	19ECE332	Mixed Signal Design	3
ENGG	19ECE333	Micro Electro Mechanical Systems	3
ENGG	19ECE334	Analog IC Design	3
ENGG	19ECE335	Applications of Linear Integrated Circuits	3
ENGG	19ECE336	Nano Electronics	3
ENGG	19ECE337	VLSI Fabrication Technology	3
ENGG	19ECE338	Solid State Devices	3
ENGG	19ECE339	Optical Engineering	3
ENGG	19ECE471	Electronic Systems: Data Communication	1
ENGG	19ECE472	Electronic Systems Data: Conversion and Power Supplies	1
ENGG	19ECE473	Electronic Systems: Essentials of SoCs	1
ENGG	19ECE474	Essentials of EMC and EMI	1
ENGG	19ECE475	PCB Design and Thermal Management	1
ENGG	19ECE476	Product Safety, Security, Compliance and Reliability	1
Digital System design and architectures			
ENGG	19ECE341	VLSI System Design	3
ENGG	19ECE342	Hardware Security and Trust	3
ENGG	19ECE343	FPGA Based System Design	3
ENGG	19ECE344	Embedded Systems	3
ENGG	19ECE345	Computer Systems Architecture	3
ENGG	19ECE346	Digital IC Design	3

ENGG	**19ECE347**	**Electronic System Level Design and Verification**	**3**
ENGG	**19ECE348**	**VLSI Testing and Testability**	**3**
ENGG	**19ECE349**	**RISC Processor Design using HDL**	**3**
ENGG	**19ECE350**	**VLSI Signal Processing**	**3**
Computational Engineering			
ENGG	**19ECE351**	**Markov Process and Queuing Theory**	**3**
ENGG	**19ECE352**	**Operations Research**	**3**
ENGG	**19ECE353**	**Convex Optimization**	**3**
ENGG	**19ECE354**	**Deep Learning**	**3**
ENGG	**19ECE355**	**Bio Inspired Algorithms**	**3**
ENGG	**19ECE356**	**Game Theory**	**3**
ENGG	**19ECE357**	**Pattern Recognition**	**3**
ENGG	**19ECE358**	**Signal Processing for Business Applications**	**3**
ENGG	**19ECE359**	**Non-linear Dynamics and Chaos**	**3**
ENGG	**19ECE360**	**Agent Based Modeling**	**3**
ENGG	**19ECE361**	**Data Structures and Algorithms**	**3**
ENGG	**19ECE362**	**Software Engineering**	**3**
ENGG	**19ECE363**	**Machine Learning**	**3**
Wireless Communications and Networks			
ENGG	**19ECE431**	**Wireless Communication**	**3**
ENGG	**19ECE432**	**Software Defined Networks**	**3**
ENGG	**19ECE433**	**Orthogonal Frequency Division Multiplexing**	**3**
ENGG	**19ECE434**	**MIMO and Multicarrier Systems**	**3**
ENGG	**19ECE435**	**Spread Spectrum Communication**	**3**
ENGG	**19ECE436**	**Wireless Sensor Networks**	**3**
ENGG	**19ECE437**	**Mobile Communication**	**3**
ENGG	**19ECE438**	**Vehicular Communication**	**3**

ENGG	**19ECE439**	**Millimeter Wave Personal Communication Systems**	**3**
ENGG	**19ECE440**	**Telecommunication Management**	**3**
RF System design			
ENGG	**19ECE441**	**Avionics**	**3**
ENGG	**19ECE442**	**Antenna Systems**	**3**
ENGG	**19ECE443**	**Planar Microwave Devices**	**3**
ENGG	**19ECE444**	**Satellite Communication**	**3**
Signal Processing			
ENGG	**19ECE451**	**Spoken Language Processing**	**3**
ENGG	**19ECE452**	**Radar Signal Processing**	**3**
ENGG	**19ECE453**	**Statistical Signal Processing**	**3**
ENGG	**19ECE454**	**Image Processing**	**3**
ENGG	**19ECE455**	**Biomedical Signal Processing**	**3**
ENGG	**19ECE456**	**Hyperspectral Image Analysis**	**3**
ENGG	**19ECE457**	**Wavelets and Application**	**3**
ENGG	**19ECE458**	**Adaptive Signal Processing**	**3**
Instrumentation and Control			
ENGG	**19ECE461**	**Intelligent Control Systems**	**3**
ENGG	**19ECE462**	**Process Control**	**3**
ENGG	**19ECE463**	**Smart Sensors**	**3**
ENGG	**19ECE464**	**Virtual Instrumentation for Communication Systems**	**3**
ENGG	**19ECE465**	**Electric Drives**	**3**
ENGG	**19ECE466**	**Industrial Instrumentation**	**3**

Industrial Electives			

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**

SYLLABUS

SEMESTER I

19BIO101	BIOLOGY FOR ENGINEERS - A	L-T-P-C: 3-0-0-3

Course Objectives

- To understand Biological concepts from an engineering perspective
- To understand the inter-connection between biology and future technologies
- To motivate technology application for biological and life science challenges

Course Outcomes

CO1: Understand the biological concepts from an engineering perspective
CO2: Understand the concepts of biological sensing and its challenges
CO3: Understand development of artificial systems mimicking human action
CO4: Integrate biological principles for developing next generation technologies

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
CO2	3	3	-	-	-	-	-	-	-	-	-	2	2	2
CO3	3	3	-	-	-	-	-	-	-	-	-	2	2	2
CO4	3	3	-	-	-	-	-	-	-	-	-	2	2	2

Syllabus

Unit 1
Need to study Biology: – Life Science Studies Significance - Bio Inspired Inventions - Role of Biology in Next Generation Technology Development – Cell Structure – Cell Potential - Action Potential – ECG and other common signals – Sodium Potassium channels – Neuron function – Central Nervous Systems – Discussion Topics - Evolution of Artificial Neural Networks - Machine Learning techniques.

Unit 2
Sensing Techniques - Understanding of Sense organs working – Sensing mechanisms - Sensor Development issues – Discussion Topics: Digital Camera – Eye Comparison - electronic nose - electronic tongue - electronic skin.

Unit 3
Physiological Assist Device - Artificial Organ Development: Kidney - Liver – Pancreas - heart valves – Design Challenges and Technological Developments.

Text Book(s)
Leslie Cromwell, "Biomedical Instrumentation", Prentice Hall 2011.

Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj R. W., Barathi S., and Jaganthan M.K., "Biology for Engineers", Tata McGraw-Hill, New Delhi, 2012.

References(s)

https://www.sciencedirect.com/topics/medicine-and-dentistry/electronic-nose.
https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/electronic-tongue.

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

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	PSO1	PSO2
CO1	1	3	---	---	---	---	---	---	---	---	---	---		
CO2	1	2	---	---	2	---	---	---	---	---	---	---		

Syllabus

Unit 1

Calculus
Graphs: Functions and their Graphs. Shifting and Scaling of Graphs. (1.5)

Unit 2
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)

Unit 3
Graphing : Extreme Values of Functions, Concavity and Curve Sketching, (4.1, 4.4).

Unit 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

Evaluation pattern

At the end of the course, a two-hour 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, analyse 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 analyse 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

Unit 1
Review: System of linear Equations, linear independence.
Unit 2
Eigen values and Eigen vectors: Definitions and properties. Positive definite, negative definite and indefinite
Unit 3
Diagonalization and Orthogonal Diagonalization. Properties of Matrices. Symmetric and Skew Symmetric Matrices, Hermitian and Skew Hermitian Matrices and Orthogonal matrices.
Unit 4
Numerical Computations: L U factorization, Gauss Seidal and Gauss Jacobi methods for solving system of equations. Power Method for Eigen Values and Eigen Vectors.

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

Reference Books
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.

Evaluation Pattern

Assessment	Weightage
Class Test/Assignment/Tutorial	30
End of course Test (2hrs)	70

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												
CO2	3	2	3		3			3	3	3				
CO3	2	1												
CO4	1	1	2		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	End Semester
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.

Text Books/References

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

- Familiarize with Bureau of Indian Standards (BIS) for creating engineering drawings
- Train the students on proper dimensioning and construction of simple geometries
- Inculcate with the concept of developing orthographic projections and isometric views using CAD drafting package

Note:

1. Drawing practice to be carried out using drafting package (Auto-CAD)
2. First angle projection to be followed

Course Outcomes

CO1: Understand the engineering drawing standards and their usage
CO2: Interpret engineering drawings
CO3: Construct and dimension 2-D geometries using CAD software
CO4: Improve coherent visualization skills
CO5: Inculcate with the concept of developing orthographic projections and isometric views

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	2	3	1	2	3		3	2	2	2
CO2	3	3	3	3		2	3	1	2	3		3	2	2	2
CO3	3	3	3	3	3	2	3	1	2	3		3	2	2	2
CO4	3	3	3	3		2	3	1	2	3		3	2	2	2
CO5	3	3	3	3	3	2	3	1	2	3		3	2	2	2

Syllabus

Unit 1

Basic principles of engineering drawing, Standards and conventions, lettering and types of lines, Introduction to drafting software, standard tool bar/menus, navigational tools. Co-ordinate system and reference planes. Creation of 2 dimensional drawing environment. Selection of drawing size and scale. Sketching of 2D simple geomentries, editing and dimensioning of 2D geomentries.

Unit 2

Orthographic Projections: Introduction, planes of projection, projection of points in all the four quadrants. Projection of straight lines, Projection of Plane Surfaces, Projection of regular solids, Sectioning of solids

Unit 3

Plan and elevation of simple buildings with dimensions

Text Book

BasantAgarwal and C M Agarwal., "Engineering Drawing", 2e, McGraw Hill Education, 2015

Reference Book(s)

Bhat N.D. and Panchal V.M. , " Engineering Drawing Plane and Solid Geometry , 42e, Charoatar Publishing House , 2010James D. Bethune, "Engineering Graphics with AutoCAD", Pearson Education, 2014
K.R. Gopalakrishna, "Engineering Drawing", 2014, Subhas Publications
Narayan K.L. and Kannaiah P, Engineering Drawing, SciTech Publications, 2003
John K.C., "Engineering Graphics for Degree", 1e, Prentice Hall India, 2009

Evaluation Pattern

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

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

19EEE100	BASIC 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.
- To understand the construction and working principle of DC and AC machines.
- To facilitate understanding of basic electronics and operational amplifier circuits.

Course Outcomes

CO 1: Understand the basic electric and magnetic circuits
CO 2: Analyse DC and AC circuits
CO 3: Interpret the construction and working of different types of electrical machines
CO 4: Analyse basic electronic components and circuits.

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	-	1		-	-	-	-	-	-	-	-	-
CO3	3	3	-	-		-	-	-	-	-	-	-	-	-
CO4	3	3	3	2	-	1	-	-	-	-	-	-	-	-

Syllabus

Unit 1

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.

Unit 2

Electrical Machines: DC Motor: Construction, principle of operation, Different types of DC motors, Voltage equation of a motor, significance of back emf, Speed, Torque, Torque-Speed characteristics, Output Power, Efficiency and applications. Single Phase Transformer: Construction, principle of operation, EMF Equation. Regulation and Efficiency of a Transformer. Induction Machine: Three Phase Induction Motor: Construction and Principle of Operation, Slip and Torque, Speed Characteristics. Stepper motor: Construction, principle and mode of operation.

Unit 3

PN Junction diodes, VI Characteristics, Rectifiers: Half wave, Full wave, Bridge. Zener Diode- characteristics, Optoelectronic devices. BJT – characteristics and configurations, Transistor as a Switch. Junction Field Effect Transistors - operation and characteristics, Thyristor – Operation and characteristics. Fundamentals of DIAC and TRIAC. 555 Timer, Integrated circuits. Operational Amplifiers – Inverting and Non-inverting amplifier – Instrumentation amplifiers.

Text Books

Edward Hughes. "Electrical and Electronic Technology", 10th Edition, Pearson Education Asia, 2019.
D. P. Kothari, I J Nagrath, "Electric Machines", 5th Edition, Tata McGraw Hill, 2017.
A. P. Malvino, "Electronic Principles", 7th Edition, Tata McGraw Hill, 2007.

References

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

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

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

19EEE181	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LAB	L-T-P-C: 0-0-3-1

Course Objective

- To understand the basics of electrical connections and analyse the performance of electrical machines and electronic circuits.

Course Outcome

CO1: To create basic electrical connections for domestic applications
CO2: To measure the various electrical parameters in the circuit
CO3: To Analyse the performance of electrical machines.
CO4: To Analyse basic electronic 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			1		
CO2	3				2				3			1		
CO3	3	1	2	2					3			1		
CO4	3	1	2						3					

LIST OF EXPERIMENTS:
Electrical

1. a) Wiring practices
   b) Study of Electrical protection systems.
2. Verification of circuit theorem
3. Experiment on DC machine
4. Experiment on single phase Transformer
5. Experiment on induction motor
6. VI characteristics of PN junction and Zener diode
7. Implementation of Half wave and Full wave rectifier using PN junction diode
8. Transistor as a switch
9. Experiment on Thyristor
10. Implementation of inverting and non-inverting amplifier using Op-amp

REFERENCES / MANUALS / SOFTWARE:
Lab Manuals

Evaluation Pattern

Assessment	Internal	End Semester
*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

CO1: Able to demonstrate various sensor interfacing using Visual Programming Language
CO2: Able to analyze various Physical Computing Techniques
CO3: Able to demonstrate Wireless Control of Remote Devices
CO4: Able to design and develop Mobile Application which can interact with Sensors and Actuators

CO – PO Mapping

CO/PO	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

Syllabus

1. Digital I/O Interface - Multicolour 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 Quadcopter.

Text Book(s)

Sylvia Libow Martinez, Gary S Stager, "Invent To Learn: Making, Tinkering, and Engineering in the Classroom", Constructing Modern Knowledge Press, 2016.

Reference(s)

Michael Margolis, "Arduino Cookbook", Oreilly, 2011.

Evaluation Pattern

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

- The course is designed as an introductory guide to the variegated dimensions of Indian cultural and intellectual heritage, to enable students to obtain a synoptic view of the grandiose achievements of India in diverse fields.
- It will equip students with concrete knowledge of their country and the mind of its people and instil in them some of the great values of Indian culture.

Course Outcomes

CO1: Be introduced to the cultural ethos of Amrita Vishwa Vidyapeetham, and Amma's life and vision of holistic education**.**

CO2: Understand the foundational concepts of Indian civilization like *puruśārtha*-s, law of karma and *varṇāśrama*.

CO3: Gain a positive appreciation of Indian culture, traditions, customs and practices**.**

CO4: Imbibe spirit of living in harmony with nature, and 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						3	2	3				2		
CO2						3	1	3				2		
CO3						3	1	3				2		
CO4						3	3	3				2		
CO5						3	1	3				2		

Syllabus

Unit 1

Introduction to Indian culture; Understanding the cultural ethos of Amrita Vishwa Vidyapeetham; 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 Book

Cultural Education Resource Material Semester-1

Reference Book(s)

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

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

SEMESTER II

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

Course Objectives

- To introduce the students to the elements of technical style
- To introduce the basic elements of formal correspondence
- To introduce technical paper writing skills and methods of documentation
- To improve oral presentation skills in formal contexts

Course Outcomes

CO1: Understand and use the basic elements of formal correspondence and methods of documentation.
CO2: Learn to edit technical content for grammatical accuracy and appropriate tone and style
CO3: Use the library and Internet recourses for research purposes
CO4: Demonstrate the ability to communicate effectively through group mock-technica presentations and other activities

CO-PO Mapping

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

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

References

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	External
Periodical 1	20	
Periodical 2	20	
Continuous Assessment (Lab) (CAL)	40	
End Semester		20

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

19MAT111	MULTIVARIABLE CALCULUS	L-T-P-C: 2-0-0-2

Course Objective

- To understand parameterisation of curves and to find arc lengths.
- To familiarise with calculus of multiple variables.
- To use important theorems in vector calculus in practical problems.

Course Outcomes

CO1: Select suitable parameterization of curves and to find their arc lengths
CO2: Find partial derivatives of multivariable functions and to use the Jacobian in practical problems.
CO3: Apply Fundamental Theorem of Line Integrals, Green's Theorem, Stokes' Theorem, of Divergence Theorem 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	---	---	---	---	---	---	---
CO3	2	2			3							

Syllabus

Unit 1

Functions of severable variables

Functions, limit and continuity. Partial differentiations, total derivatives, differentiation of implicit functions and transformation of coordinates by Jacobian. Taylor's series for two variables.

Unit 2

Vector Differentiation

Vector and Scalar Functions, Derivatives, Curves, Tangents, Arc Length, Curves in Mechanics, Velocity and Acceleration, Gradient of a Scalar Field, Directional Derivative, Divergence of a Vector Field, Curl of a Vector Field.

Unit 3

Vector Integration

Line Integral, Line Integrals Independent of Path.

Green's Theorem in the Plane, Surfaces for Surface Integrals, Surface Integrals, Triple Integrals – Gauss Divergence Theorem, Stoke's Theorem.

Unit 4

Lab Practice Problems:

Graph of functions of two variables, shifting and scaling of graphs. Vector products. Visualizing different surfaces.

Text Book

Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Tenth Edition, 2018.

Reference Book(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.

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

Evaluation Pattern

Assessment	Weightage
Class Test/Assignment/Tutorial	30
End of course Test (2hrs)	70

19MAT112	LINEAR ALGEBRA	L-T-P-C: 2-1-0-3

Course Objectives

- Understand the basic concepts of vector space, subspace, basis and dimension.
- Familiar the inner product space. Finding the orthogonal vectors using inner product.
- Understand and apply linear transform for various matrix decompositions.

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 the concept of positive definiteness, matrix norm and condition number for a given square matrix.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO1	3	2	1									
CO2	3	3	2									
CO3	3	3	2									
CO4	3	2	1									

Syllabus

Pre-request: Matrices

Review of matrices and linear systems of equations. (2 hrs)
Vector Spaces: Vector spaces - Sub spaces - Linear independence - Basis - Dimension - Inner products - Orthogonality - Orthogonal basis - Gram Schmidt Process - Change of basis. (12 hrs)
Orthogonal complements - Projection on subspace - Least Square Principle. (6 hrs)

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. (10 hrs)
Change of basis - Nilpotent transformations - Similarity of linear transformations - Diagonalisation and its applications - Jordan form and rational canonical form. (10 hrs)
SVD.

Text Book
Howard Anton and Chris Rorrs, "Elementary Linear Algebra", Ninth Edition, John Wiley & Sons, 2000.

Reference Book(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.

Evaluation Pattern

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

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

19CHY102	ENGINEERING CHEMISTRY - B	L-T-P-C: 2-1-0-3

Course Objectives

- The main objective of the course is to impart knowledge on the fundamental concepts of chemistry involved in application of several important engineering materials that are used in the industry/day-to-day life.

Course Outcomes

CO1: To understand the fundamental concepts of chemistry to predict the structure, properties and bonding of Engineering materials**.**

CO2: To understand the principle of electrochemistry/photochemistry and applications of various energy Storage system.

CO3: To be able to understand the crystals structure, defects and free electron theory

CO4: To be able to understand the mechanism and application of conductivity polymer is various electronic devices.

CO-PO Mapping

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

SYLLABUS

Unit 1

Atomic Structure and Chemical Bonding

Fundamental particles of atom – their mass, charge and location – atomic number and mass number – Schrondinger equation. Significance of ψ and ψ^2 – orbital concept – quantum numbers - electronic configuration. Periodic properties. Formation of cation and anion by electronic concept of oxidation and reduction – theories on bonding- octet, Sidwick and Powell, VSEPR and VBT-MOT. Formation of electrovalent, covalent and coordination compounds. Chemistry of weak interactions – van der Waals force and hydrogen bonding.

Unit 2

Electrochemical energy system

Faradays laws, origin of potential, electrochemical series, reference electrodes, Nernst equation, introduction to batteries – classification – primary, secondary and reserve (thermal) batteries. Characteristics – cell potential, current, capacity and storage density, energy efficiency. Construction, working and application of Leclanche cell-Duracell, Li-MnO_2 cell, lead acid batteries. Ni-Cd battery, Lithium ion batteries. Fuel cell - construction and working of PEMFC.

