Curriculum for B.E. in
Electronics Engineering
(VLSI Design & Technology)

Regulation 2024

CHENNAI INSTITUTE OF TECHNOLOGY
Transforming Lives

CHENNAI INSTITUTE OF TECHNOLOGY

Document Version

Version Number	Date	Author	Major Updates	Approved by
2.0	12.04.2024	Dr.R.M.Bommi	Included the Mandatory courses, font and alignment revised, Course code revisited	HoD
2.1	20.04.2024	Dr.R.M.Bommi	Tables removed and formatted	HoD
2.2	30.05.2024	Dr.R.M.Bommi	Included NCC, Design Thinking and OE courses	HoD
2.3	29.05.2024	Dr.R.M.Bommi	Included Latest Text Books, Checked for Lexical errors	HoD
2.4	12.06.2024	Dr.R.M.Bommi	Revisited the verticals and swapped few courses as per the suggestions provide in BoS	HoD
2.5	29.07.2024	Dr.R.M.Bommi	Sub code changed for PE &OE	HoD

Section 1: General Course Structure

A. Definition of Credit:

1 Hour Lecture (L) per week	1 Credit
1 Hour Tutorial (T) per week	1 Credit
1 Hour Practical (P) per week	0.5 Credit

B. Structure of Program:

S. No.	Category	Credits
1	Humanities & Social Science Courses (HSMC)	13
2	Basic Science Courses (BSC)	16
3	Engineering Science Courses (ESC)	20
4	Program Core Courses (PCC)	79
5	Professional Elective Courses (PEC)	18
6	Open Elective Courses (OEC)	6
7	Employability Enhancement Skills (EES)	18
8	Mandatory Course (MC)	-
	TOTAL	**170**

C. Course code and definition:

Code	Definition
L	Lecture
T	Tutorial
P	Practical
C	Credits

Course level coding scheme:

Each course code consists of 6 characters. The first 2 characters indicate the department abbreviation (e.g., CS, ME, IT, EE), except for Mandatory Courses, which use 'MC.' For Core and Mandatory Courses, the last 4 characters are digits. The digit in the thousands place represents the Regulation number (e.g., R22: 2, R22R: 3, R24: 4). The hundreds place digit signifies the semester in which the course is offered (ranging from 1 to 8), and the last digit denotes the course's serial order within that semester

For Professional Elective courses, the last 4 characters follow this format:

<Regulation number>V<Vertical number><Serial number within Vertical>

For Open Elective courses, the last 4 characters follow this format:

<Regulation number><Semester number>O<Serial number within Open Electives offered for a semester>

Category-wise Courses

Humanities & Social Science Courses (HSMC)

S. No.	Course Title	Semester	L-T-P-C
1	Communicative English – I	I	3-0-2-4
2	தமிழர் மரபு / Heritage of Tamils	I	1-0-0-1
3	Communicative English – II	II	3-0-2-4
4	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	II	1-0-0-1
5	Business Management	VII	3-0-0-3
		Total Credits	**13**

Basic Science Courses (BSC)

S. No.	Course Title	Semester	L-T-P-C
1	Calculus and Linear Algebra	I	3-1-0-4
2	Engineering Physics	I	3-0-2-4
3	Probability and Statistics	II	3-1-0-4
4	Mathematical Methods for Engineering	III	3-1-0-4
		Total Credits	**16**

Engineering Science Courses (ESC)

	Course Title	Semester	L-T-P-C
1	Problem Solving using C Programming	I	3-0-2-4
2	Data Structures and Algorithm using C	II	3-0-2-4
3	C++ Programming	II	3-0-2-4
4	Object Oriented Programming in JAVA	III	3-0-2-4
5	Fundamentals of Data Science and Machine Learning	IV	3-0-2-4
		Total Credits	**20**

Program Core Courses (PCC)

S. No.	Course Title	Semester	L-T-P-C
1	Electronic Devices	I	3-0-2-4
2	Digital System Design	I	3-0-2-4
3	Electronic Circuits	II	3-0-2-4
4	Circuit Theory	II	3-0-2-4
5	Analog and Digital Communication	III	3-0-0-3
6	CMOS VLSI Design	III	3-0-2-4
7	Microprocessor and Microcontroller	III	3-0-2-4
8	Linear Integrated Circuit	III	3-0-2-4
9	Core Course Project - I	III	0-0-2-1
10	Electromagnetic Fields	IV	3-0-0-3
11	Computer Architecture & Networks	IV	3-0-0-3
12	Analog IC Design	IV	3-0-2-4
13	Signal Processing Techniques	IV	3-0-2-4
14	Hardware Modeling using VHDL	IV	3-0-2-4
15	Core Course Project - II	IV	0-0-2-1

14	Transmission lines, Waveguides and Antenna Design	V	3-0-0-3
15	Control Systems	V	3-0-0-3
16	Mixed Signal IC Design	V	3-0-2-4
17	Core Course Project - III	V	0-0-2-1
18	Low Power VLSI Design	VI	3-0-0-3
19	VLSI Physical Design	VI	3-0-2-4
20	VLSI Testing	VI	3-0-0-3
21	Core Course Project - IV	VI	0-0-2-1
22	FPGA Architecture and Applications	VII	3-0-0-3
23	ASIC Design	VII	3-0-0-3
		Total Credits	**79**

Professional Elective courses

S. No.	Course Title	Semester	L-T-P-C
1	Professional Elective – I	V	3-0-0-3
2	Professional Elective – II	V	3-0-0-3
3	Professional Elective – III	V	3-0-0-3
4	Professional Elective – IV	VI	3-0-0-3
5	Professional Elective – V	VI	3-0-0-3
6	Professional Elective – VI	VII	3-0-0-3
		Total Credits	**18**

Open Elective Courses (OEC)

S. No.	Course Title	Semester	L-T-P-C
1	Open Elective – I	VI	3-0-0-3
2	Open Elective – II	VII	3-0-0-3
		Total Credits	**6**

Mandatory Course (MC)

S. No.	Course Title	Semester	L-T-P-C
1	Mandatory Course - I	III	1-0-0-0
2	Mandatory Course - II	IV	1-0-0-0
		Total Credits	**0**

Employability Enhancement Skills (EES)

S. No.	Course Title	Semester	L-T-P-C
1	Employability Enhancement Skills – I	I	0-0-2-1
2	Employability Enhancement Skills – II	II	0-0-2-1
3	Employability Enhancement Skills – III	III	0-0-2-1
4	Employability Enhancement Skills – IV	IV	0-0-2-1
5	Internship	VII	0-0-0-2
6	Project work Phase -I	VIII	0-0-12-6
7	Project work Phase -II	VIII	0-0-12-6
		Total Credits	**18**

D. Induction Program

- ***Catapult*** is a dynamic week-long event designed for our incoming first-year students, offering an immersive introduction to the diverse array of clubs and activities across the college campus. In addition to familiarizing them with our labs and Centers of Excellence (COEs), Catapult aims to acclimate first-year students to college life, ensuring they feel at ease with the forthcoming experiences of their four-year journey.
- This initiative fosters meaningful connections between seniors and juniors, providing a platform for them to explore departmental projects and engage in collaborative activities, thereby enhancing camaraderie and knowledge sharing within the college community.

E. Evaluation Scheme

a. For Theory Courses:

The weightage of Internal assessment is 40% and for End Semester Exam is 60%
The student has to obtain at least 50% marks individually both in internal assessment and end semester exams to pass

b. For Practical Courses:

The weightage of Internal assessment is 60% and for End Semester Exam is 40%
For Theory cum Lab
The student has to obtain at least 50% marks individually both in internal assessment and end semester exams to pass.

c. For Theory Cum Practical Courses:

The weightage of Internal assessment is 50% and for End Semester Exam is 50%
The student has to obtain at least 50% marks individually both in internal assessment and end semester exams to pass

Note: The internal assessment is based on the student's performance in 3 Internal Assessment (IA) exams, quizzes, assignments, class performance, attendance, etc.

d. For Project works:

Assessment of project works comprises three internal reviews and an end-of-semester evaluation. Internal reviews, worth 40 marks in total, encompass assessment criteria such as Project Synopsis/Proposal Evaluation, Methodology and Design of Existing System, Feasibility of Project Proposal, Planning of Project Work, and TeamWork. At the conclusion of the semester, 20 marks are designated for assessing the quality of the report, while the remaining 40 marks are reserved for evaluating performance in viva-voce, demonstration of the work, and other relevant factors.

F. Learning Beyond ClassRoom

a. Students should be encouraged to visit Centers of Excellence (COEs) in the campus and learn additional technical skills

b. Students should be encouraged to participate in internal / external competitions, hackathons, etc. on a regular basis

Section 2: Semester wise Structure and Curriculum for UG Course in VLSI DESIGN and TECHNOLOGY

Semester I							
S. No	**Theory/ Practical / T&P**	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	-		Induction Programme	-	-	-	0
2	T	MA4101	Calculus and Linear Algebra	3	1	0	4
3	T&P	HS4102	Communicative English – I	3	0	2	4
4	T&P	PH4101	Engineering Physics	3	0	2	4
5	T&P	CS4111	Problem Solving using C Programming	3	0	2	4
6	T&P	EC4101	Electronic Devices	3	0	2	4
7	T&P	EC4102	Digital System Design	3	0	2	4
8	T	HS4101	தமிழர் மரபு / Heritage of Tamils	1	0	0	1
9	P	ES4101	Employability Enhancement Skills – I	0	0	2	1
						Total	**26**

Semester II							
S. No	**Theory/ Practical / T&P**	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	T	MA4201	Probability and Statistics	3	1	0	4
2	T&P	HS4202	Communicative English – II	3	0	2	4
3	T&P	EC4201	Electronic Circuits Design	3	0	2	4
4	T&P	EC4202	Circuit Theory	3	0	2	4
5	T&P	CS4211	Data Structures and Algorithm using C	3	0	2	4
6	T&P	CS4213	C++ Programming	3	0	2	4
7	T	HS4201	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	1	0	0	1
8	P	ES4201	Employability Enhancement Skills – II	0	0	2	1
9	-	-	NCC Credit Course Level 1 ARMY WING*	2	0	0	2
						Total	**26**

*NCC Credit Course is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA

Semester III							
S. No	**Theory/ Practical / T&P**	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	T	MA4301	Mathematical Methods for Engineering	3	1	0	4
2	T	VD4301	Analog and Digital Communication	3	0	0	3
3	T&P	VD4302	CMOS VLSI Design	3	0	2	4
4	T&P	EC4302	Microprocessor and Microcontroller	3	0	2	4
5	T&P	VD4303	Linear Integrated Circuit	3	0	2	4
6	T&P	CS4311	Object Oriented Programming in JAVA	3	0	2	4
7	T	-	Mandatory Course - I	1	0	0	0
8	P	VD4304	Core Course Project - I	0	0	2	1
9	P	ES4301	Employability Enhancement Skills – III	0	0	2	1
						Total	**25**

Semester IV							
S. No	**Theory/ Practical / T&P**	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	T	EC4401	Electromagnetic Fields	3	0	0	3
2	T	VD4401	Computer Architecture & Networks	3	0	0	3
3	T&P	VD4402	Analog IC Design	3	0	2	4
4	T&P	VD4403	Signal Processing Techniques	3	0	2	4
5	T&P	VD4404	Hardware Modeling using VHDL	3	0	2	4
6	T&P	CS4411	Fundamentals of Data Science and Machine Learning	3	0	2	4
7	T		Mandatory Course - II	1	0	0	0
8	P	VD4405	Core Course Project - II	0	0	2	1
9	P	ES4401	Employability Enhancement Skills – IV	0	0	2	1
10	-	-	NCC Credit Course Level 2 NAVY WING*	2	0	0	2
						Total	**24**