Unit 3

Photochemistry and solar energy

Electromagnetic radiation. Photochemical and thermal reactions. Laws of photochemistry, quantum yield, high and low quantum yield reactions. Jablonski diagram - photophysical and photochemical processes, photosensitization, photo-polymerization and commercial application of photochemistry.

Solar energy - introduction, utilization and conversion, photovoltaic cells – design, construction and working, panels and arrays. Advantages and disadvantages of PV cells. DSSC (elementary treatment).

Unit 4

Solid state Chemistry

Crystalline and amorphous solids, isotropy and anisotropy, elements of symmetry in crystal systems indices - Miller indices, space lattice and unit cell, Bravais lattices, the seven crystal systems and their Bravais lattices, X-ray diffraction - Bragg's equation and experimental methods (powder method and rotating crystal technique), types of crystals - molecular, covalent, metallic and ionic crystals - close packing of spheres – hexagonal, cubic and body centred cubic packing, defects in crystals – stoichiometric, non-stoichiometric, extrinsic and intrinsic defects.

Unit 5

Polymer and composite Materials

Conducting polymers**:** Conducting mechanisms - Electron transport and bipolar polymers. Photoconductive polymers**:** Charge carriers, charge injectors, charge transport, charge trapping. Polymers for optical data storage - principles of optical storage, polymers in recording layer. Thermo sensitive polymers**:** Applications - Mechanical actuators and switches. Photo resists - Types - Chemically amplified photoresists -Applications. Magnetic polymers - structure and Applications. Liquid crystalline polymers**:** Fundamentals and process, liquid crystalline displays – applications. Organic LEDs-their functioning-advantages and disadvantages over conventional LEDs - their commercial uses. Piezo electric materials.

Text Books

Vairam and Ramesh "Engineering Chemistry", Wiley, 2012 Amrita Vishwa Vidyapeetham, Department of Sciences, "Chemistry Fundamentals for Engineers", McGraw Hill Education, 2015.

Reference Books

Jain and Jain, "Engineering Chemistry", DhanpatRai Publishing company, 2015
Puri, Sharma and Patania, " Principles of Physical chemistry", Vishal Publishing Co., 2017.
Atkins, "Physical Chemistry", OUP, Oxford, 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

19CHY182	ENGINEERING CHEMISTRY LAB - B	L-T-P-C: 0-0-3-1

Course Objective

- The objective of the laboratory sessions is to enable the learners to get hands-on experience on the principles discussed in theory sessions and to understand the applications of these concepts in engineering.

Course Outcomes

CO1: Learn and apply basic techniques used in chemistry laboratory for small/large scale water Analyses / Purification.

CO2: To be able estimate the ions/metal ions present in domestic/industry waste water.

CO3: To utilize the fundamental laboratory techniques for analyses such as titrations, separation/purification\ and Spectroscopy.

CO4: To be able to analyze and gain experimental skill.

CO-PO Mapping

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

Lab:

1. Estimation of alkalinity in given water samples
2. Adsorption of acetic acid by charcoal
3. Potentiometric titration – acid-base/redox
4. Conductometric titration
5. Estimation of hardness by ion-exchange method
6. Determination of molecular weight of polymer
7. Determination of cell constant and unknown concentration of electrolyte
8. Estimation of tin from stannate solution
9. Separation techniques – TLC, Column chromatography
10. Verification of B-L law by UV-spectrophotometer

Evaluation Pattern

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

* CA – Principles of experiment, skill, result analysis and report

19CSE102	COMPUTER PROGRAMMING	L-T-P-C: 3-0-3-4

Pre-Requisite(s): 19CSE100 Problem Solving and Algorithmic Thinking

Course Objectives

- This course provides the foundations of programming.
- Apart from the usual mechanics of a typical programming language, the principles and methods will form the main focus of this course.
- Shift from learn to program to programming to learn forms the core of this course.

Course Outcome

CO1: Understand the typical programming constructs: data (primitive and compound), control, modularity, recursion etc. thereby to understand a given program
CO2: Understand and analyze a given program by tracing, identify coding errors and debug them
CO3: Make use of the programming constructs appropriately and effectively while developing computer programs
CO4: 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							1						
CO2	1	1	1					1						
CO3	1	2	2					2						
CO4	2	3	2					3						

Syllabus

Unit 1
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.

Unit 2
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.

Unit 3
Structures: structure vs array comparison, complex structures, structures and functions, Union. Files and streams, file input output, command line arguments.

Text Book(s)
Forouzan BA, Gilberg RF. Computer Science: A structured programming approach using C. Third Edition, Cengage Learning; 2006.

Reference(s)
Byron Gottfried. Programming With C. Fourth Edition, McGrawHill,; 2018.
Brian W. Kernighan and Dennis M. Ritchie. The C Programming Language. Second Edition, Prentice 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, Addison Wesley (Pearson); 2007.

Evaluation Pattern

Assessment	Internal	End Semester
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.

19ECE112	ELECTRONIC DEVICES AND CIRCUITS	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce basic semiconductor devices, their characteristics and applications
- To understand analysis and design of simple diode circuits
- To learn to analyze the PN junction behavior at the circuit level and its role in the operation of diodes and active devices

Course Outcomes

CO1: Ability to analyze PN junctions in semiconductor devices under various conditions
CO2: Ability to design and analyze simple rectifiers and voltage regulators using diodes
CO3: Ability to describe the behavior of special purpose diodes
CO4: Ability to design and analyze simple BJT and MOSFET 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	-	-	-	-	-	-	-	-	-	2	-

Syllabus

Unit 1
Review of Network and Semiconductor Basics - PN Junction Diodes - Forward and Reverse Biasing - Reverse Saturation Current - Diode current components - Cut-in voltage - VI Characteristics. Diode Parameters – Data sheets - Diode Models. Rectification – Half-wave - Full-wave and Bridge – Filters- Zener Diodes -Shunt voltage regulator - Regulator Design – Case Study - Varactor Diodes - Schottky Diodes - Tunnel Diodes and LEDs.

Unit 2
Transistors – BJTs - PNP and NPN transistors – Effects - Transistor Currents - Amplifying action of a transistor. Transistor Characteristics - CE configuration - Biasing - Quiescent point - Load line - Biasing - Fixed base bias - Small Signal Model of BJT.

Unit 3
Field Effect Transistors - MOSFET - Enhancement and Depletion Modes - Regions of Operation – MOSFET Characteristics - MOSFET Amplifier - MOSFET as a switch.

Text Book(s)
Adel S Sedra, Kenneth C Smith and Arun N Chandorkar, "Microelectronic Circuits – Theory and Applications", Seventh Edition, Oxford University Press, 2017.
Robert L Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory", Eleventh Edition, Pearson India Education Services Pvt. Ltd., 2015.

Reference(s)
Donald A Neamen, "Electronic Circuits – Analysis and Design", Third Edition, McGraw Hill Education, 2006.
Albert Malvino and David Bates, "Electronic Principles", Eighth Edition, McGraw Hill Education, 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

19ECE181	ELECTRONIC SYSTEMS LAB	L-T-P-C: 0-0-3-1

Course Objectives

- To implement Hardware Prototype for a specific application
- To develop basic Graphical User Interface suitable for data visualization
- To design and develop microcontroller based solution for automating a particular process

Course Outcomes

CO1: Able to demonstrate both analog and digital sensor interfacing with a programmable platform
CO2: Able to implement various communication protocols used in the design of portable device
CO3: Able to develop graphical control panel using processing IDE
CO4: Able to design and develop embedded systems using Arduino and Processing IDE

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	3	-	2	-	-	-	3	3	-	-	-	-
CO3	3	-	3	-	-	-	-	-	3	3	-	-	-	-
CO4	3	3	3	3	2	2	2	2	3	3	-	-	3	2

Syllabus

1. GPIO and ADC Interfacing – LED – Switch – Relay - Proximity Sensor - Temperature Sensor - Moisture Sensor.
2. Serial Communication – Bluetooth – ZigBee –RFID.
3. GSM and GPS Interfacing.
4. Motor Interfacing – DC – Stepper – Servo.
5. I2C Interface – EEPROM –RTC.
6. Internet of Things – Wifi Web Server - MQTT.
7. Cloud Interfacing – UbiDots - Thinkspeak.
8. Processing IDE – 2D - 3D operations - Colour Transformations.
9. Image and Video Processing – Thresholding - Pixel manipulation – Filters - Colour Tracking.
10. Keyboard and Mouse Interfacing –Arduino Interface.

Text Book(s)

1. *Michael Margolis, "Arduino Cookbook", Oreilly, 2011.*
2. *Casey Reas, Ben Fry, "Processing: A Programming Handbook for Visual Designers and Artists", The MIT Press, 2014.*

Reference(s)

Jan Vantomme, "Processing 2: Creative Programming Cookbook", Packt Publishing, 2012.

Evaluation Pattern

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

- Introduce basic concepts pertaining to product dismantling and assembly.
- Familiarize with basic pneumatic components and design & validate simple pneumatic circuits.
- Familiarize with sheet metal tools and operations.
- Provide hands-on training on welding and soldering.
- Familiarize with plumbing tools and processes.
- Inculcate and apply the principles of 3D printing to build simple geometries.

Course Outcomes

CO1: Interpret the functionality of various components in a product through dismantling and assembly
CO2: Identify various pneumatic and electro-pneumatic components
CO3: Fabricate simple sheet metal objects using concepts of surface development
CO4: Perform metal joining operations using soldering and arc welding
CO5: Make simple plumbing joints for domestic applications
CO6: Build simple geometries using 3D printing tools

CO-PO MAPPING

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

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.

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.

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.

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)

3D-Printing Workshop

Evaluation Pattern

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

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

19ECE111	CIRCUIT 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 circuit

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	-

Syllabus

Unit 1
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's theorems - Superposition theorem - Maximum power transfer theorem.

Unit 2
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.

Unit 3
Two-port Networks - impedance - admittance – hybrid - transmission parameters - Passive filters as two port networks - poles and zeroes - filter design.

Text Book(s)
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.

Reference(s)
John D. Ryder, Myril Baird Reed and 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

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

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 in still into students a dynamic awareness and understanding of their country's achievements and civilizing influences in various fields and at various epochs.

Course Outcome

CO1: Get an overview of Indian contribution to the world in the field of science and literature.
CO2: Understand the foundational concepts of ancient Indian education system.
CO3: Learn the important concepts of Vedas and *Yogasutra*-s and their relevance to daily life.
CO4: Familiarize themselves with the inspirational characters and anecdotes from the *Mahābhārata* and *Bhagavad-Gītā* and Indian history.
CO5: Gain an understanding of Amma's role in the empowerment of women

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		3				2		
CO3						3	3	3				2		
CO4						3	3	3				2		
CO5						1		1						

Syllabus

Unit 1
To the World from India; Education System in India; Insights from Mahabharata; Human Personality. India's Scientific System for Personality Refinement.

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

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

SEMESTER III

19ECE201	ANALOG ELECTRONIC CIRCUITS	L-T-P-C: 3-0-0-3

Pre Requisite(s): Electronic Devices and Circuits

Course Objectives

- To understand the operation of BJT and MOSFET amplifiers
- To understand the operation of current sources and their use as active loads
- To understand the concept of differential amplifiers and their operation
- To effectively use simulation tools (PSpice) to understand and analyse circuits

Course Outcomes

CO1: Ability to analyze transistor (BJT and MOSFET) circuits
CO2: Ability to design amplifier circuits to given specifications
CO3: Ability to understand and apply the concept of negative feedback in electronic circuits
CO4: Ability to analyse and apply current sources in IC design
CO5: Ability to understand the operation of differential amplifiers

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	-
CO2	3	3	3	-	2	-	-	-	-	-	-	2	2	-
CO3	3	3	-	-	2	-	-	-	-	-	-	2	2	-
CO4	3	3	-	-	2	-	-	-	-	-	-	2	2	-
CO5	3	-	-	-	2	-	-	-	-	-	-	2	2	-

Syllabus

Unit 1
Review of BJT and MOSFETs – Characteristics and Biasing; Different configurations - Loadline analysis - Transistor models – Amplifiers - Multistage amplifiers - Low and High Frequency response - Effect of the coupling capacitors and the internal capacitances of the transistors - Unity Gain bandwidth - CMOS amplifier.

Unit 2
Feedback Amplifiers – Concept of negative and positive feedback; Current and Voltage sampling and mixing – different kinds of feedback - Analysis - Effect of feedback on gain - bandwidth - input resistance and output resistance.

Unit 3
Current Sources – characteristics; Current mirrors – Simple and base current compensated - Wilson current mirror- Widlar Current source - Active loads - Differential amplifier.

Text Book(s)

S. Sedra, K. C. Smith and A. N. Chandorkar, "Microelectronic Circuits – Theory and Applications", Seventh Edition, Oxford University Press, 2017.

R. L. Boylestad and L. Nashelsky, "Electronic Devices and Circuit Theory", Eleventh Edition, Pearson India Education Services Pvt. Ltd., 2015.

Reference(s)

D. A. Neamen, "Electronic Circuits – Analysis and Design", Third Edition, McGraw Hill Education, 2006.

J. Millman, C. C. Halkias and C. D. Parikh, "Millman's Integrated Electronics – Analog and Digital Circuits and Systems", Second Edition, McGraw Hill Education, 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

19ECE202	APPLIED ELECTROMAGNETICS	L-T-P-C: 3-1-0-4

Pre Requisite(s): Multivariable Calculus

Course Objectives

- To acquire knowledge on the existence of electromagnetic field and its effects
- To understand the construction of the basic mathematical model for field analysis
- To understand and analyze field- material interaction

Course Outcomes

CO1: Able to understand basic mathematical tools required for describing and analyzing Field Effect
CO2: Able to describe the relation between circuit parameters and field parameters, and laws governing them, in both static and time varying conditions.
CO3: Able to construct Plane Wave propagation Model for a medium and understand Wave – Medium Interaction.
CO4: Ability to analyze wave-medium interaction and interpret its relevance for that particular electrical engineering application

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
CO2	3	2	-	2	-	-	-	-	-	-	-	-	3	2
CO3	3	2	2	2	-	-	-	-	-	-	-	-	3	2
CO4	2	2	-	2	-	-	-	-	-	-	-	2	3	2

Syllabus

Unit 1
Static Electric Fields - Co-ordinate systems – Review - Line integral - Surface integral – Gradient – Divergence - Curl- Stoke's theorem - Divergence theorem - Helmholtz theorem- Electrostatics - Postulates - Coulomb's law - Gauss law - Electric potential - Behaviour of conductors and dielectric in static fields - Dielectric constant - Poisson's and Laplace equation.

Unit 2
Steady currents and magnetic fields - Current density - Point form of Ohm's law – Continuity equation - Lorentz force - Magneto statics – Postulates - Magnetic vector potential – Biot - savart law - Relative permeability - Hall effect.

Unit 3
Electromagnetic Fields - Faraday's law of Induction - Maxwell's equations - Differential and Integral Forms - Boundary Conditions for electromagnetic fields - Wave equation - Time harmonic electromagnetic fields - Poynting vector and group velocity – Normal incidence at conducting and dielectric boundary – Review of oblique incidence - Computation model- Solution via numerical methods.

Text Book(s)
David K.Cheng, "Field and Wave Electromagnetics", Pearson Education, Second Edition, 2002.
Clayton R. Paul, Keith W. Whites, Syed A. Nasar, "Introduction to Electromagnetic Fields", Tata McGraw-Hill Education Private Limited, Third Edition (Fifth Reprint), 2009.

Reference(s)

Kraus, Fleisch, "Electromagnetics with Applications", Tata McGraw Hill Education Private Limited, Fifth Edition, 2004.

Constantine A. Balanis, "Advanced Engineering Electromagnetics", Wiley, Second Edition, 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

19ECE204	DIGITAL ELECTRONICS AND SYSTEMS	L-T-P-C: 3-1-0-4

Course Objectives

- To understand the fundamentals of Boolean Logic and the building blocks of digital circuits
- To introduce the abstraction of simple practical problems into Boolean Logic and their efficient implementation
- To introduce the fundamentals of design with combinational and sequential subsystems

Course Outcomes

CO1: Able to frame Boolean equations for solving a simple real-life engineering problem and realize them using gate-level building blocks
CO2: Able to apply minimization techniques for efficient Boolean logic implementation
CO3: Able to realize digital blocks using combinational and sequential subsystems
CO4: Able to design using state machine descriptions for practical real-life engineering problems

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	2	-	-	-	-	-	-	-	-	-	-	2	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-	2	-

Syllabus

Unit 1
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.

Unit 2
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.

Unit 3
Synchronous sequential circuits - Basic design steps - State assignment problem - Mealy state model - Serial adders - State minimization - Introduction to Asynchronous sequential circuits – Introduction to CMOS logic.

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", Fourth Edition, Pearson Education, 3rd Ed, 2008.
Donald D Givone, "Digital Principles and Design", Tata McGraw Hill Publishing Company Limited, 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

19ECE203	SIGNALS AND SYSTEMS	L-T-P-C: 3-1-0-4

Course Objectives

- To understand the fundamental characteristics of signals and systems
- To understand signals and systems in terms of both the time and frequency domains
- To develop the mathematical skills including calculus, complex variables and algebra for the analysis and design of LTI systems used in engineering

.

Course Outcomes

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

Syllabus

Unit 1
Basic signals - unit step, unit impulse, sinusoidal and complex exponential signals - Types of signals- Basic operations on signals-system properties-Time Domain characterization of continuous time and discrete time LTI system-Convolution Integral-Convolution sum-Analysis of LTI system described by differential and difference equations.

Unit 2
Fourier series representation of continuous time periodic signals, properties of continuous time Fourier series - Fourier transform of continuous time aperiodic signals - properties of continuous time Fourier transform - Fourier series representation of discrete time periodic signals - properties of discrete time Fourier series - Discrete time Fourier transform - properties of discrete time Fourier transform.

Unit 3
Laplace Transform and Z-Transforms: Bilateral Laplace Transforms – ROC - Inverse Laplace Transforms - Unilateral Laplace Transforms - Bilateral Z-Transform: Definition – ROC - Inverse Z-transforms - Unilateral Z Transforms - Analysis and characterization of LTI system.

TextBook(s)
Simon Haykin, Barry Van Veen, "Signals and Systems", Second Edition, John Wiley and Sons, 2007.
Alan V. Oppenheim, Alan S. Wilsky, S. Hamid Nawab, "Signals and Systems". Prentice Hall India private Limited, Second Edition, 1997.

Reference(s)

Lathi B P, "Signal Processing & Linear Systems", Oxford University Press, 2006.
Rodger E. Ziemer, William H. Tranter D. Ronal Fannin, "Signals and Systems", Pearson Education, Fourth Edition, 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

19MAT205	PROBABILITY AND RANDOM PROCESSES	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 modeling.
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	PSO1	PSO2
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(s)
Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, (2005) John Wiley and Sons Inc.
A. Papoulis, and Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", Fourth Edition, McGraw Hill, 2002.

Reference Book(s)

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

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

19ECE282	DIGITAL ELECTRONICS AND SYSTEMS LAB	L-T-P-C: 0-0-3-1

Course Objectives

- Familiarization of digital components and ICs used as building blocks for realizing larger systems
- To learn to realize and troubleshoot simple digital circuits using logic gate ICs on the breadboard and verify their truth tables
- To learn to use off-the-shelf subsystems such as MSI ICs such as adders, decoders and multiplexers by appropriately configuring them with the help of datasheets for realizing circuits to solve a practical engineering problem

Course Outcomes

CO1: Able to identify, configure and use off-the-shelf digital ICs
CO2: Able to realize and troubleshoot combinational and sequential digital circuits
CO3: Able to employ MSI ICs of appropriate configuration for realizing a digital system
CO4: Able to design and implement simple digital system for a real-life problem

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	-

Syllabus

- Study of Logic Gate ICs.
- Realization of Boolean functions using logic gate ICs.
- Truth table based design and implementation of simple real life problems.
- Implementation of digital systems using MSI building blocks such as adders, multiplexers and decoders.
- Breadboard realization of synchronous sequential circuits.
- Digital system design and implementation for a real-life problem.