*NCC Credit Course is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA

Semester V							
S. No	**Theory/ Practical / T&P**	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	T	VD4501	Transmission lines, Waveguides and Antenna Design	3	0	0	3
2	T	EC4502	Control Systems	3	0	0	3
3	T		Professional Elective I	3	0	0	3
4	T		Professional Elective II	3	0	0	3
5	T		Professional Elective III	3	0	0	3
6	T&P	VD4502	Mixed Signal IC Design	3	0	2	4
7	P	VD4503	Core Course Project - III	0	0	2	1
						Total	**20**

Semester VI							
S. No	**Theory/ Practical / T&P**	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	T	VD4601	Low Power VLSI Design	3	0	0	3
2	T	VD4602	VLSI Physical Design	3	0	0	3
3	T		Professional Elective IV	3	0	0	3
4	T		Professional Elective V	3	0	0	3
5	T		Open Elective I	3	0	0	3
6	T&P	VD4603	VLSI Testing	3	0	2	4
7	P	VD4604	Core Course Project - IV	0	0	2	1
8	-	-	NCC Credit Course Level 3 AIR FORCE WING*	2	0	0	2
						Total	**20**

*NCC Credit Course is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA

Semester VII							
S. No	**Theory/ Practical / T&P**	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	T	HS4701	Business Management	3	0	0	3
2	T	VD4701	FPGA Architecture and Applications	3	0	0	3
3	T	VD4702	ASIC Design	3	0	0	3
4	T		Professional Elective VI	3	0	0	3
5	T		Open Elective II	3	0	0	3
6	P	VD4703	Internship	0	0	4	2
6	P	VD4704	Project work Phase -I	0	0	12	6
						Total	**23**

Semester VII							
S. No	**Theory/ Practical / T&P**	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	P	VD4801	Project Work Phase - II	0	0	12	6
						Total	**06**

Semester I

Course Code	INDUCTION PROGRAMME	L	T	P	C
IP4100		-	-	-	-

This is a mandatory 2-week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

"Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed."

"One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. "

Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

I. Physical Activity

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

II. Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

III. Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing. Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective

that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

IV. Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

V. Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

VI. Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

VII. Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

VIII. Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

IX. Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering

/Technology/Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

Induction Programme is totally an activity-based programme and therefore there shall be no tests / assessments during this programme.

References:

Guide to Induction program from AICTE

Course Code	Calculus and Linear Algebra (Common to all Program)	L	T	P	C
MA4101		3	1	0	4

COURSE OBJECTIVES:

The main objectives of this course are to:

- To familiarize the students with differential calculus.
- To acquire the knowledge of evaluating integrals and their applications.
- To introduce the concept of ordinary differential equations in engineering problems.
- To develop the use of matrix algebra techniques for practical applications.
- To acquire the knowledge of vector spaces and linear transformation in all engineering disciplines.

UNIT I DIFFERENTIAL CALCULUS **12**

Representation of a function - Limits - Continuity – Derivatives- Mean Value theorem - Rolle's theorem - Maclaurin series - Partial derivatives - Total derivatives - Taylors series - Maxima and minima.

UNIT II INTEGRAL CALCULUS **12**

Multiple Integration: Double and Triple integrals - Change of order of integration in double integrals - Change of variables (Cartesian to polar) -Volume of solids - Gradient - Curl - Divergence - Theorems of Green in a plane - Gauss and Stokes theorems (Excluding Proof).

UNIT III DIFFERENTIAL EQUATIONS **12**

First order linear and nonlinear differential equations - Higher order linear differential equations with constant coefficients - Method of Variation of Parameters - Cauchy's and Legendre's equations - Solution of partial differential equations.

UNIT IV LINEAR ALGEBRA **12**

Matrices: Determinants - rank of a matrix - System of linear equations (Cramer's Rule, inverse of a matrix, Gauss elimination and Gauss-Jordan) - Eigen Values - Eigen Vectors - Reduce the quadratic form into Canonical form - LU decomposition - Singular Value Decomposition.

UNIT V VECTOR SPACES AND LINEAR TRANSFORMATIONS **12**

Vector Space – Subspace - linear dependence and independence - bases and dimensions - Linear transformations - Null space - range - Dimension theorem - Matrix representation of a linear transformations.

TOTAL: 60 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES:

Upon completion of the course, the students will be able to:

CO1: Apply differential calculus tools in solving various applications in real situations.
CO2: Able to use the integral ideas in solving areas, volumes and other practical problems.
CO3: Apply various techniques in solving ordinary differential equations.

CO4: Recalling the matrix algebra methods for solving the practical problems.
CO5: Understand the concepts of vector spaces and applications of linear transformations.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi,43rd Edition, 2014.
2. Kreyszig Erwin, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
3. Friedberg. A.H., Insel. A.J, and Spence. L ., "Linear Algebra", Prentice Hall of India, New Delhi, 4th Edition, 2004.

REFERENCES:

1. Weir, M.D and Joel Hass, "Thomas Calculus", Pearson India, 12thEdition, 2016.
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3rd Edition, 2007.
3. O'Neil, P.V. "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, New Delhi,2007.
4. Sastry, S.S, "Engineering Mathematics", Vol. I& II, PHI Learning Pvt. Ltd, 4th Edition, New Delhi, 2014.
5. Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.
6. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
7. Glyn James, "Advanced Modern Engineering Mathematics", Pearson India, Eighth Edition, 2017.
8. Kumaresan. S., "Linear Algebra – A Geometric Approach", Prentice – Hall of India, New Delhi, Reprint, 2010.

Course Code	**Communicative English – I**	L	T	P	C
HS4101		3	0	2	4

COURSE OBJECTIVES:

- To improve the communication competency.
- To learn basic grammatical structures in suitable contexts.
- To build students' English language skills through LSRW.
- To enable the students to write in English precisely and effectively
- To develop language proficiency in expressing their opinions.

Introduction to Effective Communication **1**

What is effective communication? Why is communication critical for excellence during study, research, and work? What are the seven C's of effective communication?