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

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

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

19ECE281	ANALOG ELECTRONICS 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	-

Syllabus

1. Network analysis - involving Thevenin's theorem and effective resistance.
2. Characterisation of a diode.
3. Shunt Voltage Regulator.
4. Rectifiers – Half-wave - Full-wave and Bridge.
5. Clipping and Clamping Circuits.
6. Characterisation of a transistor – BJT / MOSFET.
7. Biasing of a transistor.
8. Transistor Amplifier – without feedback.
9. Transistor Amplifier – with feedback.

Textbook(s)

S. Sedra, K. C. Smith and A. N. Chandorkar, "Microelectronic Circuits – Theory and Applications", Seventh Edition, Oxford University Press, 2017.

R. L. Boylestad and L. Nashelsky, "Electronic Devices and Circuit Theory", Eleventh Edition, Pearson India Education Services Pvt. Ltd., 2015.

References(s)

D. A. Neamen, "Electronic Circuits – Analysis and Design", Third Edition, McGraw Hill Education, 2006.

Evaluation Pattern

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

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

19AVP201	**AMRITA VALUES PROGRAM I**	**1 0 0 1**
19AVP211	**AMRITA VALUES PROGRAM 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 offighting*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

SEMESTER IV

19ECE213	TRANSMISSION LINES AND RADIATING SYSTEMS	L-T-P-C: 3-1-0-4

Pre Requisite(s): Applied Electromagnetics

Course Objectives

- To study the wave characteristics along the transmission lines
- To learn wave characteristics on a transmission line and for impedance matching with the help of standard graphical tool
- To introduce uniform guiding structures and its characteristics for high frequency applications
- To understand the concept of radiating element and its parameters

Course Outcomes

CO1: Able to understand the concepts of signal propagation in transmission lines
CO2: Able to analyze impedance problems in transmission lines
CO3: Able to understand the principles of operation of waveguides
CO4: Able to understand the radiation principles on Transmission lines

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	3	-	2	-	-	-	-	-	-	-	-	3	2
CO3	3	2	-	-	-	-	-	-	-	-	-	2	3	-
CO4	2	3	2	-	-	-	-	-	-	-	-	2	3	-

Syllabus

Unit 1
Transmission line theory - TEM wave along parallel plate line – Transmission line parameters – General equations – Infinite line concept – Transmission line parameters – Finite line properties – Input impedance – Smith chart calculations – Transmission line impedance matching techniques – Stub matching.

Unit 2
Wave Guiding Systems - Transverse Electric (TE) and Transverse Magnetic(TM) modes – Electromagnetic waves between parallel plates (TE and TM) – Properties – Rectangular waveguides – TE and TM waves in rectangular waveguides – Properties - Attenuation in waveguides.

Unit 3
Radiation systems - Computation of radiation intensity - Radiation mechanism on Transmission lines-radiation patterns and parameters - Wire antenna-Loop antenna - horn antenna-reflector antennas.

Text Book(s)
David K.Cheng, "Field and Wave Electromagnetics", Pearson Education, Second Edition, 2002.
Clayton R. Paul, Keith W. Whites, Syed A. Nasar, "Introduction to Electromagnetic Fields", Tata McGraw-Hill Education Private Limited, Third Edition (Fifth Reprint), 2009.

Reference(s)

Kraus, Fleisch, "Electromagnetics with Applications", Tata McGraw Hill Education Private Limited, Fifth Edition.

Constantine A. Balanis, "Antenna Theory: Analysis and Design", Wiley-Interscience, Third Edition, 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

19ECE211	DIGITAL SIGNAL PROCESSING	L-T-P-C: 3-0-0-3

Pre Requisite(s): Signals and Systems

Course Objectives

- To introduce the frequency domain concepts and filter design in signal processing applications
- To develop knowledge in efficient transforms for signal analysis
- To provide knowledge in designing and developing signal processing systems suitable for various applications

Course Outcomes

CO1: To understand the concepts of signal processing systems and signal analysis
CO2: To design signal processing systems for specific constraints
CO3: To comprehend realization structures for filters
CO4: To develop a digital signal processing systems for different 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	-
CO2	3	2	3	-	-	-	-	-	-	-	-	2	2	
CO3	3	2	-	2	-	-	-	-	-	-	-	2	2	-
CO4	3	2	3	2	-	-	-	-	-	-	-	2	2	2

Syllabus

Unit 1
Discrete Fourier transforms - properties of DFT – linear filtering methods based on DFT – Fast Fourier Transform – efficient computation of the DFT– correlation – use of FFT in linear filtering and correlation.

Unit 2
FIR filters: symmetric and anti-symmetric FIR filters – design of linear phase FIR filter using Windows – FIR differentiators – Hilbert transforms – linear phase FIR filters- Structures for FIR systems – direct form structures - Linear phase and cascade form structures- applications.

Unit 3
IIR filters: design by approximation of derivatives – impulse invariance and Bilinear transformation – Butterworth filter- frequency transformations for analog and digital filters - Structures for IIR systems-direct form structures - cascade form structures - parallel form structures- applications.

Text Book(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 computer based approach", Tata McGraw Hill Publishing Company Limited, Fourth Edition, 2010.

Reference(s)

Allen V. Oppenheim, Ronald W. Schafer, "Discrete time Signal Processing", Prentice Hall India Privat Limited, Third Edition, 2013.

Emmanuel C.Ifeachor, and Barrie. W.Jervis, "Digital Signal Processing", Second Edition, Pearson Education, Prentice Hall, 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 Report

19ECE212	LINEAR INTEGRATED CIRCUITS	L-T-P-C: 3-0-0-3

Pre Requisite(s): Analog Electronic Circuits

Course Objectives

- To study the concepts of operational amplifiers
- To understand the design aspects of non-linear circuits
- To analyze and design oscillators

Course Outcomes

CO1: Able to understand the construction of electronic systems using operational amplifiers
CO2: Able to understand the various specification parameters of op-amp
CO3: Able to design and analyze linear and non-linear circuits with op-amps
CO4: Able to design and analyze 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	-	-	-	-	-	-	-	-	-	-	-	3	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO3	2	3	3	-	-	-	-	-	-	-	-	-	3	-
CO4	2	3	3	-	-	-	-	-	-	-	-	-	3	-

Syllabus

Unit 1
Review of Analog electronics - Basic blocks of operational amplifier - Operational Amplifiers as comparators and voltage follower - Opamp applications in negative feedback - Inverting and Non-inverting Amplifier- Effect of finite open loop gain - DC imperfections-Input offset voltage - slew rate - input offset current - Finite CMRR - Finite input impedance.
Unit 2
Adder - subtractor - Difference Amplifiers - Instrumentation amplifiers – Integrators – differentiator - Current pump - Log and Anti-Log Amplifiers - Precision Rectifiers - Peak detectors – Comparator - Schmitt triggers- Generation of Square and Triangular Waveforms using Astable Multivibrators - The Monostable Multivibrator.
Unit 3
Integrated-Circuit Timer - Astable and Monostable multivibrator with 555.Basic Principles of Sinusoidal Oscillators - RC phase shift oscillator - Wein-Bridge Oscillator - LC and Crystal Oscillators.

Text Book(s)
A S. Sedra, K. C. Smith and A. N. Chandorkar, "Microelectronic Circuits -Theory and Applications", Seventh Edition, Oxford University Press, 2017.
D. A. Neamen, "Electronic Circuit -Analysis and Design", Third Edition, McGraw Hill Education, 2006.

Reference(s)
Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", Fourth Edition, Tata McGraw Hill Publishing Company Limited, 2015.
J. Millman and A.Grabel, "Microelectronics", Second Edition, McGraw-Hill, 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 Report

19ECE214	COMMUNICATION THEORY	L-T-P-C: 3-1-0-4

Pre Requisite(s): Nil

Course Objectives

- To introduce the concepts of amplitude modulations and their spectral characteristics
- To understand the concepts of angle modulations and their spectral characteristics
- To study the effect of noise on communication systems
- To understand the concepts of analog to digital conversion

Course Outcomes

CO1: ability to understand the basic principles of signal modulation
CO2: ability to analyze the time domain and frequency domain representation of amplitude and angle modulations
CO3: able to analyze the effect of noise on analog communication systems
CO4: able to apply the concepts of modulation schemes in the design of communication systems

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	-
CO2	3	3	3	-	-	-	-	-	-	-	-	2	3	-
CO3	3	3	3	-	-	-	-	-	-	-	-	2	3	-
CO4	3	3	3	-	-	-	-	-	-	-	-	2	3	-

Syllabus

Unit 1
Amplitude Modulation-Amplitude modulation - DSB-SC - SSB modulation and demodulation - Introduction to vestigial sideband modulation - Implementation of AM modulator and demodulator - Super heterodyne receiver.

Unit 2
Angle Modulation-Angle modulation -Introduction and representation - Spectral characteristics of angle modulation - Implementation of modulator and demodulator for angle modulation.

Unit 3
Noise Analysis and Analog to Digital conversion-Random process basic concepts and linear systems - Gaussian white process - Narrow band noise and filtering - Effect of noise in AM system - Effect of noise in FM system Analog to digital conversion - Waveform coding - PCM - DPCM - Delta modulation.

Text Book(s)
John. G. Proakis, Masoud Salehi, "Fundamentals of Communication Systems", Pearson Education, 6th edition, 2011.
Simon Haykin, "Communication Systems", John Wiley and Sons, 4th edition, 2001.

Reference(s)

Bruce Carlson, Paul.B. Crilly, Janet.C.Ruteledge, "Communication Systems", McGraw-Hill, 1993, Fourth Edition.

Rodger. E. Ziemer, William. H. Tranter, "Principle of Communication", John Wiley, 1998, Fifth Edition.

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

19MAT213	OPTIMIZATION TECHNIQUES	L-T-P-C: 3-0-0-3

Course Objectives

- *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 different types of Optimization Techniques in engineering problems. Learn Optimization methods such as Bracketing methods, Region elimination methods, Point estimation methods.
CO2: Learn Optimizations Techniques in single variables problems.
CO3: Learn unconstrained Optimizations Techniques in single variables problems
CO4: Learn constrained optimization techniques and Kuhn-Tucker conditions

CO-PO Mapping

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

Syllabus

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)

S.S. Rao, "Optimization Theory and Applications", Second Edition, New Age International (P) Limited Publishers, 1995.

Reference(s)

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

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

19ECE284	DIGITAL SIGNAL PROCESSING 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

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

Syllabus

Generation of signals-Operation on signals-Sampling of analog signals -study of aliasing - Computation of DFT using direct /linear transformation method - Properties of DFT -Computation of 2-N point DFT of a real sequence by using an N point DFT just once -Computation of FFT through DIT and DIF-Linear filtering-Design of FIR filter (different windowing technique)-Design of IIR Butterworth filter- Applications of DSP - a few case studies Term Work.

Text Book(s)

John G Proakis, G. Manolakis, "Digital Signals Processing Principles, Algorithms, Applications", Prentice Hall India Private Limited, Fourth Edition, 2007.

Reference(s)

Allen V. Oppenheim, Ronald W. Schafer, "Discrete time Signal Processing", Prentice Hall India Private Limited, Third Edition, 2013.

Evaluation Pattern

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

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

19ECE283	LINEAR INTEGRATED CIRCUITS LAB	L-T-P-C: 0-0-3-1

Course Objectives

- To be able to characterize operational amplifiers to extract the parameters
- To experimentally verify and appreciate the difference between op-07 and UA-741
- To be able design, simulate and implement amplifiers, non-linear wave shaping circuits and Oscillators

Course Outcomes

CO1: Able to characterize op-amp
CO2: Able to understand the various specification parameters of op-amp
CO3: Able to design, simulate, analyze and implement linear and non-linear circuits with op-amps
CO4: 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	-

Syllabus

1. Characterization of Operational Amplifiers(op-amp).
2. Inverting and Non-inverting Amplifier.
3. Difference Amplifiers.
4. Instrumentation amplifiers.
5. Integrators, differentiator.
6. Precision Rectifiers, Comparators.
7. Schmitt triggers.
8. Generation of Square and Triangular Waveforms.
9. Integrated-Circuit Timer Astable and Monostable multivibrator with 555.
10. RC phase shift oscillator/ Wein-Bridge Oscillator.

Text Book(s)

A.S. Sedra, K. C. Smith and A. N. Chandorkar, "Microelectronic Circuits - Theory and Applications", Seventh Edition, Oxford University Press, 2017.
D. A. Neamen, "Electronic Circuit -Analysis and Design", Third Edition, McGraw Hill Education, 2006.

Reference(s)

Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", Fourth Edition, Tata McGraw Hill Publishing Company Limited, 2015.
J. Millman and A.Grabel, "Microelectronics", Second Edition, McGraw-Hill, 2001.

Evaluation Pattern

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:

PO/PSO / CO	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

19ECE304	MICROCONTROLLERS AND INTERFACING	L-T-P-C: 3-0-3-4

Pre Requisite(s): Digital Design

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: Able to identify the importance of 32 bit Microprocessor
CO2: Able to understand architecture of the ARM Processor
CO3: Able to analyze Peripherals and their programming aspects
CO4: Able to design and develop embedded systems using microcontroller

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

Syllabus

Unit 1
Introduction to ARM Processor-ARM Processor–Processor Families – Features of ARM - ARM7 TDMI Architecture – Programmer's Model – Interrupts and Exceptions – Operating Modes– Addressing Modes – ARM Instruction Set – THUMB Instruction Set – Basic ARM Assembly Language Programs-Pipelining in ARM – ARM Cortex M - A & R series.

Unit 2
ARM LPC2148 Microcontroller-Introduction to LPC2148-Architecture-Advanced Microcontroller Bus Architecture-Memory Map-Phase Locked Loop - VPB Divider - Wakeup Timer - Brown-out Detector - Introduction to Embedded C Programming – Introduction to Keil IDE – GPIO – LED and Switch Interfacing – UART - Transmission and Reception – ADC -Potentiometer Interfacing.

Unit 3
LPC2148 Peripherals and Interfacing-External Interrupts - Device Control – Timers - Delay Timer – PWM - DC Motor Speed Control – DAC – Sine Wave Generation Interfacing - Keypad - LCD - Seven Segment - Stepper Motor - Temperature Sensor.

Lab component: Basic Assembly Language Programs - PLL configuration - GPIO programming - Analog Sensor interfacing using ADC - Serial Communication using UART - External Interrupt configuration - PWM based motor speed control - Single stepping of Stepper Motor - Sine wave generation using DAC - Universal Timer using Timer peripheral - Digital Panel meter using Seven Segment Display Keypad and LCD interfacing.

Text Book(s)

Steve Furber, "ARM system On Chip Architecture", Addison Wesley, 2000.
LPC21488 User manual, NXP Semiconductors.

Reference(s)

T Martin, "The Insider's Guide to the Philips ARM7-based Microcontrollers: An Engineer's Introduction to the LPC2100 Series", Hitex, 2005.
Tammy Noergaard, "Embedded Systems Architecture A Comprehensive Guide for Engineers and Programmers", Newnes, 2013.

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

19ECE303	RADIO FREQUENCY ENGINEERING	L-T-P-C: 3-0-0-3

Pre Requisite(s): Applied Electromagnetics

Course Objectives

- To understand the principle of operation of radio frequency devices and circuits
- To study the device performance using scattering parameters
- To understand the concepts of wireless communication systems
- To expose the RF technologies used in various applications

Course Outcomes

CO1: Able to understand basic mathematical tools required for analyzing RF systems
CO2: Able to design planar devices and analyze their performance
CO3: Able to comprehend system level parameters in RF systems
CO4: Able to apply RF design concepts to Wireless 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	2
CO3	3	2	2	-	-	-	-	-	-	-	-	2	3	2
CO4	3	2	3	-	-	-	-	-	-	-	-	2	3	2

Syllabus

Unit 1
Electromagnetic frequency spectrum with applications – network parameters – scattering matrix – S-parameter analysis of passive waveguide devices – power dividers, combiners - phase shifters – Rectangular waveguide resonators.

Unit 2
Planar passive devices – microstrip lines – striplines –transmission line resonators – T-junction power dividers – quarter-wave transformers – Noise in RF systems – Noise figure computations – non linear distortion – Dynamic range.

Unit 3
RF Communication systems – Friss formula – link budget – antenna noise temperature – carrier to noise ratio – antenna parameters – bit error rate calculations – Case studies on direct broadcasting systems – global positioning systems – WLAN – Spectrum regulations and standards.

Text Book(s)
David M. Pozar, "Microwave Engineering", Wiley India Limited, Fourth Edition, 2012.
Samuel. Y. Liao, "Microwave Devices and Circuits", Pearson Education, Third Edition, 2004.

Reference(s)
Ludwig R, Bogdanov G,"RF Circuit Design, Theory and Applications", Pearson Education Inc, Second Edition, 2013.

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

19ECE302	DIGITAL COMMUNICATION	L-T-P-C: 3-0-0-3

Pre Requisite(s): Communication Theory

Course Objectives

- Understand the fundamental principles of digital modulation and demodulation methods
- Quantify the impact of noise and channel impairments on digitally modulated signals
- Design digital signals and optimum receivers to combat the impact of noise and channel impairments
- Understand and appreciate the techniques to make digital modulation and demodulation methods power efficient, bandwidth efficient, and suitable for hardware implementation

Course Outcomes

CO1: Able to understand the fundamental principles of digital modulation and demodulation methods
CO2: Able to quantify the impact of noise and channel impairments on digitally modulated signals
CO3: Able to design digital signals and optimum receivers to combat the adverse impact of noise and channel impairments
CO4: Able to choose and apply efficient digital modulation schemes for a given channel type

CO – PO Mapping

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

Syllabus

Unit 1
Signal Space Representation of Waveforms - GS orthogonalization – Bandpass and lowpass orthonormal basis - Line coding -Unipolar –Polar -Bipolar - RZ; NRZ – Manchester.

Unit 2
Digital Carrier Modulation: Memoryless carrier modulation –ASK – PSK – QAM – FSK - Carrier modulation with memory – CPFSK – MSK – GMSK – OQPSK - π/4-QPSK; Differential encoding – DPSK, - DQPSK - Power spectra of digitally modulated signals - Optimum Receiver Design for AWGN Channels - Correlation-type and matched-filter-type demodulators - MAP and ML detectors - Optimum coherent receivers for AWGN channels -Probability of error– union bound.

Unit 3
Signaling and Optimum Receiver Design for Band limited Channels -Inter-Symbol Interference (ISI) - Signal design for bandlimited channels –Nyquist criterion for no ISI - Optimum detection for channels with ISI and AWGN – Equalization.

Text Book(s)
John G. Proakis and Masoud Salehi, "Digital Communications", McGraw-Hill Higher Education, Fifth Edition, 2008.
Simon Haykin, "Digital Communication Systems", John Wiley & Sons, 2014.

Reference(s)

John G. Proakis, Masoud Salehi and Gerhard Bauch, "Contemporary Communication Systems Using MATLAB.Cengage Learning India", Third Edition, 2012.

John G. Proakis and Masoud Salehi, "Fundamentals of Communication Systems. Pearson Education", Second Edition, 2013.

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

19ECE301	CONTROL THEORY	L-T-P-C: 3-1-0-4

Pre Requisite(s): Signals and Systems

Course Objectives

- To introduce the basic steps in a model based design process
- To understand behavior of systems based on their time and frequency domain characteristics
- To introduce the concepts of compensation for meeting desired system characteristics

Course Outcomes

CO1: Able to understand the applications of differential equations and Laplace transforms for modeling and analysis of physical systems
CO2: Able to develop mathematical models of simple physical systems
CO3: Able to carry out time and frequency domain analysis on physical system models
CO4: Able to design compensators for the given system model to meet the given performance specifications

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	-	-	-	-	-	-	-	-	-	-	1	-
CO3	-	3	-	-	1	-	-	-	-	-	-	-	1	-
CO4	-	3	3	-	1	-	-	-	-	-	-	-	1	-

Syllabus

Unit 1
Introduction - System Configurations - Analysis and design objectives - Design process - Computer-aided design - Laplace transform review - The transfer function - Electrical network Transfer functions - Translational mecha nical system transfer functions - Electric circuit analogs – Nonlinearities – Linearization - Transfer function of a DC motor. Poles, Zeros and system response - Time response analysis (1st, 2nd order) - Block diagram reductio n techniques - Signal flow graph - Mason's gain formula. Stability - Routh-Hurwitz criterion - Steady-state error for unity feedback systems - Static error constants and system type - Steady-state error specifications.

Unit 2
The root locus, properties of the root locus - Sketching the root locus - Transient response Design via gain adjustment - Frequency response techniques - Asymptotic approximations: Bode plots - Introduction to the Nyquist criterion – Stability - Gain margin and Phase margin via Nyquist diagram and Bode plots. Relation between closed loop transient and closed loop frequency responses - Relation between closed and open loop frequency responses - Relation between closed loop transient and open loop frequency responses - Steady-state error characteristics from frequency response - Systems with time delay - Obtaining transfer functions.

Unit 3
Design via frequency response - Transient response design via gain adjustment - Lag compensation - Lead compensation - The general state - Space representation - Applying the state-space representation - Converting a transfer function to sate-space - Converting from state-space to a transfer function.

Text Book(s)

Norman Nise, "Control System Engineering", John Wiley & Sons, Inc., Sixth Edition, 2011.
Dorf R. C. and Bishop R. H, "Modern control systems", Addison-Wesley Longman Inc., Eighth Edition, Indian reprint, 1999.

Reference(s)

Katushiko Ogata, "Modern control engineering", Pearson education, Third Edition, 2004.
Benjamin C. Kuo, "Automatic Control Systems", Prentice Hall India Ltd, Sixth Edition, 2000.

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

19ECE381	RF AND SIMULATION LAB	L-T-P-C: 0-0-3-1

Course Objectives

- To get hands on experience in building the RF circuits and analyze its performance
- To practice the tools used for simulations and its parameters and syntax in the circuit design
- To become the expertise in RF design and performance analysis

Course Outcomes

CO1: ability to understand the concepts of RF signal transmission through waveguides
CO2: ability to analyze the scattering parameters of RF devices
CO3: ability to apply the RF design concepts and characterize using simulation tools
CO4: ability to design and analyze RF 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	3	3	3	3	3	-	-	-	-	-	-	3	3	3
CO2	3	3	3	3	3	-	-	-	-	-	-	3	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	3	3	3
CO4		2	-	-	-	-	-	-	3	3		3	-	-

Syllabus

1. Characterization of waveguide based microwave setup.
2. Measurement of radiation pattern of horn antennas.
3. Measurement of return loss and insertion loss of any selected microwave component.
4. Characterization of materials using two-antenna method.
5. Electromagnetic simulation and scattering parameters study on microstrip lines.
6. Electromagnetic simulation and characterization of rectangular microstrip antenna.
7. Electromagnetic simulation and characterization of circular microstrip antenna.
8. Electromagnetic simulation and characterization of microstrip power dividers .
9. Electromagnetic simulation and characterization of rectangular microstrip resonator.
10. Electromagnetic simulation and characterization of hybrid ring couplers.

Text Book(s)
David M. Pozar, "Microwave Engineering", Wiley India Limited, Fourth Edition, 2012.

Reference(s)
Samuel. Y. Liao, "Microwave Devices and Circuits", Pearson Education, Third Edition, 2004.

Evaluation Pattern

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

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

19ECE382	COMMUNICATION SYSTEMS LAB	L-T-P-C: 0-0-3-1

Pre Requisite(s): Nil

Course Objectives

- To gain hands-on experience of analog and digital modulation and demodulation methods by seeing the hardware implementation and/or computer simulation of the methods in action
- To acquire the skill of troubleshooting the hardware realization and debugging the computer simulation code of modulation and demodulation methods
- To conduct communication experiments in an organized manner by thorough pre-experiment preparation including gaining the knowledge about the hardware components and/or software functions

Course Outcomes

CO1: Able to implement modulation and demodulation methods in hardware and troubleshoot
CO2: Able to simulate modulation and demodulation methods in computer and analyze the performance
CO3: Able to understand the strengths and limitations of the hardware components and computer simulations
CO4: Able to organize communication experiments and present the outcomes in an effective manner

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	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	3	3	3
CO4	-	-	-	-	-	-	-	-	3	3	-	3	-	-

Syllabus

1. Amplitude Modulation.
2. Frequency Modulation.
3. Time Division Multiplexing.
4. Pulse Amplitude Modulation.
5. Amplitude Shift Keying.
6. Phase Shift Keying.
7. Frequency Shift Keying.
8. Eye Pattern Generation,
9. Digital Pulse Modulation Schemes(computer experiment).
10. Gram Schmidt orthogonalization (computer experiment).
11. Probability of Error Calculation (computer experiment).

Text Book(s)

John G. Proakis and Masoud Salehi, "Digital Communications", McGraw-Hill Higher Education, Fifth Edition, 2008.

Reference(s)

John G. Proakis, Masoud Salehi and Gerhard Bauch,"Contemporary Communication Systems Using MATLAB, Cengage Learning India", Third Edition, 2012.

Evaluation Pattern

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

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

19ECE311	COMPUTER NETWORKS	L-T-P-C: 4-0-0-4

Pre Requisite(s): Nil

Course Objectives

- Gain in-depth understanding of the fundamental networking principles, the challenges involved and implementation issues encountered in designing practical network protocols at Internet scale
- Analyze both qualitatively and quantitatively the performance of network protocols and system architectural design choices
- Connect networking principles with the actual implementation details as found in networking standards currently used in practice
- Gain hands-on experience by watching the protocols in action through simulation and/or software/hardware experiments

Course Outcomes

CO1: Able to understand the fundamental networking principles and protocol concepts
CO2: Able to connect networking principles with the practical network protocols currently used in the Internet
CO3: Able to analyze the performance of network protocols and system architectural design choices
CO4: 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

Syllabus

Unit 1
Introduction to the Internet - Services and Protocols, Edge and Core, Packet Switching vs. Circuit Switching - Performance Metrics – Delay - Loss – Throughput - Protocol Layers and Service Models – OSI and TCP/IP models - Application Layer: Client-Server and Peer-to-Peer architectures - Application Layer protocols - Transport Layer - Unreliable Connectionless vs. Reliable Connection-Oriented Services - Multiplexing; Stop-and-Wait - Go-Back-N and Selective-Repeat - UDP vs. TCP - Flow and Congestion Control.

Unit 2
Network Layer - Data plane forwarding vs. Control plane routing - Software Defined Networking (SDN) approach - Network Services - Router architecture - Switching fabrics - Input and output queueing IPv4 and IPv6 addressing – DHCP -NAT - IPv4 and IPv6 fragmentation - SDN based generalized forwarding - Routing and Supporting Algorithms - Link State vs. Distance Vector - RIP - OSPF – BGP – ICMP - SNMP - SDN Control Plane.

Unit 3
Link Layer – Services - Error Detection and Correction; Multiple Access protocols – Channel partitioning - Random access - Taking-Turns protocols - Switched LANs – ARP - Ethernet - Link layer switching – VLANs – MPLS - Introduction to Wireless and Mobile Networks - Link characteristics - CDMA - 802.11 WiFi - Bluetooth and Zigbee - Cellular Networks - GSM – UMTS – LTE - Mobility management and handoff - Mobile IP .

Text Book(s)

James Kurose and Keith Ross, "Computer Networking: A Top-Down Approach", Seventh (Global) Edition, Pearson Education Ltd., 2017.

Larry L. Peterson and Bruce S. Davie, "Computer Networks - A Systems Approach", Morgan Kaufmann, Fifth Edition, 2011.

Reference(s)

Brandon Rhodes, John Goerzen, "Foundations of Python Network Programming", Third Edition, Apress, 2014.

Teerawat Issariyakul and Ekram Hossain, "Introduction to Network Simulator NS"2, Springer, Boston, MA, 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

19ECE312	INFORMATION THEORY AND CODING	L-T-P-C: 3-0-0-3

Pre Requisite(s): Communication Theory

Course Objectives

- To provide foundation in information theory that gives understanding about quantitative measures of information and allows analyzing and characterizing the fundamental limits of communication systems
- To provide an insight of Galois fields and primitive polynomials
- To provide an introduction to traditional and modern coding theory and analyzing performance of different decoding algorithm

.

Course Outcomes

CO1: Able to understand the Information theory fundamentals and the fundamental limits of communication system
CO2: Able to analyze the basic types of codes and understand the source coding algorithms
CO3: Able to derive the channel capacity of communication channel models
CO4: Able to understand the method of encoding and decoding technique of linear block code, cyclic code, convolutional codes
CO5: Able to carry out implementation of different source coding and channel coding algorithms

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	1	-	-	-	-	-	-	-	-	-	-	3	1
CO3	3	2	-	-	-	-	-	-	-	-	-	-	3	2
CO4	3	2	-	-	-	-	-	-	-	-	-	-	3	2
CO5	3	2	2	-	2	-	-	-	-	-	-	-	3	2

Syllabus

Unit 1
Introduction to Information Theory: Modeling of information sources – uncertainty and information – Entropy – information measures for continuous random variable – source coding theorem – Kraft inequality – source coding algorithms: Huffman coding – arithmetic coding – Lempel-Ziv algorithm. Rate distribution function – Entropy rate of stochastic process - Modeling of communication channels - Binary symmetric channel – binary erasure channel – channel capacity – noisy channel coding theorem – Information capacity theorem – Shannon's limit – bounds on communication.

Unit 2
Linear block codes - structure – matrix description – Hamming codes - Standard array arithmetic of Galois fields - Integer ring – finite fields based on integer ring – polynomial rings – finite fields based on polynomial rings – primitive elements - Structure of finite fields - Cyclic codes - Structure of cyclic codes – encoding and decoding of cyclic codes.

Unit 3
BCH codes - Generator polynomials in terms of minimal polynomial – Decoding of BCH codes – Reed-Solomon codes – Peterson-Gorenstein – Zierler decoder – Introduction to low density parity check codes - Convolutional Codes: Introduction to Convolutional Codes – Basics of Convolutional Code encoding and decoding – Sequential decoding – Viterbi decoding- Introduction to Turbo codes.

Text Book(s)

Ranjan Bose, "Information Theory, Coding and Cryptography", Tata McGraw-Hill Publishing Company ltd., New Delhi, Second Edition, 2008.

Thomas M Cover and Joy A Thomas, "Elements of Information Theory", Second Edition John Wiley, 2006.

Reference(s)

J.Proakis, M. Salehi, "Fundamentals of Communications systems", Pearson Education, Second Edition, 2005.

Shu Lin and Daniel J.Costello, "Error Control Coding –Fundamentals and Applications", Pearson, Second Edition, 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

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

Pre Requisite(s): Nil

Course Objectives

- To explore and understand about models and model parameters of MOSFET, CMOS circuits
- To learn to design and simulate digital building blocks using HDL
- To learn configuration and synthesis of circuits in FPGA

Course Outcomes

CO1: Able to design and simulate digital systems using HDL
CO2: Able to understand the different modelling styles in HDL
CO3: Able to synthesize and implement combinational and sequential digital circuits in FPGA
CO4: Able to understand and analyse CMOS circuits

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	-
CO5	3	2	2	-	2	-	-	-	-	-	-	-	3	2

Syllabus

1. Design and Simulation using behavioral - structural and dataflow modeling using VHDL.
2. Design and FPGA implementation of a synchronous sequential circuit using structural and dataflow modeling VHDL.
3. Implementation of a digital sub system in FPGA.
4. Familiarization with MOS model parameters in SPICE and device characteristics.
5. Simulation of CMOS Inverter switching characteristics in SPICE.
6. Dynamic Simulation of CMOS circuits in SPICE.

Text Book(s)

Douglas L.Perry, VHDL: "Programming by Example", McGraw-Hill, 2002.
Samir Palnitkar, Verilog HDL – "A Guide to Digital Design and Synthesis", 2nd Edition, Pearson, 2003.

Reference(s)

PSPICE Reference Guide, "Cadence Design Systems", Second Online Edition, 2000.
Sanjay Churiwala, "Designing with Xilinx® FPGAs", Using Vivado, Springer, 2015.
Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital logic with VHDL Design", Tata McGraw Hill Publishing Company Limited, Special Indian Edition, 2007.
J. Bhasker, Verilog HDL Synthesis, "A Practical Primer", Star Galaxy Publication, 2018.

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.

19ECE391	SEMINAR	L-T-P-C: 0-0-3-1

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

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

19ECE384	OPEN LAB	L-T-P-C: 0-0-3-1

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

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

19ECE495	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

CO/ PO	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

19ECE499	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

Analog and Mixed Signal Systems

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 equipments
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

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

19ECE333	MICRO ELECTRO MECHANICAL SYSTEMS	L-T-P-C: 3-0-0-3

Pre Requisite(s): Nil

Course Objectives

- To gain basic knowledge on overview of Microelectromechanical System and various Fabrication Techniques
- To familiarize with the operation principles of selected MEMS Sensors and Actuators
- To develop interdisciplinary skills towards higher learning and research

Course Outcomes

CO1: Able to understand the world of microelectromechanical devices and systems (MEMS)
CO2: Able to gain fundamental knowledge on material properties & fabrication technologies
CO3: Able to comprehend working principles of sensing and actuation
CO4: Able to understand the operation of micro devices and their applications
CO5: Able to design micro devices, micro systems using the MEMS fabrication process

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	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	2	2	2
CO4	3	2	-	-	-	-	-	-	-	-	-	2	2	2
CO5	3	2	3	-	-	-	-	-	-	-	-	2	2	2

Syllabus

Unit 1
Introduction to MEMS Technology and Applications - MEMS Materials and their Properties - Microfabrication Techniques - Chemical Vapor Deposition - Physical Vapor Deposition - Evaporation Sputtering - Wet Additive Methods - Electro – Plating - Electro less - Plating and Electro – Deposition.

Unit 2
Photolithography - Wet and Dry Etching Methods - Isotropic Etching and Anisotropic Etching - Wafer Bonding and Packaging Aspects - High Aspect - Ratio Processes (LIGA) Techniques for Sensing and Actuation - Bulk and Surface Micromachining Techniques – Silicon and Quartz Micromachining.

Unit 3
MEMS Pressure and Flow sensors - Electrostatic Sensing and Actuation principles - Thermal Sensing and Actuation principles - Piezoresistive sensing principles - Piezoelectric sensing and actuation principles - Magnetic sensing and actuation principles - Optical Sensing and Actuation - Microfluidics and BioMEMS - Introduction to RF MEMS and MEMS Accelerometers.

Text Book(s)
Tai - Ran Hsu, "MEMS and Microsystems - Design, Manufacture, and Nanoscale Engineering," Second Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008.
Marc J. Madou, "Fundamentals of Microfabrication - The Science of Miniaturization", Second Edition, CRC Press, Published 2018.

Reference(s)

Julian W. Gardner and Vijay K. Varadan, "Microsensors, MEMS and Smart Devices", First Edition, John Wiley & Sons, Inc. New York, NY, USA 2001.
Stephen D. Senturia, "Microsystem design", Kluwer Academic Publishers Norwell, MA, USA 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

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

19ECE336	NANO ELECTRONICS	L-T-P-C: 3-0-0-3

Pre Requisite(s): VLSI Design

Course Objectives

- To study deep sub-micron effects of MOSFETs and understand the latest trends in the technology and principles of nano-electronics
- To familiarize new material devices and their performances
- To introduce the mathematical methods applied for advanced material based MOSFET models
- To provide a unified applied treatment of fundamental mathematics of quantum transport and use it for device modeling using the principles learnt above

Course Outcomes

CO1: Able to understand the deep sub-micron effects and limits of scaling on nano-electronic devices
CO2: Ability to use of wave – particle analysis in the development of transport properties
CO3: Able to use mathematical methods for advanced nanomaterial studies
CO4: Able to develop spice compatible models

CO – PO Mapping

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

Syllabus

Unit 1
Deep Submicron Devices Limits to Scaling –Nano Devices – Quantum Effects– Atomic Scale Parameter Fluctuation – Nanoscale MOSFET –FINFETS –Vertical MOSFETS - Tunnel FETS - The Schrödinger Equation –Electrons in a Crystal Lattice – Quantum Well– Wire and Dot Devices - Scattering Rates and Lifetimes in Electronic Devices - CVD and Other Processes in Fabrication of Nano Devices.

Unit 2
Band-Structure and Transport Resonant Tunneling Transistors –Single Electron Transistors –and Spintronics Devices - Atoms–up Approaches – Transport in Molecular Structures – Molecular Systems as Schrodingers equation – Nano-Scale and Quantum Devices –Single Electron Transistor – Quantum Wires —– Quantum Dot Cellular Automata.

Unit 3
Alternatives to Conventional Electronics – Drift Diffusion– Ballistic Transport –NEGF –Molecular Interconnects – Graphene–Carbon Nanotubes and Silicon Nanowire, Technology Devices and Circuits - 1 D transport - Reflection, Transmission and The non-equilibrium Green Function Formalism (NEGF) - Contacting the schodinger - Density of states – Hamiltonian - and Spice compatible modeling of carbon based advanced nanomaterial channels for MOSFET devices.

Text Book(s)

S. Datta, "Lessons from Nanoelectronics", World Scientific, 2012.
S. Datta, "Quantum Transport: Atom to Transistor", Cambridge University Press, 2005.

Reference(s)

Gerhard Klimeck, "Nanoelectronic Modeling: From Quantum Mechanics and Atoms to Realistic Devices", https://nanohub.org/resources/8086, 2010.
Waser Ranier, "Nano Electronics and Information Technology:Advanced Electronic Materials and Novel Devices" Wiley VCH, 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

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

19ECE338	SOLID STATE DEVICES	L-T-P-C: 3-0-0-3

Pre Requisite(s): Nil

Course Objectives

- To enable the students to understand and apply the underlying physics that govern semiconductors
- To enrich the students with fundamental knowledge on electron transport and working principles of PN junctions
- To prepare the students towards higher learning of solid state electronic devices

Course Outcomes

CO1: Able to understand the fundamentals of solid state physics and quantum mechanics that forms the basis for semiconductor devices
CO2: Able to understand the basics and the nature of semiconducting materials
CO3: Able to apply the physics to comprehend the manifestation of charge carriers in a semiconductor
CO4: Able to describe the factors and processes that influence the flow of charge in p-type and n-type semiconductors
CO5: Able to acquire and analyze the knowledge on the working principles of PN Junction-based devices

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	-	-	-	-	-	-	-	-	-	2	2	-
CO3	3	3	-	-	-	-	-	-	-	-	-	2	2	-
CO4	3	3	-	-	-	-	-	-	-	-	-	2	2	-
CO5	3	3	-	-	-	-	-	-	-	-	-	2	2	-

Syllabus

Unit 1
Semiconductor materials - Elemental and Compound semiconductors - Crystal Structure of Silicon and GaAs - Miller indices for Planes and directions - Unit cell characteristics - Essentials of Quantum Mechanics - Formation of Energy Bands - Direct and Indirect semiconductors - Effective mass - Density of States - Fermi Dirac Distribution Function.

Unit 2
Semiconductor in Equilibrium - Intrinsic and Extrinsic Semiconductors - Carrier Concentration - Temperature dependence-Position of Fermi Level Drift Velocity and Mobility - Conductivity - Hall effect - Diffusion of carriers and diffusion current - Einstein relation. Built in fields - Non equilibrium Excess carriers - Generation and Recombination - Recombination Lifetime - Continuity Equation - Steady State Carrier Injection.

Unit 3
PN junctions - Space charge at a junction - Electric field across junction - contact potential - Band diagram Forward and Reversed biased p-n junction diode - depletion width - carrier injection - junction capacitance - Ideal pn junction current - junction breakdown - equivalent circuit. MOSFET - Ideal MOS - band diagram - flat band voltage - threshold voltage - MOS capacitor characteristics.

Text Book(s)

Donald A. Neamen, "Semiconductor Physics and Devices: Basic Principles", Fourth Edition, McGraw-Hill International, 2012.
Ben G. Streetman and Sanjay Kumar Banerjee, "Solid State Electronic Devices", Sixth Edition, Prentice Hall India, 2009.