UNIT I Integrals of Communication (Greetings & Introduction) **8**

Listening – Listening comprehensions, listening to News
Speaking – Just A Minute, Introducing a friend
Reading – Reading Newspaper / Articles/ Magazines, Reading comprehension
Vocabulary – Synonyms & Antonyms, Acquaintance with Prefixes & suffixes from foreign languages in English to form derivatives and Word formation
Grammar – Parts of Speech, Mixed Tenses, Active & Passive Voice
Writing –Letter of Introduction, Developing the Hints

UNIT II Giving and Receiving Instructions **9**

Listening – Listening to short stories, Narrations and Persuasive speech
Speaking – Giving Instructions to use the Product/ Presenting or summarizing about a product
Reading – Reading Advertisements / Biographies
Vocabulary – Abbreviation, Acronyms, One – word Substitutes
Grammar – WH Questions/Yes or No Questions, Imperatives
Writing – Instructions, Paragraph Writing

UNIT III Describing People and Places **9**

Listening – Listening to the description of a product
Speaking –Picture Description, Narrating personal experiences and events
Reading – Gadget Reviews, User Manuals
Vocabulary – Homonyms, Homophones, Compound Words
Grammar – Adjectives, Adverbs, Articles.
Writing –Recommendations, Product/ Process Description.

UNIT IV Visualization and Classification **9**

Listening – TED talks
Speaking – Interviewing a celebrity/Famous Personality
Reading – Company profiles, Business Letters
Vocabulary– Discourse Markers, Linking words and Phrases Collocation.
Grammar – Pronouns, Conjunction, Preposition
Writing – Interpretation of Charts and Graphs

UNIT V Exposition **9**

Listening – Watching Movies / Listening to Dialogues and Conversations
Speaking – Role play, Panel Discussion, Debate
Reading – Blogs, Novels, Short Stories
Vocabulary – Phrasal Verbs
Grammar– Simple/Compound/Complex Sentences, Error Spotting, Punctuation.
Writing – Descriptive Essay, Dialogue Writing

TOTAL: 45 PERIODS

LIST OF EXERCISES: **30 PERIODS**

1. Extempore (Oral)
2. Conversation on asking directions
3. Picture Description, about purchasing a product.
4. Summarising a TED talk.
5. Role play.

TOTAL (THEORY AND PRACTICAL): 75 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES:

After the completion of the course, students will be able to

CO1: Use appropriate words in a professional context

CO2: Gain an understanding of basic grammatical structures and use them in the right context.

CO3: Write definitions, descriptions, narrations and essays on various topics

CO4: Speak fluently and accurately in formal and informal communicative contexts

CO5: Express their opinions effectively in both oral and written medium of communication.

TEXT BOOKS

1. English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition)
2. English for Science & Technology Cambridge University Press, 2021.Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.
3. Professional English-II, V.K. Publications, Dr.S.N. Mahalakshmi.

REFERENCES

1. Technical Communication – Principles and Practices By Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2. A Course Book On Technical English By Lakshminarayanan, Scitech Publications (India) Pvt.Ltd, 2012
3. Learning to Communicate–Dr.V. Chellammal. Allied Publishers, New Delhi,2004

Course Code	**Engineering Physics**	L	T	P	C
PH4101		3	0	2	4

COURSE OBJECTIVES:

- To enable students to understand the mechanics and properties of matter.
- To provide an overview of sound and ultrasonic production, detection and applications.
- To introduce the basics of lasers.
- To enrich the basic knowledge of optical fiber
- To understand quantum mechanical phenomena and apply them in computing fields.

UNIT I MECHANICS AND PROPERTIES OF MATTER 9

Center of mass (CM) – motion of the CM – moment of inertia – theorems of M. I – moment of inertia of continuous bodies (Ring, Disc) – gyroscope. Elasticity –Type of modulus: Young's Modulus, Bulk Modulus, Rigidity Modulus –Poisson ratio - Hooke's law – stress-strain diagram – Factors affecting elasticity – bending of Beams – Young's modulus by uniform bending and non–uniform bending – Torsional Pendulum – I – shaped girders.

UNIT II ACOUSTICS AND ULTRASONICS 9

Acoustics: Classification and characteristics of sound – decibel – Weber – Fechner law – Factors affecting acoustics of buildings and their remedies – Absorption Coefficient. - Doppler effect. Ultrasonic – Production of Ultrasonic by Magnetostriction and piezoelectric methods – acoustic grating – Non-destructive testing – Pulse-echo system through transmission and reflection modes – A, B and C – scan displays.

UNIT III LASER **9**

Laser: Characteristics – Spontaneous and stimulated emission – Pumping methods – Optical Resonator – Active medium and Active center – Einstein's coefficient – Principles of Laser – population inversion- Components Laser systems - Types of laser – Nd – YAG laser, CO2 laser, Semiconductor lasers: homojunction and heterojunction - Industrial and medical application

UNIT IV FIBRE OPTICS **9**

Fiber optics – Principle, Numerical aperture and acceptance angle – types of optical fibers (material, refractive index, mode) – Attenuation, Dispersion – Fiber Optical Communication system (Block diagram) – Displacement sensors- Temperature/Pressure sensors –Optical fibers in computers - Medical Applications: Endoscope.

UNIT V QUANTUM MECHANICS **9**

Blackbody Radiation - Planck's quantum theory – Compton effect – Particle properties of wave: Matter waves, wave function – The Schrodinger equation (Time-dependent and time-independent forms) – Particle in an infinite potential well: One Dimensional Box –Qubit-Quantum computing – the role of Quantum computing in advancing Artificial intelligence.

THEORY: 45 PERIODS

PRACTICAL EXERCISES (FIVE ONLY)

1. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids.
2. Non-Uniform bending – Determination of Young's modulus.
3. Uniform bending – Determination of Young's modulus.
4. Laser – Determination of the wavelength of the laser using grating.
5. Optical fiber – Determination of Numerical Aperture and acceptance angle.
6. Acoustic grating – Determination of velocity of ultrasonic waves in liquids.
7. Michelson Interferometer.

PRACTICAL: 30 PERIODS
TOTAL: 75 PERIODS

COURSE OUTCOMES

After the completion of the course, students will be able to

CO1. Understand the importance of mechanics and express their knowledge in properties of matter

CO2. Analyze the applications of acoustics and ultrasonic in the engineering field.

CO3. Acquire knowledge in laser and its applications

CO4. Demonstrate a strong foundational knowledge in fiber optics.

CO5. Comprehend and apply quantum mechanical principles.

TEXT BOOKS

1. D. Kleppner and R. Kolenkow. An Introduction to Mechanics. McGrawHill Education (Indian Edition), 2017.
2. Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGraw – Hill (Indian Edition), 2017.
3. Gaur R.K. and Gupta S.L. Engineering Physics. Dhanpat Rai publishers, 2009.
4. Kasap, Safa, Capper, " Handbook of Electronic and Photonic Materials"2nd edition, Springer,2017.

5. Eleanor Rleffel and Wolfgang Polak, "Quantum computing a gentle introduction", 1st edition,The MIT press,2012.

REFERENCES

1. R. Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition),2009.

2. K. Thyagarajan and A. Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications, (Indian Edition), 2019.

3. D. Halliday, R. Resnick, and J. Walker. Principles of Physics, Wiley (Indian Edition), 2015.

4. Hugh D. Young, Roger A. Freedman, A. Lewis Ford, Searls and Zemansky University Physics, 2009.

5. David J. Griffiths, "Introduction to Quantum Mechanics", 2nd edition, Cambridge University Press, 2017.

WEB REFERENCES

1. Advanced Quantum Mechanics With Applications – https://nptel.ac.in/courses/115103104
2. Quantum Mechanics And Molecular Spectroscopy – https://nptel.ac.in/courses/104101126
3. Fiber Optic Communication Technology – https://nptel.ac.in/courses/108106167
4. Introduction To Photonics – https://nptel.ac.in/courses/108106135
5. Introduction To Laser – https://nptel.ac.in/courses/115102124
6. Biomedical Ultrasound - https://nptel.ac.in/courses/12110845.

Course Code	**Problem Solving Using C Programming**	L	T	P	C
CS4111		3	0	2	4

COURSE OBJECTIVES:

- To understand the basic programming constructs of C Language
- To develop C programming using arrays and strings
- To develop modular applications in C using functions and pointers
- To develop applications in C using structs and unions
- To do input/output and file handling in C

UNIT I Basics of C Programming 15

Introduction to programming paradigms – Structure of C program – Creating C programs – Variables, Keywords, Data types, Constants, Operators, input / output statements – Decision making statements – Looping with while, do-while, and for loops – Nested loops and loop control statements

Coding Exercises

1. Write a C program to find the sum of two integers entered by the user
2. Write a C program to check if a given number is even or odd
3. Write a C program to find the largest among three numbers using if-else statements

Problems-solving Assignments

1. Write a C program to calculate the factorial of a given positive integer using a loop
2. Write a C program to check if a given number is a prime number
3. Write a C program to find the GCD of two numbers using a function

UNIT II Arrays and Strings 15

Working with arrays: One dimensional array: declaration, initialization, and accessing elements – Two dimensional arrays: Declaration -Initialization – Accessing elements – Operations: Read – Print – Sum – Transpose, Strings in C: string functions and manipulation – linear and binary Search, Selection sort

Coding Exercises

1. Implement a program that finds the largest element in an array of integers
2. Write a C program to count the number of vowels and consonants in a given string
3. Write a program to reverse a string without using the standard string library functions

Problems-solving Assignments

1. Write a C program to merge two sorted arrays into a single sorted array
2. Write a C program to find the second largest element in an array
3. Write a program that finds the intersection of two arrays and stores the result in third array

UNIT III Functions and Pointers 15

Modular programming – Function prototype, function definition, function call, Built-in functions (string functions, math functions) – Recursion– Parameter passing: Pass by value, Pass by reference– Introduction to pointers and memory management – Pointer operators – Pointer arithmetic - Pointers and arrays

Coding Exercises

1. Write a C program to exchange the values of variables
2. Implement a recursive function to calculate the factorial of a given number

Problems-solving Assignments

1. Write a C program to sort an array of strings in alphabetical order using function
2. Create a program to implement a binary search algorithm to search for an element in a sorted array using recursion

UNIT IV Structure and Union 15

Structure – Nested structures – Pointer and Structures – Array of structures – Self-referential structures – Dynamic memory allocation – Singly linked list – Typedef – Union – Storage classes and Visibility

Coding Exercises

1. Write a C program to find the average and total marks of students using a structure

Problems-solving Assignments

1. Write a C program to create a structure representing a book with title, author, and publication year. Implement functions to add, display, and search for books in a library
2. Implement a program to manage a student database using structs, including functions to add, delete, and display student records

UNIT V File Processing 15

Files – Types of file processing: Sequential access, Random access – Sequential access file – Random access file – Command line arguments – Code optimization and best practices

Coding Exercises:

1. Create a program that reads data from a file and calculates the average of a set of numbers
2. Write a program to copy the contents of one file into another file

Problems-solving Assignments:

1. Write a C program to read student records from a file and calculate their total and percentage
2. Develop a program to read employee details from a file, sort them based on salary, and write the sorted data back to the file

Final Project (sample): Design a simple inventory management system for a small store using structs and file handling. The program should allow users to add, update, and delete items in the inventory and display the current stock

TOTAL (THEORY AND PRACTICAL): 75 PERIODS

COURSE OUTCOMES: After completion of the course, students will be able to:

CO1: Demonstrate knowledge on C Programming constructs
CO2: Design and implement applications using arrays and strings
CO3: Develop and implement modular applications in C using functions and pointers
CO4: Develop applications in C using structures and unions
CO5: Develop applications using sequential and random-access file processing

TEXT BOOKS

1. Kernighan, B.W and Ritchie, D.M, "The C Programming language", Second Edition, Pearson Education, 2015.
2. Paul Deitel and Harvey Deitel, "C How to Program", 9th edition, Pearson, 2021
3. E Balagurusamy, "Programming in ANSI C", Eighth Edition, McGraw Hill Education, 2019.