References(s)

S. M. Sze and Kwok K. NG, "Physics of Semiconductor Devices", Third Edition, John Wiley and Sons, Inc., 2007.
S. O. Kasap, "Principles of Electronic Materials and Devices", Third Edition, Tata 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

19ECE339	OPTICAL ENGINEERING	L-T-P-C: 3-0-0-3

Pre Requisite(s): Nil

Course Objectives

- To provide an overview of Geometrical (ray) optics and Electromagnetic wave theory of light
- To discuss mathematical model of some of the widely occurring optical beams like Gaussian beams
- To introduce applications in Lasers, Non-Linear optics and Optoelectronic circuits

Course Outcomes

Student should have an overview of a wide variety of tools available in optical engineering
CO1: Able to understand the physics of light propagation and manipulation
CO2: Able to understand the basic structure of an optical system and its building blocks
CO3: Able to understand working of basic components of an optical system
CO4: Able to have an awareness of implementation technologies for optical systems

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	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO4	3	-	-	2	-	-	-	-	-	-	-	-	3	-

Syllabus

Unit 1
Rays - optical beams and resonators - Ray matrices - Gaussian beam modes in quadratic index media - propagation with a gain profile - guided waves - optical resonators – Lasers - Theory of laser oscillation - rate equation - mode locking - Q switching.
Unit 2
Non-Linear optics: second harmonic generation - parametric amplification and oscillation - Up conversion -Kerr effect - four-wave mixing Semiconductor detectors - Physics of light absorption – PIN - APD devices - noise in optical detection.
Unit 3
Optoelectronic integrated circuits – Materials - integrated transmitters and receivers - guided wave devices, - prospects for interconnects - optical switching - introduction to optical networks.

Text Book(s)
Ammon Yariv, Pochi Yeh –"Photonics Optical Electronics in Modern Communication", Sixth. Ed. Oxford University Press, 2007.

Reference(s)
Pallab Bhattacharya – "Semiconductor Optoelectronic Devices", Sec. Ed. 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

Digital System Design and Architectures

19ECE341	VLSI SYSTEM DESIGN	L-T-P-C: 3-0-0-3

Pre Requisite(s): VLSI Design

Course Objectives

- To introduce the various modeling styles for Hardware Description Languages (HDLs)
- To introduce Register Transfer Level (RTL) abstraction for HDL based design flow
- To understand the behavioral HDL modeling of combinational and sequential subsystems

Course Outcomes

CO1: Able to model digital blocks in Verilog HDL using different modeling styles
CO2: Able to design a system at the RTL abstraction for a particular engineering problem and model it in Verilog HDL
CO3: Able to write synthesizable Verilog behavioral models for different digital blocks and assess the impact of modeling style on timing and area
CO4: Able to analyze the working of standard VLSI System building blocks, design them for given specifications and model them in Verilog HDL

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	3	3	3	-	-	-	-	-	-	-	-	3	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-	2	-
CO4	3	3	3	-	-	-	-	-	-	-	-	-	2	-

Syllabus

Unit 1
Review of VLSI Design Flow - Introduction to HDLs - Verilog modeling styles – Structural - Dataflow and Behavioral - Register Transfer Level (RTL) abstraction for HDL Based Design Flow.

Unit 2
Behavioral Verilog Modeling of Combinational and Sequential Subsystems: Multiplexer – Decoder – Encoder – dders – Multipliers – Counters - Shift Registers - State Machines.

Unit 3
Basics of Timing - Speed of a Digital system - Design Case Studies - Simple Processor – FIFO - Circular Buffer - DSP Blocks – LFSR.

Text Book(s)
Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Second Edition, Pearson, 2003.
Michael D Ciletti, "Advanced Digital Design with the Verilog HDL", Second Edition, Pearson, 2017.

Reference(s)
Wayne Wolf, "FPGA Based System Design", First Edition, 2004.
T. R. Padmanabhan and B. Bala Tripura Sundari, "Design through the Verilog HDL", First Edition, Wiley Interscience, 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

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

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

19ECE344	EMBEDDED SYSTEMS	L-T-P-C: 3-0-0-3

Pre Requisite(s): Microcontrollers and Interfacing

Course Objectives

- To identify the difference between ARM7 and Cortex M family of Microprocessors
- To apply the knowledge of Embedded C Programming for configuring various peripherals of a microcontroller
- To develop basic understanding of Real Time Operating Systems
- To learn to design and develop Microcontroller based solutions for solving real world problems

Course Outcomes

C**O1**: Able to identify the advanced features of Cortex M3 Processor
CO2: Able to analyze MSP432 Peripherals and its configuration using Embedded C
CO3: Able to implement a basic Application using Real Time Operating System
CO4: Able to design and develop embedded systems using MSP432 Microcontroller

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	3	3	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	3	3	2	2	2	2	3	3	-	-	3	3

Syllabus

Unit 1
ARM Cortex M3 Processor: Overview of the Cortex-M3 - Registers – Special Registers -Operation Modes - Built-In Nested Vectored Interrupt Controller - Memory Map – Bus Interfaces - Instruction Set - Memory Systems- Cortex-M3 Implementation Overview – Exceptions - Nested Vectored Interrupt Controller and Interrupt Control - Interrupt Behavior - Cortex-M3 Programming - Advanced Programming Features and System Behavior - The Memory Protection Unit - Other Cortex-M3 Features - Debug Architecture - Debugging Components.

Unit 2
MSP432 Architecture and Peripherals - Introduction to MSP432 Architecture – Memory Map – Clock System – Power Control Manager – Power Mode – DMA – Digital Input Output – Enhanced Universal Serial Communication Interface – Precision ADC – Programming MSP432 using Energia IDE.

Unit 3
Introduction to FreeRTOS and Programming - Introduction to RTOS – Task States – Semaphores – Scheduling – Preemptive - Rate Monotonic – Earliest Deadline First - Inter Task Communication – Message Queue – MailBox – Pipes – Introduction to FreeRTOS – Task Management – Interrupt Management – Queue Management.

Text Book(s)
Joseph Yiu, "The Definitive Guide to the ARM Cortex M3", Second Edition, Elsevier Inc., 2010.
Muhammad Ali Mazidi, Shujen Chen, Sepehr Naimi, "TI MSP432 ARM Programming for Embedded Systems", Volume 4, 2016 .

Reference(s)

Jean J. Labrosse, "MicroC OS II: The Real Time Kernel", 2002.
Richard Barry, "Using the Free RTOS Real Time Kernel ARM Cortex-M3 Edition", Real Time Engineers Ltd., 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

19ECE345	COMPUTER SYSTEMS ARCHITECTURE	L-T-P-C: 3-0-0-3

Pre Requisite(s): Digital Design

Course Objectives

- To introduce the basic organization of a computer system
- To learn the functioning of data path and control path elements in a processor
- To understand the memory organization of a processor system
- To understand the input-output operations in a processor system

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Course Outcomes

CO1: Able to comprehend operations and arithmetic of computer systems
CO2: Able to identify data-path and control-path operations involved in the execution of a processor instruction
CO3: Able to understand and analyze the CPU, memory and IO architecture of a processor at the system level
CO4: Able to analyze the trade-offs involved in the CPU and memory organization of a processor system

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	-

Syllabus

Unit 1
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.

Unit 2
Data path and controller design- Introduction to CPU design- Processor organization - Execution of complete instruction - Design of control unit - Hardwired Control - Microprogrammed Control.

Unit 3
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 - Input/output processing - Introduction to Interrupts and DMA - Introduction to RISC and CISC approaches.

Text Book(s)
V. Carl Hamacher, Zvonko G. Varanesic and Safat G. Zaky, "Computer Organisation", Fifth edition, Indian Edition, McGraw-Hill Education, 2011.
John P. Hayes, "Computer Architecture and Organisation", Indian Edition, McGraw-Hill Education, 2017.

Reference(s)

M. Morris Mano, "Computer System Architecture", Third Edition, Pearson Education, 2007.
Behrooz Parhami, "Computer Architecture", Indian Edition, Oxford University Press, 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

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

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

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

Computational Engineering

19ECE351	MARKOV PROCESSES AND QUEUING THEORY	L-T-P-C: 3-0-0-3

Pre Requisite(s): Probability Theory and Random Processes

Course Objectives

- To provide a thorough understanding of the mathematical foundations of telecommunication and computer communication networks
- To teach the application of Markov processes and queueing theory to analyze the performance of and address the design questions in circuit- and packet-switching networks
- To gain hands-on experience of discrete-event simulations of queueing systems

Course Outcomes

CO1: Able to map frequently occurring scenarios in telecommunication and computer networking into standard stochastic models, i.e., able to construct mathematical models from the physical description of the problems
CO2: Able to identify appropriate solution methods and physically interpret the mathematical results
CO3: Able to analyze and compare the performance of queueing systems by discrete-event simulations
CO4: Gain professional knowledge and skills by term projects

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	2	3	3	3
CO3	3	3	3	3	-	-	-	-	-	3	2	3	3	3
CO4	-	-	-	3	-	-	-	-	2	3	2	3	3	3

Syllabus

Unit 1
Selected Topics in Probability and Random Variables - Memoryless property of exponential and geometric random variables - Moment generating function - Laplace-Stieljes transform (LST) of random variables - Selected Topics in Stochastic Processes: Stationarity – Ergodicity – Independence – Correlation -Stationary Increment and Independent Increment Processes: Bernoulli trials - Poisson processes - Gaussian processes.

Unit 2
Markov Processes - Discrete time Markov chains (DTMCs) - Continuous time Markov chains (CTMCs)- Recurrence – Transience - Stability - Renewal Processes and Markov Renewal Processes; Queueing Theory - Common queueing models (M/M/1 - M/M/1/K - M/M/K/K - M/G/1 - M/G/1/K - G/M/1 - Geo/Geo/1 - M/G/∞) -Vacation models - Loss networks and delay networks - Multiclass queueing models with priority - Open and closed networks of queues.

Unit 3
Discrete-Event Simulation of Queueing Systems; Applications to Telecommunications and Computer Communication Networks - Capacity design, Dynamic channel allocation in cellular networks and tele-communication switching - Throughput and delay analysis in wireless local area networks (WLANs), Coverage analysis in wireless sensor networks (WSNs).

Text Book(s)

Vidyadhar G. Kulkarni, "Modeling and Analysis of Stochastic Systems", CRC Press, 2016.
Anurag Kumar, "Discrete Event Stochastic Processes", available online. http://ece.iisc.ernet.in/~anurag/books/anurag/spqt.pdf.

Reference(s)

Dimitri P. Bertsekas, and Robert G. Gallager, "Data Networks". Prentice-Hall International, 1987.
Alberto Leon-Garcia, Probability, "Statistics, and Random Processes for Electrical Engineering", 3rd ed. Pearson/Prentice Hall, 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

19ECE352	OPERATIONS RESEARCH	L-T-P-C: 3-0-0-3

Pre Requisite(s): Nil

Course Objectives

- To familiarize students with quantitative techniques applied in business decision making scenarios
- To comprehend the mathematical methods to optimize the company resources and find optimal solution within constraints

Course Outcomes

CO1: Identify, formulate and analyze models to optimize organizational resources and maximize profit.
CO2: Choose the appropriate management tool to lead a team and provide solutions in complex decision making scenarios
CO3: Apply continuous learning and help improve company financials by efficiently managing projects
CO4: Analyse the data and comprehend on performance based on scheduling, queueing and inventory

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	3	1	-	-
CO2	3	1	-	3	-	-	-	3	3	2	3	1	-	-
CO3	-	3	3	3	-	-	-	3	2	1	3	3	-	1
CO4	-	1	-	3	-	-	-	3	3	1	3	2	-	-

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Syllabus

Unit 1
Evolution of OR - Fundamentals of OR Modelling Approach - Linear Programming –Assumptions – formulation - graphical method - simplex method - duality theory - primal-dual relationships - sensitivity analysis - Transportation and Assignment Problems - Specific features and methods of transportation problem - Hungarian method for solving assignment problems - travelling salesman problem - Dynamic Programming – Characteristics - optimality principle - deterministic problems.

Unit 2
Network Models - Project Networks - CPM / PERT - Project Scheduling, crashing networks and cost considerations - Resource leveling and smoothing - shortest route problem - minimal spanning tree problem - maximal flow problem - Decision Theory - Decision making under uncertainty - decision trees - decision under risk – EMV - EOL, EVPI - Game theory - mixed strategies, - dominance property - 2 x n and m x 2 games.

Unit 3
Flow shop scheduling– Johnsons algorithm for n jobs and two machines and n jobs and m machines. Inventory models - Deterministic manufacturing and purchase models - quantity discounts Queueing models - Poisson arrival and exponential service times - Single server and multi-server model Simulation –Monte Carlo simulation - simple problems.

Text Book(s)

Taha, H A, "Operations Research - An Introduction", Sixth Edition, Prentice Hall of India Private Limited, N. Delhi, 2004.
Ravindran, A., Phillips, D.J., and Solberg, J.J., "Operations Research- Principles and Practice", John Wiley & Sons, 2005.

Reference(s)
Wagner H M, "Principles of Operations Research", Second Edition, Prentice Hall of India Private Limited, New Delhi, 2003.
Hardley, G.,"Linear Programming", Narosa Book Distributors Private Ltd 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

19ECE353	CONVEX OPTIMIZATION	L-T-P-C: 3-0-0-3

Pre Requisite(s): Linear Algebra

Course Objectives

- To efficiently solve mathematical optimization problems which arise in a variety of applications
- To discover/identify various applications in areas such as, estimation and signal processing, communications and networks, electronic circuit design, data analysis and modeling, statistics, automatic control systems and finance

Course Outcome

CO1: Able to recognize, formulate, and analyze convex optimization problems
CO2: Able to design sophisticated algorithms based on convex Optimization for applications in communication and signal processing
CO3: Able to solve convex problems using computationally efficient techniques
CO4: Able to analyze and evaluate optimization techniques

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	3	2	2	2	-	-	-	-	-	-	-	2	2	2
CO3	3	3	3	2	-	-	-	-	-	-	-	2	2	-
CO4	3	3	2	2	-	-	-	-	-	-	-	2	2	2

Syllabus

Unit 1
Introduction - linear algebra fundamentals - Solving linear equations with factored matrices - Block elimination and Schur complements - Convex sets - Convex functions – examples.

Unit 2
Classes of Convex Problems - Linear optimization problems - Quadratic optimization problems - Geometric programming - Vector optimization - Reformulating a Problem in Convex Form.

Unit 3
Lagrange Duality Theory and KKT Optimality Conditions - Interior-point methods - Primal and Dual Decompositions – Applications.

Textbook(s)
Stephen Boyd and Lieven Vandenberghe, "Convex Optimization", Cambridge University Press, 2004.
Daniel Palomar, Convex "Optimization in Signal Processing and Communications", Cambridge University Press, 2009.

Reference(s)

Dimitri P Bertsekas, "Convex Optimization Theory", Athena Scientific, 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

19ECE354	DEEP LEARNING	L-T-P-C: 3-0-0-3

Pre Requisite(s): Nil

Course Objectives

- To introduce the idea of artificial neural networks and their architecture
- To introduce techniques used for training artificial neural networks
- To enable design of an artificial neural network for classification
- To enable design and deployment of deep learning models for machine learning problems

Course Outcomes

CO1: Able to understand the mathematics behind functioning of artificial neural networks
CO2: Able to analyze the given dataset for designing a neural network based solution
CO3: Able to carry out design and implementation of deep learning models for signal/image processing applications
CO4: Able to design and deploy simple TensorFlow-based deep learning solutions to classification problems

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	-	-	-	-	-	-	-	-	-	3	-
CO3	-	2	3	2	-	-	-	-	-	-	-	-	3	-
CO4	2	2	2	2	-	-	-	-	-	-	-	-	2	-

Syllabus

Unit 1

Artificial Neural Networks - The Neuron-Expressing Linear Perceptrons as Neurons - Feed-Forward Neural Networks - Linear Neurons and Their Limitations - Sigmoid, Tanh, and ReLU Neurons - Softmax Output Layers - Training Feed-Forward Neural Networks.-Gradient Descen t- Delta Rule and Learning Rates - Gradient Descent with Sigmoidal Neurons - The Backpropagation Algorithm-Stochastic and Minibatch Gradient Descent - Test Sets - Validation Sets - and Overfitting- Preventing Overfitting in Deep Neural Networks - Implementing Neural Networks in Tensor Flow.

Unit 2

Local Minima in the Error Surfaces of Deep Networks- Model Identifiability - Spurious Local Minima in Deep Networks - Flat Regions in the Error Surface - Momentum-Based Optimization - Learning Rate Adaptation - Convolutional Neural Networks (CNN) - Architecture - Accelerating Training with Batch Normalization - Building a Convolutional Network using TensorFlow - Visualizing Learning in Convolutional Networks.

Unit 3

Embedding and Representation Learning: Autoencoder Architecture-Implementing an Autoencoder in TensorFlow - Denoising- Sparsity in Autoencoders. Models for Sequence Analysis - Recurrent Neural Networks - Vanishing Gradient s- Long Short-Term Memory (LSTM) Unit s- TensorFlow Primitives for RNN Models - Augmenting Recurrent Networks with Attention.

Text Book(s)

Nikhil Buduma, "Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms ", O'Reilly, 2017.

Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press, 2016.

Reference(s)

Aurélien Géron, "Hands-On Machine Learning with Scikit- Learn and TensorFlow", O'Reilly, 2017.

Nikhil Ketkar, "Deep Learning with Python: A Hands-on Introduction", Apress, 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

19ECE355	BIO-INSPIRED ALGORITHMS	L-T-P-C: 3-0-0-3

Pre Requisite(s): Nil

Course Objectives

- To introduce the characteristics of natural agents and building blocks involved in biological processes
- To provide an understanding on the application of bio inspired algorithms to solve complex problems
- To provide insights into the implementation of bio inspired algorithms

Course Outcomes

CO1: To understand phenomena guiding biological processes through self-organization and adaptability
CO2: To visualize the effect of low-level interactions on high-level phenomena
CO3: To analyze complex engineering problems and solve them by adapting biological processes suitably
CO4: To design and implement simple bio-inspired algorithms

CO – PO Mapping

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

Syllabus

Unit 1
Artificial Neural Networks – Pattern classification – Single and Multilayer perceptrons – Backpropagation – Pattern Association – Hebbian learning – Hopfield networks – Bidirectional Associative Memory Networks – Competitive learning – Kohenen's Self Organizing Maps.

Unit 2
Genetic algorithms – Representation – Reproduction, Crossover and Mutation Operators – Crossover and Mutation rates – Selection mechanisms – Fitness proportionate, ranking and tournament selection – Building Block Hypothesis and Schema Theorem.

Unit 3
Swarm Intelligence – Stigmergy – Competition and Cooperation – Particle Swarm Optimization – Anatomy of a particle – Velocity and Position updation – PSO topologies – Control parameters – Ant Colony Optimization – Pheromone updation and evaporation.

Text Book(s)
Leandro Nunes De Castro, Fernando Jose Von Zuben, "Recent Developments in Biologically Inspired Computing", Idea Group Publishing, 2005.
Laurene Fausett, "Fundamentals of neural networks: architectures, algorithms, and applications", Prentice-Hall, 1994.

Reference(s)

Goldberg D, "Genetic algorithms in search optimization and machine learning", Addison Wesley, 1999.
Xin-She Yang, "Recent Advances in Swarm Intelligence and Evolutionary Computation", Springer International Publishing, Switzerland, 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

19ECE356	GAME THEORY	L-T-P-C: 3-0-0-3

Pre Requisite(s): Nil

Course Objectives

- To formalize the notions of strategic thinking and rational choice by using the tools of game theory
- To draw the connections between game theory and its applications in communications, signal processing and computer networking, emphasizing the computational issues
- To gain hands-on experience by seeing game-theoretic algorithms in action

Course Outcomes

CO1: Ability to map communications, signal processing and networking problems into standard game-theoretic models
CO2: Ability to apply game-theoretic concepts to solve engineering problems and obtain insights
CO3: Ability to numerically implement game-theoretic design algorithms and investigate performance
CO4: Gain professional knowledge and skills by term projects

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	2	3	3	3
CO3	3	3	3	3	-	-	-	-	-	3	2	3	3	3
CO4	-	-	-	3	-	-	-	-	2	3	2	3	3	3

Syllabus

Unit 1
Introduction to Game Theory - Non-cooperative games: strategic form vs. dynamic- Bayesian games - static vs. dynamic games in extensive form - Differential games: connections with optimal control theory.