REFERENCE BOOKS

1. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.
2. Byron S. Gottfried, "Schaum's Outline of Theory and Problems of Programming with C", McGraw-Hill Education, 1996.
3. Peter van der Linden, "Expert C Programming", Pearson, 1994.
4. Reema Thareja, "Programming In C", Second Edition, Oxford University Press India, 2016.

Course Code	ELECTRONIC DEVICES	L	T	P	C
EC4101		3	0	2	4

COURSE OBJECTIVES:

- To acquaint the semiconductor properties ,examine the formation of PN Junction diode and its characteristics
- To study the operation of Bipolar Junction Transistors(BJT)
- To study the operation of Junction Field Effect Transistors(FET)
- To study the operation of Metal Oxide Junction Field Effect Transistors(MOSFET)
- To learn the construction and operation of Power Electronic Devices

UNIT I SEMICONDUCTOR THEORY 9

Classification of semiconductors - Energy Band Diagram -Conductivity of a semiconductor-Carrier concentration–Mass action law – Properties of intrinsic semiconductors – diffusion and drift currents – Carrier lifetime – Continuity equation. Generation & Recombination, Einstein's Relation, Direct & Indirect Band gap Semiconductors. PN junction diode, Current equations, Forward and reverse bias characteristics, Transition and Diffusion Capacitances

UNIT II BJT AND ITS BIASING CIRCUITS 9

NPN -PNP -Operations- Input and Output characteristics of CE, CB - Hybrid -π model - h-parameter model- Early effect-Current equations- Need for biasing - DC Load Line and Bias Point – DC analysis of Transistor circuits - Various biasing methods of BJT Thermal stability - Stability factors

UNIT III JFET AND ITS BIASING 9

Construction, operation and characteristics of JFET – Characteristic parameters of JFET– Expression for saturation drain current – JFET - DC Load Line and Bias Point - Various biasing methods of JFET.

UNIT IV MOSFET AND ITS BIASING 9

Construction and operation of N-Channel and P-Channel MOSFET – Enhancement and depletion type MOSFET –Characteristics – Threshold voltage – Channel length modulation- MOS Capacitor- MOSFET - DC Load Line and Bias Point - Various biasing methods of MOSFET.

UNIT V POWER ELECTRONIC DEVICES 9

Construction, Operation and characteristics of Zener diode, UJT, SCR, DIAC and TRIAC, Optoelectronic Devices: Photo diode, LED and solar cell. Rectifiers and Zener regulator

TOTAL: 45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. Characteristics of PN Junction Diode and Zener diode.
2. Half and Full Wave Rectifier with Filters.
3. Design of Zener Regulator.
4. Common Emitter input-output Characteristics.
5. Common Base input-output Characteristics.
6. JFET Drain current and Transfer Characteristics
7. MOSFET Drain current and Transfer Characteristics.
8. Characteristics of SCR and UJT.
9.Simulation of Device characteristics(Any Four)

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Explain the fundamental semiconductor theory, working principle of PN Junction Diode
CO2: Explain the working principle, construction and operation of BJT
CO3: Describe the construction, operation and applications of JFET
CO4: Examine the operation and characteristics of MOSFET
CO5: Describe the construction, operation and applications of Power Electronic Devices

Text Books:

1. Donald A Neaman, Semiconductor Physics and Devices, McGraw Hill, Fourth Edition, 2017.
2. Adel .S. Sedra, Kenneth C. Smith, "Micro Electronic Circuits", Oxford University Press, 7 th Edition, 2014.

References:

1. Robert.L. Boylestead, "Introductory Circuit Analysis", Pearson Education India, 12th Edition, 2014. David Bell, "Fundamentals of Electric Circuits", Oxford University press, 7thEdition, 2009.
2. Jacob Millman, Christos C. Halkias and SatyabrataJit, Electronic Devices and Circuits, McGraw Hill, Fourth Edition, 2015.
3. Robert Boylestad and Louis Nashelsky, Electron Devices and Circuit Theory, Pearson, Eleventh Edition, 2013.

Course Code	DIGITAL SYSTEM DESIGN	L	T	P	C
EC4102		3	0	2	4

COURSE OBJECTIVES:

- To present the fundamentals of digital circuits and simplification methods
- To practice the design of various combinational digital circuits using logic gates
- To bring out the analysis and design procedures for synchronous and asynchronous Sequential circuits
- To learn integrated circuit families.
- To introduce semiconductor memories and related technology

UNIT I BASIC CONCEPTS 9

Review of number systems-representation-conversions, Review of Boolean algebra-theorems, sum of product and product of sum simplification, canonical forms minterm and maxterm, Simplification of Boolean expressions-Karnaugh map, completely and incompletely specified functions, Implementation of Boolean expressions using universal gates, Tabulation methods.

UNIT II COMBINATIONAL LOGIC CIRCUITS 9

Problem formulation and design of combinational circuits - Code-Converters, Half and Full Adders, Binary Parallel Adder – Carry look ahead Adder, BCD Adder, Magnitude Comparator, Decoder, Encoder, Priority Encoder, Mux/Demux, Case study: Digital trans-receiver / 8 bit Arithmetic and logic unit, Parity Generator/Checker, Seven Segment display decoder

UNIT III SYNCHRONOUS SEQUENTIAL CIRCUITS 9

Latches, Flip flops – SR, JK, T, D, Master/Slave FF, Triggering of FF, Analysis and design of clocked sequential circuits – Design - Moore/Mealy models, state minimization, state assignment, lock - out condition circuit implementation - Counters, Ripple Counters, Ring Counters, Shift registers, Universal Shift Register. Model Development: Designing of rolling display/real time clock

UNIT IV ASYNCHRONOUS SEQUENTIAL CIRCUITS 9

Stable and Unstable states, output specifications, cycles and races, state reduction, race free assignments, Hazards, Essential Hazards, Fundamental and Pulse mode sequential circuits, Design of Hazard free circuits

UNIT V LOGIC FAMILIES AND PROGRAMMABLE LOGIC 9

Logic families- Propagation Delay, Fan - In and Fan - Out - Noise Margin - RTL ,TTL,ECL, MOS - Comparison of Logic families - Implementation of combinational logic/sequential logic design using standard ICs, PROM, PLA and PAL, basic memory, static ROM,PROM,EPROM,EEPROM EAPROM. **TOTAL: 45 PERIODS**

PRACTICAL EXERCISES: 30 PERIODS

1. Design of adders and subtractors & code converters.
2. Design of Multiplexers & Demultiplexers.
3. Design of Encoders and Decoders.
4. Design of Magnitude Comparators
5. Design and implementation of counters using flip-flops
6. Design and implementation of shift registers.

Course Outcomes:

At the end of the course the students will be able to

CO1: Use Boolean algebra and simplification procedures relevant to digital logic.

CO2: Design various combinational digital circuits using logic gates.

CO3: Analyze and design synchronous sequential circuits.

CO4: Analyze and design asynchronous sequential circuits.

CO5: Build logic gates and use programmable devices.

Text Books:

1. M. Morris Mano and Michael D. Ciletti, „Digital Design", Pearson, 5th Edition, 2013 Jacob Millman.

References:

1. Charles H. Roth, Jr, „Fundamentals of Logic Design", Jaico Books, 4th Edition, 2002.
2. William I. Fletcher, "An Engineering Approach to Digital Design", Prentice- Hall of India,1980.
3. Floyd T.L., "Digital Fundamentals", Charles E. Merril publishing company,1982.

Course Code	Heritage of Tamils	L	T	P	C
HS4101		1	0	0	1

UNIT I Language and Literature 3

Language Families in India – Dravidian Languages – Tamil as a Classical Language – Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature – Management Principles in Thirukural – Tamil Epics and Impact of Buddhism & Jainism in Tamil Land – Bakthi Literature Azhwars and Nayanmars – Forms of minor Poetry – Development of Modern literature in Tamil – Contribution of Bharathiyar and Bharathidhasan.

UNIT II Heritage – Rock Art Paintings to Modern Art – Sculpture 3

Hero stone to modern sculpture – Bronze icons – Tribes and their handicrafts – Art of temple car making – Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments – Mridhangam, Parai, Veenai, Yazh and Nadhaswaram – Role of Temples in Social and Economic Life of Tamils

UNIT III Folk and Martial Arts 3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance – Sports and Games of Tamils.

UNIT IV Thinai Concept of Tamils 3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature – Aram Concept of Tamils – Education and Literacy during Sangam Age – Ancient Cities and Ports of Sangam Age – Export and Import during Sangam Age – Overseas Conquest of Cholas.

UNIT V Contribution of Tamils to Indian National Movement and Indian Culture 3

Contribution of Tamils to Indian Freedom Struggle – The Cultural Influence of Tamils over the other parts of India – Self – Respect Movement – Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL: 15 PERIODS

TEXT – CUM – REFERENCE BOOKS

1. Social Life of Tamils (Dr. K.K. Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
2. Social Life of the Tamils – The Classical Period (Dr. S. Singaravelu) (Published by: International Institute of Tamil Studies.
3. Historical Heritage of the Tamils (Dr. S.V. Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
5. Keeladi – Sangam City Civilization on the banks of river Vaigai (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation)
6. Studies in the History of India with Special Reference to Tamil Nadu (Dr. K.K.Pillay) (Published by: The Author)

Course Code	**Employability Enhancement Skills – I**	L	T	P	C
ES4101		0	0	2	1

COURSE OBJECTIVES:

- To comprehend number classification, place value, prime factorization, and basic arithmetic operations.
- To solve problems involving factors, multiples, LCM, HCF, and progressions.
- To enhance reasoning skills with a focus on analogies, classifications, and coding-decoding.
- To understand and apply ratio and proportion concepts in problem-solving scenarios.
- To apply percentage calculations for profit, loss, discount, and interest, including GST and overhead expenses.

UNIT I Numbers 6

Introduction – Classification of numbers – Formation of Numbers (Small & Large) –Place Value – Face Value – Divisibility Rule – Prime, Composite Numbers – Prime Factorization – Number of factors – Number of factors (Odd & Even) – Sum of factors – Successors and Predecessors – Greatest Integer Value – Vedic Mathematics – Trailing Zeroes – Unit Digits– Remainder Theorem – Real Number – Rational Numbers: Integers, Fractions – Comparison of Numbers – Operations on fractions – Scientific Notation

UNIT II Problems on Letters, Numbers and Symbols 6

Factors and Multiples, LCM and HCF – Relationship between LCM and HCF – Factorial – Simplification – VBODMAS – Square, Square Root – Cube, Cube Root – Exponents & Powers (Surds and Indices) – Sequence & Series: Arithmetic Progression – Geometric Progression – Special Progression, Letter Series, Number Series, Alpha – Numeric Series, Continuous Pattern Series

UNIT III Verbal and Non – Verbal Reasoning 6

Verbal Reasoning – Analogy: Completing the Analogous pair, Direct Analogy, Choosing the Analogous pair, Double Analogy, Choosing a Similar Word, Detecting Analogies, Multiple word Analogy, Number Analogy, Alphabet Analogy – Classification: Odd Words and Numerals – Coding and Decoding: Letter, Number, Symbol, Matrix, Substitution, Deciphering Message Word, Number and Symbols. Non – Verbal Reasoning Figure Series – Missing figure, Incorrect

figure – Analogy: Similarity Related Pair, Similarity Related figures, unrelated figures, Group of figures.

UNIT IV Ratio and Proportion **6**

Introduction – Ratio – Proportion: Direct and Indirect – Unitary Method – Problems on Ages – Chain Rule – Partnership – Mixture or Allegation – Time and Work: Individual, Group, Efficiency, Wages – Pipes and Cistern: Inlet, Outlet, and Leakage

UNIT V Percentage **6**

Introduction – Percentages in real life – Profit and Loss – Discount – Simple Interest – Compound Interest – Relationship between Simple Interest and Compound Interest – Overhead Expenses and GST.