Unit 2
Evolutionary games - evolutionarily stable strategies - replicator dynamics, reinforcement learning - Cooperative games - bargaining- coalitional games - Auction theory and mechanism design - VCG auction.

Unit 3
Application to Communication Networks - Applications to cellular and broadband wireless access networks - Applications to wireless local area networks - Applications to multihop networks - Applications to cooperative communication networks - Applications to Cognitive radio networks - Applications to Internet congestion control and Net Neutrality.

Text Book(s)
M. J. Osborne, "An Introduction to Game Theory", Oxford University Press, 2003.
Han, Zhu, Dusit Niyato, Walid Saad, Tamer Başar, and Are Hjørungnes, "Game theory in wireless and communication networks: theory, models, and applications". Cambridge university press, 2012.

Reference(s)

MacKenzie, Allen B., and Luiz A. DaSilva, "Game theory for wireless engineers", Synthesis Lectures on Communications, 1, no. 1 (2006): 1-86.

N. Nisan, T. Roughgarden, E. Tardos, and V. V. Vazirani, "Algorithmic Game Theory", Cambridge University 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 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

19ECE358	SIGNAL PROCESSING FOR BUSINESS APPLICATIONS	L-T-P-C: 3-0-0-3

Pre Requisite(s): Nil

Course Objectives

- To understand the functioning of financial markets and the behavior of financial time series
- To provide an introduction to application of signal processing techniques for identifying and forecasting patterns in financial time series
- To develop an understanding of the process for design of a profitable trading system

Course Outcomes

CO1: Able to understand the structure of financial markets and asset pricing models
CO2: Able to analyze a financial time series and employ technical analysis to identify patterns in it
CO3: Able to employ filters for detection and analysis of business cycles
CO4: Able to design an adaptive filter based system for predicting financial time series

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	3	-	-	-	-	-	-	-	-	-	2	2	-
CO3	2	3	-	-	-	-	-	-	-	-	-	2	2	2
CO4	-	2	3	-	-	-	-	-	-	-	-	2	2	2

Syllabus

Unit 1
Structure of financial markets - financial instruments - stock price models - asset returns-modern portfolio theory-capital asset pricing model-relative value and factor models - Trading terminology-long and short positions-cost of trading-backtesting-pairs trading and mean reversion-statistical arbitrage-trend following- trending in multiple frequencies.

Unit 2
Measuring business cycles- The Hodrick – Prescott filter - Baxter–King filter. Technical Analysis-Indicators-Oscillators- Signal to noise ratio - Sine wave indicator – Instantaneous trend line - Identifying market modes–Transform arithmetic – FIR – IIR - Removing lag - Adaptive moving averages - Ehlers filters.

Unit 3
Measuring market spectra - optimum predictive filters - Adapting standard indicators- High frequency trading-Designing profitable trading system.

Text Book(s)
Ali N. Akansu and Mustafa Torun, "A Primer for Financial Engineering: Financial Signal Processing and Electronic Trading", Academic Press, 2015.
Ramazan Gencay, Faruk Selcuk& Brandon Whitdly, "An Introduction to Wavelets and other filtering methods in Finance and Economics", Academic Press, 2002.

Reference(s)

John F Ehlers, "Rocket Science for Traders: Digital Signal Processing Applications", John Wiley 2001.
Jack Clark Francis, Richard W. Taylor, "Investments, Schaum's Outlines", Tata McGraw Hill, 2006.

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

19ECE359	NON-LINEAR DYNAMICS AND CHAOS	L-T-P-C: 3-0-0-3

Pre Requisite(s): Nil

Course Objectives

- To understand dynamical systems using maps and flows
- To familiarize with methods for detection and quantification of chaos in time series data
- To comprehend the need and use of nonlinear analysis for chaotic signals

Course Outcomes

CO1: Demonstrate the ability to understand the concepts underlying dynamical systems
CO2: Analyze and model dynamical systems using computational methods
CO3: Critically evaluate the requirements for analyzing chaotic signals
CO4: Apply non-linear methods to characterize biological data

CO – PO Mapping

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

Unit 1
Introduction to dynamical systems and chaos – deterministic versus stochastic systems – state space- phase space- fixed points and its stability- chaos- Lyapunov exponent - maps - logistic map -Henon map.

Unit 2
Flows – harmonic oscillator –butterfly effect –Lorenz attractor- Rossler attractor – introduction to fractals- dimensionsionality of fractals- quantifying chaos using fractals.

Unit 3
Time series properties – chaos in biological signals - conventional linear methods limitation – alternate methods –time-delay embedding, entropy - complexity measures.

Text Book(s)
Alligood KT, Sauer TD and Yorke JA, "Chaos", First Edition, Springer New York; 1996.Strogatz SH, "Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering", First Edition, CRC Press, 2001.

Reference(s)
Sprott JC, "Chaos and time-series analysis", First Edition, Oxford University Press, 2003.
Ditto, William L. "Applications of chaos in biology and medicine", AIP Conference Proceedings. Vol. 376. No. 1. AIP, 1996.

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

19ECE360	AGENT BASED MODELING	L-T-P-C: 3-0-0-3

Pre Requisite(s): Nil

Course Objectives

- To introduce the concept of artificial agents
- To provide an understanding of the features and design considerations for developing a multi-agent system
- To provide an overview of the applicability of data mining techniques for design of intelligent agents

Course Outcomes

CO1: Able to apply the concepts of data mining for designing a simple agent based model
CO2: Able to analyze the given problem and formulate an agent-based solution
CO3: Able to design a simple multi-agent system model to solve complex engineering problems
CO4: Able to carry out design and simulation of artificial agents using agent based modeling software

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	-	-	-	-	-	-	-	-	-	3	-
CO3	-	2	3	2	-	-	-	-	-	-	-	-	3	-
CO4	2	2	2	2	-	-	-	-	-	-	-	-	2	-

Syllabus

Unit 1
Introduction to Agents – Features - Classification of agents - Multi Agent Systems (MAS) and properties - Agent communication ontology - Agent communication languages - Internal structure of MAS - Shell – Reasoning engine - MAS development methodology - Agent behavior - Agent action - Knowledge diffusion in MAS - Application level - behavior level and evolutionary agent communities.

Unit 2
Data mining techniques for intelligent Agents - Association rule mining – Clustering - Classification and evolutionary algorithms.

Unit 3
Applying data mining to agents - Study of available agent based modeling software - Case studies - Application level - behavior level and evolutionary agent communities.

Text Book(s)
A. L. Symeonidis, P. A. Mitkas, "Agent Intelligence through Data Mining", Springer, 2005.
Uri Wilensky, William Rand, "An Introduction to Agent-Based Modeling", MIT Press, 2015.

Reference(s)
M. Mohammadian, "Intelligent Agents for Data Mining and Information Retrieval", Idea Group Publishing, 20 03.
D. L. Poole, A. K. Mackworth, "Artificial Intelligence: Foundations of Computational Agents", Cambridge Univ ersity Press, 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

19ECE361	DATA STRUCTURES AND ALGORITHMS	L-T-P-C: 3-0-0-3

Pre Requisite(s): Computer Programming

Course Objectives

- To learn the linear and non-linear data structures and explore its applications
- To understand representation using graph data structure
- To comprehend and emloy basic sorting and searching algorithm

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

CO/ PO	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	-

Syllabus

Unit 1
Algorithm Analysis: Methodologies for Analyzing Algorithms - Asymptotic Notation - Recurrence Relations - Data Structures: Linear Data Structures (Stacks – Queues - Linked-Lists - Vectors) -Trees (Binary Search Trees - AVL trees - Red-Black trees - B-trees) - Hash-Tables (Dictionaries - Associative Arrays - Database Indexing, Caches - Sets) and Union-Find Structures.

Unit 2
Searching and Sorting (Insertion and Selection Sort - Quick sort - Merge sort - Heap sort - Bucket Sort and Radix Sort) - Comparison of sorting algorithms and lower bounds on sorting - Fundamental Techniques - The Greedy Method - Divide and Conquer - Dynamic Programming.

Unit 3
Graph Algorithms: Elementary Algorithms - Breadth-first search, Depth-first search, Topological sort, strongly connected components - Minimum Spanning Trees - Single-Source Shortest Paths - All-Pairs Shortest Paths - Maximum Flow - Network Flow and Matching - Flows and Cuts.

Text Book(s)
Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", Third Edition, MIT Press, 2009.
Robert Sedgewick and Kevin Wayne, "Algorithms", Fourth Edition, Addison Wesley, 2011.

Reference(s)
Kurt Mehlhorn and Peter Sanders, "Data Structures and Algorithms:The Basic Toolbox", Springer, 2008.
John V. Guttag, "Introduction to computation and Programming using Python", MIT Press, second edition, 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 Report

19ECE362	SOFTWARE ENGINEERING	L-T-P-C: 3-0-0-3

Pre Requisite(s): Nil

Course Objectives

- To introduce basic software engineering concepts to novice (beginners who have coded only less than 20 lines of code)
- To introduce the Agile Software development process
- To provide an awareness on issues in the engineering of software systems and software development project design. It includes the present state of software engineering, what has been tried in the past, what worked, what did not, and why

Course Outcomes

CO1: Able to understand the principles of software engineering
CO2: Able to understand various software process models
CO3: Able to apply the appropriate design methodology for a real world application
CO4: Able to evaluate a system developed for real-world applications in Agile Mode
CO5: Able to understand various industry standards

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	-	-	-	-	-	-	-	-	-	-	3	-
CO3	3	-	2	-	-	-	-	-	-	-	-	-	3	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-	3	-

Syllabus

Unit 1
Process Models – overview - Introduction to Agile - Agile Manifesto - principles of agile manifesto - Agile Requirements - User personas - story mapping, user stories - estimating and prioritizing stories – INVEST - acceptance criteria - Definition of Done - Release planning Key aspects of Scrum: roles - Product Owner - Scrum Master, Team and product backlog Scrum process flow - product backlog - sprints backlog - scrum meetings – demos - How sprint works - Sprint Planning - Daily scrum meeting - updating sprint backlog, Burn down chart-sprint review - sprint retrospective - Scrum Metrics- velocity - burn down - defects carried over.

Unit 2
Traditional process Models - Waterfall, incremental Requirements Engineering - Tasks Initiation-Elicitation-Developing Use Cases-Building the analysis Model - Negotiation- Validation Requirements Modelling - building the analysis model - Scenario based methods - UML Models.

Unit 3
Design engineering Design concepts - Design models - software architecture - architectural styles and patterns - Performing user interface Design-Golden Rules-User Interface Analysis and Design- Interface Analysis-Interface design steps - Testing strategies and tactics - Unit testing, integration testing - validation and system testing.

Text Book(s)

Pressman R S, Bruce R.Maxim, "Software engineering - A Practitioner's Approach", 8th Ed, Tata McGraw-Hill, 2019.

James A. Crowder, "Agile Project Management: Managing for Success", Shelli Friess, Springer 2014.

Reference(s)

Andrew Stellman, Jennifer Greene, Lean, and Kanban, O Reilly, "Learning Agile: Understanding Scrum", XP, 2015.

Janet Gregory, Lisa Crispin, "More Agile Testing: Learning Journeys for the Whole Team", Addison Wesley, 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

19ECE363	MACHINE LEARNING	L-T-P-C: 3-0-0-3

Pre Requisite(s): Nil

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

CO1: Able to generate, analyze and interpret data summaries
CO2: Able to carry out analysis on machine learning algorithms
CO3: Able to design and implement classifiers for machine learning applications
CO4: Able to design and implement frequent itemset mining systems

CO – PO Mapping

CO/ PO	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	-

Syllabus

Unit 1
Measuring the central tendency - measuring the dispersion of data - graphic displays of basic descriptive data summaries - Missing values - noisy data - data cleaning as a process - Data integration - data transformation- Data cube aggregation - attribute subset selection - dimensionality reduction.

Unit 2
Cluster Analysis using k–Means - k–Medoids - single linkage - complete linkage - UPGMA and expectation maximization - Assessing clustering tendency - determining the number of clusters - measuring clustering quality - k–nearest neighbor - Bayes - decision tree and Support Vector Machines (SVM) classifiers - Classifier accuracy Measures - evaluating the accuracy of a Classifier.

Unit 3
Efficient and Scalable Frequent Itemset Mining Methods - Mining Various Kinds of Association Rules- From Association Mining to Correlation Analysis- Constraint-Based Association Mining.

Text Book(s)
Jiawei Han , Micheline Kamber , Jian Pei , "Data Mining : Concepts and Techniques", 3rd Edition, Morgan Kaufmann Publishers (Elsevier), 2011.
K.P Soman, R. Loganathan , V. Ajay, "Machine Learning with SVM and other Kernel Methods", PHI Learning Private Ltd., New Delhi, 2009.

Reference(s)
Earl Gose, Richard Johnsonbaugh, Steve Jost, "Pattern Recognition and Image Analysis", Pearson Education India, 2015.
Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.

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

Wireless Communications and Networks

19ECE431	WIRELESS COMMUNICATION	L-T-P-C: 3-0-0-3

Pre Requisite(s): Digital Communication

Course Objectives

- To introduce the physical layer characteristics of wireless communication systems
- To impart insights of fading channel parameter evaluation and study of statistical channel models
- To facilitate the importance of signal processing techniques to mitigate the channel impairments

Course Outcomes

CO1: Able to understand the physical medium characteristics for the analysis of wireless communication systems
CO2: Able to identify the fading channel parameters to propose design solutions for terrestrial wireless systems
CO3: Able to conduct investigations and provide valid conclusions in the field of communication
CO4: Able to apply the contextual knowledge in design, development of solutions of complex engineering problems
CO 5: 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	-	-	3	-	-	-	-	-	2	-
CO4	3	3	3	3	-	-	-	-	-	-	-	-	3	2
CO5	3	-	-	-	-	-	-	-	-	-	-	3	-	-

Syllabus

Unit 1
Introduction to wireless communications - Large scale path loss - Free space propagation model - Two ray model - Practical link budget design – Outdoor and indoor propagation models. Small scale multi path propagation - Impulse response model of a multi path channel - Parameters of mobile multi path channels - Types of small scale fading.

Unit 2
Rayleigh and Rician distributions – Statistical models for multipath fading channels – Theory of multipath shaping factors - Equalization - Linear - Decision feedback - Adaptive equalizers - Training and tracking. Diversity – Receiver diversity – Transmitter diversity.

Unit 3
Capacity of wireless channels – Capacity in AWGN – Flat fading channels – Frequency selective channels – Time invariant and variant channels - Performance of digital modulations over wireless channels – AWGN and Fading channels.

Text Book(s)

Andrea Goldmith, "Wireless Communication", Cambridge University Press, 2005.

T.S. Rappaport, "Wireless Communication, Principles and Practice, Pearson Education", Second Edition, 2002.

Reference(s)

William C Y Lee, "Wireless and Cellular Communications", Tata McGraw Hill Publishing Company Limited, Third Edition, 2006.

Robert W. Heath Jr., "Introduction to Wireless Digital Communication: A Signal Processing Perspective", Prentice Hall, First Edition, 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

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

19ECE433	ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING	L-T-P-C: 3-0-0-3

Pre Requisite(s): Digital Communication

Course Objectives

- To develop mathematical theory of digital communications over fading channels
- To learn multicarrier techniques for fading wireless channels
- To analyzes and design of multi-channel techniques for communication
- To understand the synchronization issues in multicarrier environment

Course Outcomes

CO1: Ability to apply knowledge of design processes in multicarrier systems
CO2: To generate innovative designs to fulfill new needs, particularly in the fields of broadband networks and mobile communication systems
CO3: Able to analyze the performance of multicarrier system in wireless cellular systems
CO4: Understand the concepts of channel estimation in fading channels

CO – PO Mapping

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

Syllabus

Unit 1
Introduction-High Rate Wireless Applications -Single-Carrier vs. Multi-Carrier Transmission- Introduction to OFDM -Basic Principle of OFDM -Modeling of OFDM for Time-Varying Random Channel-Appropriate Channel Model for OFDM Systems -Impairments of Wireless Channels to OFDM Signals -Application to Millimeter-Wave Radio Channels.

Unit 2
Coded OFDM-Multiple Access Extensions of OFDM–Multiband OFDM-MIMO OFDM - Performance Optimization -Channel Partitioning -Synchronization -Timing Offset Estimation -Frequency Offset Estimation - Synchronization in Cellular Systems.

Unit 3
Channel Estimation - Pilot Structure -Training Symbol-Based Channel Estimation -DFT-Based Channel Estimation - Decision-Directed Channel Estimation - PAPR Reduction-Inter - Cell Interference Mitigation Techniques.

Text Book(s)
Ye (Geoffrey) Li and Gordon L. Stuber, "Orthogonal Frequency Division Multiplexing for Wireless Communications", Springer, 2006.
Ramjee Prasad, "OFDM for Wireless Communications Systems", Artech House, 2004.

Reference(s)

Bahai, Saltzberg and Ergen, "Multi-Carrier Digital Communications, Theory and Applications of OFDM," Second Edition, Springer, 2004.

Henrik Schulze and Christian Lueders, "Theory and Applications of OFDM and CDMA Wideband Wireless Communications", John Wiley and Sons, 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

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

19ECE435	SPREAD SPECTRUM COMMUNICATION	L-T-P-C: 3-0-0-3

Pre Requisite(s): Digital Communication

Course Objectives

- To provide foundation in spreading techniques and gives insight of scrambling effect, anti-jamming, Low probability of detection
- To provide an insight of Galois fields and primitive polynomials
- To provide an introduction to traditional and modern techniques of synchronization and tracking

Course Outcomes

CO1: Able to understand principles of spread spectrum systems, and anti-jamming
CO2: Able to analyse the various spreading code generation techniques
CO3: Able to understand principles of finite fields and primitive polynomials
CO4: Able to analyse the performance spreading code acquisition and tracking

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	2	2	-	-	-	-	-	-	-	-	-	3	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-	3	2
CO4	3	3	2	-	-	-	-	-	-	-	-	-	3	2

Syllabus

Unit 1
Introduction to spread spectrum - Direct sequence spread spectrum - Spreading sequences and Waveforms: - Pseudo-random sequence generation - Maximal sequences - Autocorrelations and Power spectrums of codes - Characteristic polynomials - Generation of gold codes – Interference rejection for DS/SS - Frequency hopping spread spectrum - Frequency synthesizers - Multitone jamming - Hybrid systems.

Unit 2
Synchronization issues for spread-spectrum - Phase lock loop - Delay lock loop - Acquisition of spreading sequences – Serial search acquisition - Introduction to code tracking.

Unit 3
Detection of spread spectrum signals - Performance of direct sequence spread spectrum - Performance of frequency hopped spread spectrum - Performance of spread spectrum system with forward error correction. Low probability of detection - Code division multiple access (CDMA).

Text Book(s)
Roger L Peterson, Rodger E Ziemer, David E Borth, "Introduction to Spread Spectrum Communication", Pearson Education, First Edition, 2013.
John. G. Proakis & Masoud Salehi, "Digital Communication", Tata McGraw Hill Publishing Company Limited, Fifth Edition, 2009.

Reference(s)

Rappaport, T. S, "Wireless Communications", Pearson Education Asia Edition, 2003.
Don Torrieri, "Principles of Spread-Spectrum Communication Systems", Second Edition, Springer New York Dordrecht Heidelberg London.2011.

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

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

19ECE437	MOBILE COMMUNICATION	L-T-P-C: 3-0-0-3

Pre Requisite(s): Digital Communication

Course Objectives

- To understand the evolution of mobile radio communication system
- To explore the basic cellular concepts and its performance analysis
- To understand wireless channel propagation model, signal processing techniques and different architecture of cellular standards

Course Outcomes

CO1: Able to understand the evolution of mobile radio communication system
CO2: Able to understand and analyze the basic cellular concepts with its performance measure
CO3: Able to understand various wireless channel propagation model and signal processing techniques
CO4: Able to explore the architecture of modern cellular standards

CO – PO Mapping

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

Syllabus

Unit 1
Introduction to cellular mobile systems - Basic Cellular System - Cellular communication infrastructure: Cells – Clusters - Cell Splitting - Frequency reuse concept and reuse distance calculation - Cellular system components - Operations of cellular systems – Handoff / Handover - Channel assignment - Fixed and dynamic - Cellular interferences: Co-Channel and adjacent channel and sectorization.

Unit 2
Channel Models: Properties of mobile radio channels - Intersymbol interference - Multipath and fading effects - Interleaving and diversity - Multiple access schemes (TDMA- FDMA- CDMA - SDMA) – Inter user interference - Traffic issues and cell capacity - Power control strategies - Channel assignment - Handoff.

Unit 3
Introduction to modern cellular standards - 2G Architecture such as GSM and CDMA based - 2.5G- GPRS: GPRS and its features - GPRS network architecture - GPRS protocol architecture - GPRS backbone network - 3G standard details such as UMTS - Introduction to LTE.

Text Book(s)
Theodore S. Rappaport, "Wireless Communications Principles and Practice", Second Edition, PHI, 2002.
Gottapu Sasibhushana Rao, "Mobile Cellular Communication", Pearson Education, 2012.

Reference(s)

Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005.
William Stallings, "Wireless Communication and Networking", PHI, 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

19ECE438	VEHICULAR COMMUNICATION	L-T-P-C: 3-0-0-3

Pre Requisite(s): Digital Communication

Course Objectives

- Understand the applications of and fundamental principles vehicular communications
- Gain knowledge about the emerging technologies and standards in the area of vehicular communication systems and networks
- Appreciate the challenges and design considerations of vehicle-to-anything (V2X) communications at various networking layers

Course Outcomes

CO1: Ability to understand the theories, principles, technologies, standards and system architecture of vehicular communication networks
C**O2**: Ability to design and evaluate vehicular communication technologies forvarious safety and infotainment applications
CO3: Ability to appreciate the challenges and design considerations of V2X communication systems at various networking layers
CO4: Gain professional knowledge and skills through mini projects

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
CO2	3	3	3	3	-	-	-	-	-	-	-	3	3	3
CO3	3	3	3	3	-	-	-	-	-	-	-	3	3	3
CO4	-	3	3	3	-	3	3	3	-	-	-	3	3	3

Syllabus

Unit 1
Applications of V2X - Safety vs. non-safety - Use cases - Service requirements - Mapping service requirements to communication technologies - Protocol Layering and Standards - Fundamental principles of protocol layering - DSRC/WAVE - ETSI ITS-G5 and ARIB architectures - DSRC standard: Channelization - SAE J2735 message set dictionary - Basic Safety Message - IEEE 1609 WAVEmulti-channel operation - IEEE 802.11p MAC and PHY.

Unit 2
Vehicular Wireless Channel Characteristics – Pathloss - shadowing and small-scale fading -Delay spread and Doppler spread;Coherence bandwidth and coherence time -Impact of channel impairments on system design - Techniques for combating noise and vehicular channel impairments - Digital modulation schemes in 802.11p – Diversity – Equalization - Multicarrier modulation and OFDM - Design of OFDM parameters in 802.11p (symbol time - sub-carrier spacing - pilot spacing) - Transmit power control and transmit masks.

Unit 3
Routing in VANETs - Flooding and the 'Broadcast Storm Problem' - Traditional MANET routing - Topology based / table-driven routing protocols - Proactive (DSDV) vs. reactive / on-demand (DSR – AODV - DYMO) routing protocols - Geographic routing protocols - Beaconing - DTN and peer-to-peer ideas for VANET routing.

Text Book(s)

Christophe Sommer and Falko Dressler, "Vehicular Networking". Cambridge University Press, 2014.
Hannes Hartenstein and Kenneth Laberteaux (eds.), "VANET Vehicular Applications and Inter-networking Technologies". John Wiley & Sons, 2009.

Reference(s)

Claudia Campolo, "Antonella Molinaro and Riccardo Scopigno, Vehicular ad hoc Networks: Standards, Solutions, and Research". Springer, 2015.
Andrea Goldsmith, "Wireless Communications". 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

19ECE439 MILLIMETER WAVE PERSONAL COMMUNICATION SYSTEMS. L-T-P-C: 3-0-0-3

Pre Requisite(s): Digital Communication

Course Objectives

- To introduce the indoor physical layer characteristics of gigabit communication systems
- To impart insights of fading channel parameter evaluation and study of statistical channel models
- To facilitate the importance of signal processing techniques to mitigate the channel impairments

Course Outcomes

CO1: Able to understand the indoor propagation characteristics for the analysis of gigabit wireless communication systems
CO2: Able to comprehend the standards and principles to propose design solutions for high date rate wireless systems
CO3: Able to conduct investigations and provide valid conclusions 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	-	-	3	-	-	-	-	-	2	-
CO4	3	3	3	3	-	-	-	-	-	-	-	-	3	2
CO5	3	-	-	-	-	-	-	-	-	-	-	3	-	-

Syllabus

Unit 1
Indoor propagation modeling - Introduction – Interference - Indoor propagation effects - ITU indoor path loss model - Long distance path loss model - link budget - Millimeter Wave (MMW) characteristics: MMW characteristics - 60 GHz MMW radio: Principle and technology - Channel performance at 60 GHz - Gigabit wireless communications - Development of MMW standards - Coexistence with wireless backhaul.

Unit 2
Review of modulations for MMW communications - PSK - OFDM. MMW transceivers: Transceiver architecture- MMW antennas: Path loss and antenna directivity - Antenna beam width – Beam steering antenna.

Unit 3
MMW MIMO - Spatial diversity of antenna arrays - Multiple antennas - Multiple transceivers - Noise coupling in a MIMO system. Potential benefits of advanced diversity for MMW: Spatial and temporal diversity - Spatial and frequency diversity - Dynamic spatial - Frequency and modulation allocation. Advanced beamsteering and beamforming - The need for beam steering / beam forming - MMW applications.

Text Book(s)

Kao-Cheng Huang, Zhoacheng Wang, "Millimeter Wave Communication Systems", Wiley IEEE press, 2011.

Theodore S.Rappaport, Robert W. Heath Jr. Robert C. Daniels and James N. Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.

Reference(s)

John S. Seybold, "Introduction to RF propagation, "John Wiley and Sons, 2005.
Chia-Chin Chong, Kiyoshi Hamaguchi, Peter F. M. Smulders and Su-Khiong, "Millimeter - Wave Wireless Communication Systems: Theory and Applications", Hindawi Publishing Corporation, 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

19ECE440	TELECOMMUNICATION MANAGEMENT	L-T-P-C: 3-0-0-3

Pre Requisite(s): Nil

Course Objectives

- To understand the application of wireless communication Protocols, TCP/IP, Satellite communication
- To analyze the regulation and standards of telecom regulatory bodies and Performance criteria
- To carry out investigation of spectrum Management and Business on Bandwidth
- To develop and design networks modeling and system evaluation for disaster management

.

Course Outcomes

CO1: To acquire basic knowledge of the applications of wireless communication Protocols, TCP/IP, Satellite communication
CO2: Able to analyze the regulation and standards of telecom regulatory bodies. Performance criteria
CO3: Able to apply cost computation for electronic components such as mobile, Wi-Fi and DTH operators
CO4: Able to carry out investigation of Frequency Management and Business on Bandwidth.
CO5: To design the networks modeling and system evaluation

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	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	2	-	2	3	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO5	2	2	2	2	-	-	-	-	2	2	2	-	2	-

Syllabus

Unit 1
Telecommunication Technology Fundamentals - Signal transmission and channels – Network media – Data compression – Protocols and topology – Connectivity in networks – Ethernet principles – Wireless communication principles – Broadcasting versus link - TCP/IP model – OSI model - Telecom network management - LAN – WAN – Repeaters – Bridges – Routers – Gateways – Hubs - Electronic commerce - Internet and intranet – Role of government in data communication quality of service in telecommunication - Telecommunication Standards and Regulations - International telecommunication union (ITU) - TRAI and its role – Frequency management – Cost computations – Mobile and DTH operations – Role of wireless planning commission (WPC) for telecommunications in India - Service providers.

Unit 2
Telecom business management - Automated teller machines – Teleconferencing – Telecommuting – Enterprise applications – Customer oriented communication aspects – Telecom billing - Revenue assurance & fraud management Business on Spectrum - Concepts of data rate and bandwidth requirements – Digital subscriber line – Broadband technologies – Digital home – Voice enabled DSL - Bandwidth brokerage.

Unit 3
Telecommunication project management - Telecommunication design and implementation – Network analysis and design – Sources of projects – Methodology for designing - developing and implementing telecommunication capabilities – Disaster Management - Network modeling – Phases of project management.

Text Book(s)

Willium C. Y. Lee, "Wireless & Cellular Telecommunications", McGraw-Hill Companies Inc, Third Edition, 2006.

Vincent W. S. Wong. "Key Technologies for 5G Wireless Systems", Cambridge University Press, 2017.

Reference(s)

John G. Proakis and Masoud Salehi, "Fundamentals of Communication Systems", Pearson Education, First Edition, 2007.

Simon Haykin, "Digital Communications", Wiley India Private Limited, First Edition, 2006.

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

RF System design

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

19ECE441	ANTENNA SYSTEMS	L-T-P-C: 3-0-0-3

Course Objectives

- To understand the radiation concepts for antenna systems
- To design, develop and analyze specific antenna and array systems for various applications
- To motivate for pursuing project and research in the antenna domain

Course Outcomes

CO1: Design and analyze various types of antenna systems and study using electromagnetic simulation
CO2: Provide end-to-end solutions in the antenna design aspects and able to choose the suitable configurations
CO3: Apply the design and analysis aspects of antennas in research and support the industrial requirements
CO4: Ability to provide solutions for wireless connectivity in the RF front-end domain.

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
CO2	3	3	3	-	-	-	-	-	-	-	-	-	3	3
CO3	3	3	3	-	-	-	-	-	-	-	-	3	3	3
CO4	3	2	-	-	-	-	-	-	-	-	-	3	3	3

Syllabus

Unit 1
Review of radiation concepts from electromagnetic theory - near and far field - power density Antenna parameters - wire antennas - dipole and monopolr - printed dipole - helical antenna - microstrip rectangular and annular ring antenna.
Unit 2
Feed techniques feed systems for circular polarization - Axial ratio - Bandwidth enhancement - Case studies on antenna design for selected applications and electromagnetic simulation studies.
Unit 3
Design of Array antenna systems - Principle of array operation - array factor - radiation pattern analysis - side-lobe suppression techniques - element spacing - gain computation - microstrip array - helical array - feed techniques, -impedance matching planar feed techniques - corporate feed techniques - multi-layer antenna array and feed systems - Electromagnetic simulations of array antenna systems.

Text Book(s)
Constantine A. Balanis, "Antenna Theory: Analysis and Design", 4th Edition, Wiley and Sons, ISBN: 978-1-118-64206-1 February 2016.
J R James and P S Hall, "Microstrip Antenna: Theory and Design", Peter Peregrinus Ltd., 1986.

Reference(s)
Hubregt J Visser, "Antenna Theory and Applications", Wiley, 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

19ECE443	PLANAR MICROWAVE DEVICES	L-T-P-C: 3-0-0-3

Course Objectives

- To study the planar transmission lines characteristics
- Analysis of general properties of three and four port networks and then design of common types of dividers, couplers and hybrids
- To study the planar microstrip filter theory and design with the frequency characteristics

Course Outcomes

CO1: Able to understand the concepts of planar transmission line characteristics
CO2: Able to analyze the effective dielectric constant and characteristics impedance of different types of planar transmission line
CO3: Able to understand the properties of passive microwave components used for power division / combining
CO4: Able to design planar microwave circuit

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
CO2	3	2	2	-	-	-	-	-	-	-	-	-	3	2
CO3	3	2	-	-	-	-	-	-	-	-	-	-	3	2
CO4	3	2	2	-	-	-	-	-	-	-	-	-	3	2

Syllabus

Unit 1
Introduction to planar transmission lines - Stripline – Microstrip line – Suspended stripline – Impedance – Effect of thickness – Attenuation – Applications – Distributed and lumped elements – Terminations – Resonators.

Unit 2
Power dividers and Directional couplers - Properties of Dividers and Couplers – Lossless divider – Resistive divider – Wilkinson divider – Directional couplers – Quadrature couplers – Ferrite devices – Circulators – Isolators – Attenuators – Non-ferrite non reciprocal devices.

Unit 3
Microwave Filters – Periodic structures – Image parameter method – Insertion loss method – Impedance and frequency scaling – Filter implementation – Stepped impedance filter – Coupled line filter.

Text Book(s)
David M. Pozar, "Microwave Engineering", Wiley India Limited, Third Edition, 2007.
Leo G. Maloratsky, "Passive Rf& Microwave Integrated Circuits", Elsevier Inc, First Edition, 2006.

Reference(s)
Samuel. Y. Liao, "Microwave Devices and Circuits", Pearson Education, Third Edition, 2004.
David K.Cheng, "Field and Wave Electromagnetics", Pearson Education, Second Edition, 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

19ECE444	SATELLITE COMMUNICATION	L-T-P-C: 3-0-0-3

Pre Requisite(s): Communication Theory

Course Objectives

- To provide an overview of the satellite communication systems
- To understand design parameters involved in the communication using satellites
- To appreciate the contribution of satellite communication to the technological advancement in the area of communication

Course Outcomes

CO1: Able to understand the orbital mechanics, various functional principles and prepare link budget for satellite communication systems
CO2: Able to comprehend the various subsystems involved in satellite communication and its functionalities
CO3: Able to analyze signal processing schemes for satellite communications
CO4: Able to understand the application of satellite communication systems

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	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	3	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-	3	2
CO4	3	2	2	-	-	3	-	-	-	-	2	3	3	-

Syllabus

Unit 1
Review of Microwave Communications - Overview of satellite communications - Satellite orbits - Orbital mechanics and effects - Kepler's laws - Configurations of various orbits - Orbital elements - Elevation and azimuth angles - Doppler effect - Effect of the sun and moon - Sun transit outage. Satellite link models and design - Satellite system parameters - Link budget design.

Unit 2
Satellite subsystems – AOCS - TTC&M - Power and communication subsystems - Computations and controlling by processors - Satellite multiple access schemes – FDMA - TDMA and CDMA - Spread spectrum concepts - Comparison of multiple access schemes.

Unit 3
Satellite applications – VSAT - DTH television principles - Direct broadcast radios - Principles of navigation – GPS - Satellites and launch vehicles – INSAT - IRS satellites – PSLVs – GSLVs.

Text Book(s)
T.Pratt, C.W.Bostain and J.E.Allnut, "Satellite Communications", John Wiley and Sons, Second Edition, 2003.
Dennis Roddy, "Satellite Communications", McGraw-Hill Publishing Company, Fourth Edition, 2006.

Reference(s)
Wilbur L.Pritchard, Hendri G. Suyderhoud, Robert A. Nelson, "Satellite Communication Systems Engineering", Prentice Hall/Pearson, 2007.
M.Richharia, "Satellite Communication Systems-Design Principles", Macmillan 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

Signal Processing

19ECE451	SPOKEN LANGUAGE PROCESSING	L-T-P-C:

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)

1. *Joseph Mariani (Ed), "Spoken Language Processing", John Wiley & Sons, 2009.*
2. *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

19ECE452	RADAR SIGNAL PROCESSING	L-T-P-C: 3-0-0-3

Pre Requisite(s): Signals and Systems

Course Objectives

- To introduce the signal models used in radar signal processing
- To familiarize the different signal processing concepts and wave form design
- To implement and analyze signal processing aspects of radar

Course Outcomes

CO1: Able to understand the signal processing techniques and applying it to practical problems
CO2: Able to develop signal models and analyze real time systems
CO3: Able to generate and model mathematically the radar wave forms and performs the analysis
CO4: Able to apply the signal processing techniques to different radar systems

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	2	-	-	-	-	-	-	-	-	-	-	2	2
CO3	3	3	-	3	-	-	-	-	-	-	-	-	2	2
CO4	3	2	3	3	-	-	-	-	-	-	-	-	2	2

Syllabus

Unit 1
Review of selected signal processing concepts and operations for radar -Sampling in radar signals- fast time - slow time - Doppler spectrum - spatial and angle dimensions - Quantization.

Unit 2
Signal Model - Amplitude models - Clutter - Frequency models - spatial models - spectral model - and noise model and signal to noise ratio - Waveforms-Pulse burst waveform - frequency modulated pulse compression waveforms.

Unit 3
MIMO radar and Phased array radar - Beamforming and space time adaptive processing-Conventional beamforming - adaptive beamforming - Space time signal environment - processing space time signal model.

Text Book(s)
Mark A.Richards, "Fundamentals of Radar signal Processing", Tata McGraw-Hill edition, Tata McGraw-Hill education pvt Ltd., 2005.
Merill I Skolink, "Introduction to radar systems", Third edition.Mc Graw Hill Education(India)Edition, 2001.

Reference(s)
Bassemr Mahafza, "Radar System Analysisand design using Matlab", Third edition, CRC Press, 2015.
Jian Li, Petre Stoica, "MIMO Radar Signal Processing", First Edition, John Wiley &Sons Inc, 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

19ECE453	STATISTICAL SIGNAL PROCESSING	L-T-P-C: 3-0-0-3

Pre Requisite(s): Digital Signal Processing

Course Objectives

- To enable the students to understand discrete-time random process and fundamentals of signal models
- To enable the students to understand the concepts of filters
- To enable the students to understand the various estimation methods

Course Outcomes

CO1: Able to understand discrete-time random processes and various signal models and hence apply it to real time problems
CO2: Able to analyze and develop algorithms for linear filtering and adaptive filtering
CO3: Able to understand the spectral estimators and hence be able to analyse the different types and hence design solution for estimation problems
CO4: Able to formulate and apply frequency estimation algorithms

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	1	1
CO2	3	3	1	-	-	-	-	-	-	-	-	-	3	1
CO3	3	3	3	2	-	-	-	-	-	-	-	-	3	3
CO4	3	3	3	2	-	-	-	-	-	-	-	-	3	3

Syllabus

Unit 1
Random processes- Gaussian Processes-Stationary processes- Autocovariance and Autocorrelation matrices, - Ergodicity - White noise - Power spectrum, Autoregressive moving average processes- Signal Modeling - The Least Squares method - Autocorrelation method - Covariance method - Autoregressive moving average models.

Unit 2
Levinson-Durbin Recursion- Lattice filters - FIR Lattice filter - IIR Lattice filter. Wiener filtering - FIR Wiener filter-IIR Wiener filter - Adaptive filtering - FIR adaptive filters-Steepest Descent adaptive filter - LMS algorithm - Gradient adaptive lattice filter - Adaptive Recursive filters-Recursive Least squares.

Unit 3
Spectrum Estimation: Nonparametric methods – Periodogram - Barlett's method - Welch's method, Blackman and Tukey method of smoothing periodogram. Parametric methods-Autoregressive spectrum estimation - Moving average spectrum estimation - Frequency estimation - Eigen decomposition of Autocorrelation matrix - Detection of Harmonic signals - Pisarenko's method - MUSIC algorithm.

Text Book(s)
M.H. Hayes, "Statistical Digital Signal Processing and Modelling", John Wiley, 1996.
P.Stroica & R.Moses, "Spectral Analysis of signals", Prentice hall, 2005.

Reference(s)
Steven M. Kay, "Fundamentals of Statistical Signal Processing", Vol. 1: Estimation Theory, Vol. 2: Detection Theory, Pearson, 2009.
Louis Scharf, "Statistical Signal Processing", Pearson, 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 Report

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

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 preprocessing techniques used for hyperspectral image analysis
CO3: Able to apply the machine learning algorithms used for hyperspectral image classification
CO4: Able to implement the preprocessing 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

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

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

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

19ECE462	PROCESS CONTROL	L-T-P-C: 3-0-0-3

Pre Requisite(s): Control Theory

Course Objectives

- To equip the student with working knowledge of chemical process modelling
- To impart knowledge to the student regarding the various modes of control and their application
- To impart knowledge to the student regarding the various types of control valves and their application
- To impart the student working knowledge of piping and instrumentation diagrams

Course Outcomes

CO1: Able to develop models for simple chemical process
CO2: Able to develop practical understanding of various control modes
CO3: Able to develop understanding of various control elements especially control valves
CO4: Able to understand advanced control strategies like feed-forward and cascade control schemes
CO5: Ability to read and draw simple P&IDs (Process & Instrumentation Diagrams)

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
CO5	3	2	-	-	-	-	-	-	-	-	-	2	2	2

Syllabus

Unit 1
Incentives for Chemical Process Control - Design aspects - Hardware for a Process Control System - Modelling of Chemical Processes - Development of a mathematical model with examples of STH and CSTR - State Variables and State Equations - Dead Time - linearization of Nonlinear systems - Input-output Model - Degrees of freedom and process controllers - Transfer function of a process with single/multiple outputs - Dynamic Behavior of First Order - second order and higher order systems.

Unit 2
Controller Principles - Process characteristics - Control System Parameters - Discontinuous controller Modes - Two-Position - Multi position - Floating Control Mode - Continuous controller Mode – P - I and D - Composite control Modes - PI – PD - PID. Control action generation in electronic - pneumatic controllers – Direct Digital Control: components and working of DDC – benefits of DDC. Design of Feed Back controllers: Outline of Design problems - simple performance criteria - time integral performance content - selection of a feedback controller - controller tuning using Cohen-Coon method - Bode Stability criterion - gain and phase margins - Ziegler-Nichols Tuning Technique.

Unit 3
Control Valves - Terminology – control valve characteristics – valve classifications and types – valve positioner – selection criteria for control valves - P & I Diagram: Terminology – instrument identification - examples. Advanced control strategies: Cascade - Feed-forward - feedforward-feedback and Ratio Control.

Text Book(s)

Stephanopoulos, "Chemical Process control", PHI, 2006.
Surekha Bhanot, "Process Control - Principles & Applications", Oxford University Press, 2008.

Reference(s)

C. D. Johnson, "Process control Instrumentation Technology," Pearson Education, Eighth Edition, 2006.

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

19ECE464 VIRTUAL INSTRUMENTATION FOR COMMUNICATION SYSTEMS L-T-P-C: 3-0-0-3

Pre Requisite(s): Nil

Course Objectives

- To introduce various basic blocks available in Lab VIEW
- To provide knowledge about signal processing and image processing tool kits
- To familiarize with usage of data acquisition cards
- To develop real time application using Arduino interface

Course Outcomes

CO1: Able to identify and explain the function of each basic blocks used in the given program
CO2: Able to examine the given signal using signal processing toolkit
CO3: Able to demonstrate real time application of image processing toolkit
CO4: Able to code programs to communicate data with real time sensors through DAQ and Arduino

CO – PO Mapping

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

Syllabus

Unit 1
Introduction and familiarization to LabVIEW programming environment – spectral analysis – digital filters – adaptive filtering – multirate signal processing – generating signals – frequency domain processing – DSP integration – Software defined radio.

Unit 2
Image types and file management – Image Acquisition – Displaying Images – Image Processing – Morphology – Image Analysis – Introduction to Machine Vision.

Unit 3
Most Common Communication Buses – Using the DAQ Assistant to Automatically Generate LabVIEW Code – DAQ Programming – Debugging Techniques – Real-World DAQ Programming Techniques – Real-Time Issues – DAQ at a Distance-Network and Distributed Systems – Simple programming with Arduino-LabVIEW interface.
.

Text Book(s)

Cory L. Clark, "LabVIEW Digital Signal Processing and Digital Communications", McGraw-Hill, 2005.
Nasser Kehtarnavaz and Namjin Kim, "Digital Signal Processing System-Level Design Using LabVIEW", Elsevier, Newnes, 2005.
Christopher G. Relf, "Image Acquisition and Processing with LabVIEW", CRC Press, 2003.

Reference(s)

Behzad Ehsani, "Data Acquisition Using LabVIEW", Packt Publishing Ltd, 2016.
Marco Schwartz and Oliver Manickum, "Programming Arduino with LabVIEW", Packt Publishing Ltd, 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

19ECE465	ELECTRIC DRIVES	L-T-P-C: 3-0-0-3

Pre Requisite(s): Basic Electrical and Electronics Engineering

Course Objectives

- To equip the student with basic principles of operation of motors
- To equip the student with basic principles of operation of DC motors and drives
- To equip the student with basic principles of operation of induction motors and drives

Course Outcomes

CO1: Understand the basic principles of operation of motors
CO2: Understand the construction various motors and Drives
CO3: Understand the working of various motors and Drives
CO4: Understand principles and operation of other types of AC and DC drives

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

Syllabus

Unit 1
Introduction to Electric Motors - Review of mathematical tools - phasor diagrams - solving ODEs - Z- transforms - Producing Rotation - Magnetic Circuits - Torque Production - Specific Loadings And Specific Output - Energy Conversion–Motional Emf - Equivalent Circuit - General Properties Of Electric Motors - Power Electronic Converters For Motor Drives - Introduction Voltage Control - Controlled Rectification - Single Phase Inversion - Inverter Switching Devices - Conventional D.C. Motors - Introduction - Torque Production - Motional E.M.F, D.C. Motor–Steady-State Characteristics - Transient Behavior – Shunt - Series and Compound Motors - Four-Quadrant Operation and Regenerative Braking.

Unit 2
D.C. Motor Drives - Thyristor D.C. Drives - Control Arrangements for D.C. Drives - Chopper-Fed D.C. Motor Drives - D.C. Servo Drives - Digitally Controlled Drives - Induction Motors - The Rotating Magnetic Field - Torque Production - Influence Of Rotor Current On Flux - Stator Current-Speed Characteristics - Methods Of Starting Cage Motors - Run-Up And Stable Operating Regions - Torque–Speed Curves–Influence Of Rotor Parameters - Influence Of Supply Voltage - Generating And Braking - Speed Control - Power Factor Control and Energy Optimization - Single-Phase Induction Motors.

Unit 3
Inverter-Fed Induction Motor Drives - Torque–Speed Characteristics–Constant V/F Operation, Control Arrangements For Inverter-Fed Drives - Vector (Field-Oriented) Control, D-Q model of induction motor - Cyclo-Converter Drives - Stepper motors – Synchronous - Brushless D.C. And Switched Reluctance Drives.

Text Book(s)

Austin Hughes, "Electric Motors and Drives Fundamentals, Types and Applications, Newnes press", Elsevier Ltd. 3rd edition, 2006.

David Polka, "Motors and Drives: A Practical Technology Guide, The Instrumentation, Systems, and Automation Society", 2003.

Nagrath I J and Kothari D P, "Electrical Machines", Tata McGraw-Hill, Second Edition, 2000.

Reference(s)

Gopal K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, 2001.

Pillay. S.K, A "First Course on Electric Drives", Wiley Eastern Limited, Bombay, 1987.

Evaluation Pattern

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

19ECE466	INDUSTRIAL INSTRUMENTATION	L-T-P-C: 3-0-0-3

Pre Requisite(s): Nil

Course Objectives

- To impart understanding of the various generalizations used in instrumentation
- To impart working knowledge of various commonly used transducers in industry
- To impart understanding of various commonly used transducers for measuring important parameters in industry

Course Outcomes

CO1: Able to understand and apply static and dynamic characteristics of generalized measurement systems
CO2: Able to understand the principles of operation of various transducers
CO3: Able to understand the construction of sensors
CO4: Able to apply sensors for measurement of various quantities

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

Syllabus

Unit 1
Introduction: Elements of a generalized instrumentation system – Classification of instruments - I/O Configuration – method of correction for spurious inputs – Static characteristics – Errors in measurements and their statistical analysis – Dynamic characteristics.

Unit 2
Measurement of Displacement Force, Torque, speed and Temperature: Displacement measurement – LVDT – Potentiometer - Force measurement - Electric balance - Magneto elastic load cell - Strain gauge load cell. Torque measurement - Strain gauge - Relative regular twist - Speed measurement - Revolution counter - Capacitive tacho - Drag cup type tacho - D.C and A.C tacho generators - Stroboscope. Temperature measurement - Bimetallic Thermometers – RTD – Thermistor – Thermocouple - Semiconductor thermometers - Radiation pyrometers.

Unit 3
Measurement of Flow and Pressure: Flow measurement – Variable head flow meters – Orifice – Venturi - Pitottube – Rotameter –EM flow meter – Hotwire anemometers – Turbine flow meters – Ultrasonic meter – Vortex shedding flow meter – Nutating disc. Pressure Measurement - Dead weight tester – Manometers – Elastic pressure elements - Low pressure measurement: Mcleod's gauge – Viscosity gauge – Pirani Gauge – Thermocouple gauge – Ionization gauges.

Text Book(s)
A.K. Sawhney, Puneet Sawhney, "A Course in Mechanical Measurements and Instrumentation", Dhanpat Rai and Company Private Limited, Twelfth Ed, 2007.
E. O. Doeblin, "Measurement system Application and design", Tata McGraw Hill Publishing Company Limited, Fifth edition, 2007.

Reference(s)

T. G. Beckwith, Roy D. Marangoni and John H. Lientar, "Mechanical Measurements", Pearson Education, fifth edition, 2006.

D. Patranabis, "Principles of Industrial Instrumentation", Wheeler Publishing Company Limited, Second edition, 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

19ECE471 ELECTRONIC SYSTEMS: DATA COMMUNICATION L-T-P-C: 1-0-0-1

Course Objectives:

- To understand the need for communication, in electronic systems.
- To understand the operation of different kinds of communication employed in modern electronic systems.

Course Outcomes:

CO1: Able to understand the operation of different communication strategies in modern electronicsystems
CO2: Able to recognize the various advantages and shortcomings of the various communicationsystems.

CO-PO Mapping

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

Syllabus

RF / Wireless / Wired Communication - Transmission lines; Antenna wave propagation - Channel Impairments; System noise; non-linearity; Link budget - Case studies on WLAN Transceivers – MIMO - Data Communication Systems - Serial Link & system impairments - CAN interfaces - Ethernet Network interfaces – USB - Power over Data.

Textbooks

[1] D. M. Pozar, *Microwave engineering*, 4th ed. Wiley India, 2017.
[2] Steer M B, *Microwave and RF Design*, Tbh / Yes Dee, 2012.
[3] R. Zurawski, Ed., *Industrial communication technology handbook*, 2. ed. Boca Raton, Fla: Taylor & Francis,2015.
[4] Forouzan B A, *Data Communications and Networking*, 5th ed. India: McGraw-Hill, 2017.
[5] Maniktala S, *Power over ethernet interoperability*, New York, NY: McGraw-Hill, 2013.

Evaluation Pattern:

Assessment	Internal	External
Continuous Assessment**	50	
Semester Examination		50

** *Can be quizzes / Assignments*

19ECE472 ELECTRONIC SYSTEMS: DATA CONVERSION AND POWER SUPPLIES L-T-P-C: 1-0-0-1

Course Objectives:

- To understand the need for data conversion and interfacing
- To understand the various issues to be considered in data conversion
- To understand the different techniques used in designing power supplies for electronic systems

Course Outcomes:

CO1: Able to understand the various parameters characterising data conversion

CO2: Able to understand driver circuits and regulators

CO3: Able to understand the operation of power management ICs

CO-PO Mapping

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

Syllabus

ADC / DAC - Data Conversion; Reference Voltages; Sampling Time; Resolution; ADC Errors – Non-linearity; Offset; Gain; Noise – reference voltage; signal; Dynamic Range mismatch; ENOB; signal source impedance; parasitic capacitances; channel cross-talk; ADC / DAC interface Design - Case Study

Power Supplies, Drives, Switches, Regulators & PMIC - Fundamentals of MOSFET and IGBT gate driver circuits; Linear and Switching Regulators – Buck and Boost; high-side and low-side switches; H-Bridge; Current Sensing Techniques; Need for PMIC; Applications; Examples; Input and Output Supply Ranges; Power Sequence; Supervisory; Watchdog operation.

Textbooks / References

[1] G. Manganaro, *Advanced Data Converters*. Cambridge: Cambridge Univ. Press, 2012.

[2] R. Van de Plassche, *CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters*, 2nd ed. Springer (India) Private Limited, 2005.

[3] W. A. Kester, *Data Conversion Handbook*. Amsterdam: Elsevier Newnes, 2005.

[4] Franco S., *Design with Operational Amplifiers and Analog Integrated Circuits*, 4th edition. New York, NY: McGraw-Hill Education, 2015.

[5] M. M. Hella, P. P. Mercier, and K. Iniewski, Eds., *Power management integrated circuits*. Boca Raton London New York: CRC Press, Taylor & Francis Group, 2016.

Evaluation Pattern:

Assessment	Internal	External
Continuous Assessment**	50	
Semester Examination		50

** *Can be quizzes / Assignments*

19ECE473 ELECTRONIC SYSTEMS: ESSENTIALS OF SoCs L-T-P-C: 1-0-0-1

Course Objectives:

- To understand the role of SoCs in modern electronic systems
- To understand the process of choosing a specific SoC

Course Outcomes:

CO1: Able to understand different SoC architectures
CO2: Able to understand the different functions provided by a So

CO-PO Mapping

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

Syllabus

System on Chip Architecture: Embedded System-on-Chip Architectures - Elements of SoC Solutions - Defining Requirements and Specifications - Cycle Time: Definition, Optimum Pipeline - Power/Performance/Area Trade-offs – Reliability - Building an Interconnect Protocol - Interconnecting Multiple Requestors and Completers - Jacinto 7 processors: Overview of SoC subsystems and features - heterogeneous processing cores - application-specific hardware accelerators - device management, memory and data movement - virtualization, security, and power; Comparison of different SoCs

Textbook(s)

[1] Beuchat R D, Depraz F, Kashani S, and Guerrieri A, *Fundamentals of System-on-Chip Design on Arm Cortex-M Microcontrollers*. S.l.: Arm Education Media, 2021.

Evaluation Pattern:

Assessment	Internal	External
Continuous Assessment**	50	
Semester Examination		50

** *Can be quizzes / Assignments*

19ECE474	ESSENTIALS OF EMC AND EMI	L-T-P-C: 1-0-0-1

Course Objectives:

- To understand the importance of electromagnetic interference and compatibility in electronic systems
- To obtain an overview of EMC/EMI issues, affecting electronic systems
- To know the different standards and agencies, associated with EMC / EMI

Course Outcomes:

CO1: Able to understand the effect of EMI and EMC on electronic systems / devices
CO2: Able to recognize the various ways in which EMI / EMC affect system performance
CO3: Able to recognize the various agencies and standards associated with EMI / EMC

CO-PO Mapping

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

Syllabus:

Awareness about EMI/EMC - Case studies regarding EMI /EMC events disasters; Emissions – Conducted and Radiated, Susceptibility – Conducted and Radiated; Frequency bands and Nomenclature – Types of devices – Class A, B and other types of classifications; EMC Control and Prediction; Standards and Agencies : CISPR- FCC, IEC, WPC; EMC / EMI standards in Automotive and biomedical industries

Textbook(s)

Paul C R, Introduction to Electromagnetic Compatibility, 2nd ed. Wiley, 2010.

Reference(s)

1. Prasad V K, Engineering Electromagnetic Compatibility - Principles, Technologies and Computer Models, 2nd ed. BSP Books, 2010.
2. C. Christopoulos, Principles and techniques of electromagnetic compatibility, 2nd ed. Boca Raton, Fla.:CRC Press, 2018.

Evaluation Pattern:

Assessment	Internal	External
Continuous Assessment**	50	
Semester Examination		50

** Can be quizzes / Assignments

19ECE475	PCB DESIGN AND THERMAL MANAGEMENT	L-T-P-C: 1-0-0-1

Course Objectives:

- To understand the need for PCBs, to achieve desired system performance
- To realise the role of PCB layout in minimising noise and optimizing system performance
- To understand the need for proper thermal management in electronics

Course Outcomes:

CO1: Able to understand the importance of proper PCB design
CO2: Able to recognize the various issues involved in PCB layout
CO3: Able to understand the crucial effect of temperature on electronic circuit design

CO-PO Mapping

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

Syllabus

PCB Design, Rules and Manufacturability - PCB Technology – Component Packaging; Layer Stackup, Via Technology, HDI Concept; PCB Materials; Thermal and Mechanical Properties; PCB Design – Influencing Factors; Final Concept of the Board – functionality, features and interconnection, placement in the final product and dimensions, Temperature Range, Identifying the kind of PCB required; Schematic – components required, values, rating, sizes, etc.; BoM; Functional Blocks; File format; Routing; Testing – ERC and DRC; Documentation; Power, Ground and Signal Trace considerations; Thermal Issues; Choice of CAD

Thermal Management for Electronics - Introduction; Heat Transfer Theory; Concept of thermal resistance; Use of datasheets; Passive and Active Cooling; Aspects of heat sink design; Heat management in Automotive and Biomedical applications; Examples

***Textbooks / References**:*

1. M. Scarpino, *Designing circuit boards with EAGLE: make high-quality PCBs at low cost*, Upper SaddleRiver, NJ: Prentice Hall, 2014.
2. Wilson P, *The circuit designer's companion*, 3rd ed. Oxford: Newnes, 2011.
3. T. Y. Obidi, Ed., *Thermal management in automotive applications*, Warrendale, Pennsylvania, USA: SAEInternational, 2015.
4. R. Remsburg, *Thermal design of electronic equipment*, Boca Raton, Fla.: CRC Press, 2001.

Evaluation Pattern:

Assessment	Internal	External
Continuous Assessment**	50	
Semester Examination		50

** *Can be quizzes / Assignments*

19ECE476	PRODUCT SAFETY, SECURITY, COMPLIANCE AND RELIABILITY	L-T-P-C: 1-0-0-1

Course Objectives:

- To understand the need for embedding product safety, security, compliance and reliability considerations aspart of the design process
- To obtain an overview of the different standards governing product safety, security, compliance and reliability

Course Outcome

CO1: Able to understand the need for product safety, security, compliance and reliability
CO2: Able to recognize some of the common faults in electronic products
CO3: Familiar with different standards associated with product safety, security, compliance and reliability
CO4: Familiar with different parameters for gauging product reliability

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	2					2							2	
CO3	2					2							2	
CO4	2					2							2	

Syllabus:

Product Safety - Need for Product Safety; Examples – Automotive; Airline; Biomedical; Organisations - EN / ISO / IEC / BIS;Safety Education; Voltage Faults – Surge and Ringing, Polarity Reversal; Current Fault – Short Circuit, Inrush, Reverse; Thermal – Over-temperature, Thermal Protection; Automotive and Biomedical Standards; ISO 26262

Product Security - Need for Product Security – Automotive and Biomedical Devices; Examples; ISO/IEC 80001; ISO/IEC 27032:2012; IEC 62304:2006

Product Compliance and Certification - Regulatory compliance - Product-specific; Substance Regulations (RoHS); Documentation; Labeling and Testing; Voluntary (Industry) Compliance – Industry-specific; Technical documentation; EUDeclaration of Conformity; Usage Instructions; Traceability; IATF 16949:2016; ISO 9000; ISO 14000; ASPICE; GDPR; IEC 60601-1; IEC 60601-1-11:2015; Process of Certification; ISO / IEC 17065 Conformity Assessment; ISO 17011; Certifying Bodies; Standards; Marking / Certificate; Accreditation Bodies; IAF, FCC / FDA / CE / BIS

Reliability Engineering - Functional Reliability; Typical causes of poor reliability; Quality vs Relaibility; Principles of Reliability; Types and Severity of Failures; Statistical Distribution Curves of Failures; Failure Mode and Effects Analysis; Mean Time Between Failures; Fault Tree Analysis

Textbooks/ References

1. National Safety Council and Product Safety Committee, *Product safety management guidelines*. Itasca, IL: The Council, 1997.
2. S. Brobeck, A. C. Averyt, J. Gillis, and Consumer Federation of America, *The product safety book: the ultimateconsumer guide to product hazards*. New York: Dutton, 1983.
3. J. Doherty, *Wireless and Mobile Device Security*, 2nd ed. Jones and Bartlett Learning, 2021.
4. K. C. Kapur and M. Pecht, *Reliability engineering*. Hoboken, NJ: Wiley, 2014.

Evaluation Pattern:

Assessment	Internal	External
Continuous Assessment**	50	
Semester Examination		50

** Can be quizzes / Assignments