TOTAL: 30 PERIODS

COURSE OUTCOMES: After the completion of the course, students will be able to

CO1: Develop the arithmetic ability and properties of numbers that we use in day to day life,
CO2: Demonstrate the logic behind the formation of numbers, alphabet series.
CO3: Apply the reasoning methods logically and evaluate complex relationships between the variables and numbers.
CO4: Use the concept of ratios and proportion in ages and partnership problems.
CO5: Apply the shortcuts of the mathematical tricks to reduce the time duration in problem solving.

TEXT BOOKS

1. "Quantitative Aptitude for Competitive Examinations" by R.S. Aggarwal – 2022"
2. "Teach Yourself Quantitative Aptitude" by Arun Sharma – 2017
3. "A modern approach to verbal and non – verbal reasoning" by R.S. Aggarwal – 2017

REFERENCES

1. "Shortcuts in Mathematics" by Akhilesh Khare – 2016
2. "Vedic maths for competitive exams" by Ravi Shankar – 2016
3. "Quantitative Aptitude for Competitive Examination" by Abhijit Guha – 2017

Course Code	**NCC Credit Course***	L	T	P	C
		2	0	0	2

UNIT I NCC General **6**

Aims, Objectives & Organization of NCC (1)–Incentives (2)–Duties of NCC Cadet (1) – NCC Camps: Types & Conduct (2)

UNIT II National Integration and Awareness **4**

National Integration: Importance & Necessity (1) –Factors Affecting National Integration (1) – Unity in Diversity & Role of NCC in Nation Building (1) –Threats to National Security (1)

UNIT III Personality Development **7**

Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving (2) –Communication Skills (3) –Group Discussion: Stress & Emotions (2)

UNIT IV Leadership **5**

Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code (3) –Case Studies: Shivaji, Jhansi Ki Rani (2)

UNIT V Social Service and Community Development **8**

Basics, Rural Development Programmes, NGOs, Contribution of Youth (3) –Protection of Children and Women Safety (1) Road/ Rail Travel Safety (1) –New Initiatives (2) –Cyber and Mobile Security Awareness (1)

TOTAL:30 PERIODS

Levels:

Level	Activities
1 ARMY	II semester: The NCC cadets are fresh to NCC activities are provided with above curriculum / syllabus
2 NAVY	For the Higher semester cadets of IV semester the credits are awarded with the basic qualifying needs a) Minimum one Combined Annual training Camp (CATC) or Attachment Camp or Centrally Organised Camp has to be attended (camp certificate is required) b) Appeared for B Certificate Exam
3 AIR FORCE	For the Higher semester cadets of VI semester the credits are awarded with the basic qualifying needs a) Minimum one Combined Annual training Camp (CATC) or Attachment Camp or Centrally Organised Camp has to be attended (camp certificate is required) b) Appeared for C Certificate Exam

Semester II

Course Code	**Probability and Statistics (Common to all Program)**	L	T	P	C
MA4201		3	1	0	4

COURSE OBJECTIVES:

The main objectives of this course are to:

- To introduce the basic concepts of probability and distributions.
- To learn the basic concepts of two -dimensional random variables.
- To acquire the knowledge in random processes, stationary, Markov and Poisson process.
- To acquire the knowledge of testing of hypothesis for small and large samples this plays an important role in real life problems.
- To summarize the design of experiments in the field of agriculture.

UNIT I PROBABILITY AND RANDOM VARIABLES **12**

Probability: Axioms – Sample space – Events - Conditional Probability – Baye's Theorem - Discrete and continuous random variables - Moments - Moment generating functions - Standard distributions: Binomial - Poisson - Geometric - Uniform - Exponential and Normal distributions.

UNIT II TWO DIMENSIONAL RANDOM VARIABLES **12**

Joint distributions - Marginal and conditional distributions - Covariance - Correlation - linear regression - Transformation of random variables - Central limit theorem (excluding proof).

UNIT III RANDOM PROCESSES AND MARKOV CHAINS **12**

Random Processes: Introduction and Classification -Stationary Processes -Markov Processes - Poisson Processes -Discrete Parameter Markov Chains -Chapman-Kolmogorov Equations (Statement only) -Limiting Distributions.

UNIT IV TESTING OF HYPOTHESIS **12**

Sampling distributions - Estimation of parameters **-**Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means - Tests based on t, F and Chi-square distributions for mean, variance **-** Contingency table (test for independent) - Goodness of fit.

UNIT V DESIGN OF EXPERIMENTS **12**

One way and two-way classifications - Completely randomized design - Randomized block design - Latin square design.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to:

CO1: Understand the fundamental knowledge of the concepts of probability and have knowledge of Standard distributions which can describe real life phenomena.

CO2: Recognize the basic concepts of two - dimensional random variables and apply in engineering applications.

CO3: Develop the basic concepts of random processes which are widely used in engineering fields.

CO4: Apply the concept of testing of hypotheses for small and large samples in real life problems.

CO5: Investigate the design of experiments in the field of agriculture.

TEXT BOOKS:

1. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.
3. Ibe, O.C.," Fundamentals of Applied Probability and Random Processes ", 1st Indian Reprint, Elsevier, 2007.

REFERENCES:

1. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
2. Papoulis, A. and Unnikrishnapillai, S., "Probability, Random Variables and Stochastic Processes", McGraw Hill Education India, 4th Edition, New Delhi, 2010.
3. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2004.
4. Spiegel. M.R., Schiller. J. and Srinivasan, R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004.
5. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 8th Edition, 2007.

Course Code	Communicative English –II	L	T	P	C
HS4202		3	0	2	4

COURSE OBJECTIVES:

- To engage learners in meaningful language activities to improve their LSRW skills
- To enhance learners awareness of general rules of writing for specific audiences
- To help learners understand the purpose, audience, contexts of different types of writing
- To develop analytical thinking skills for problem solving in communicative contexts
- To cultivate the learners to understand job applications and interviews for internship and placements.

UNIT I Making Comparisons 9

Listening – Evaluative Listening: Advertisements, Product Descriptions, – Audio/ video Speaking–Marketing a product, Persuasive Speech Techniques. Reading – Reading advertisements, user manuals, brochures Writing – Letter to the editor; Compare and Contrast Essay Grammar – Impersonal passive voice; Prepositional phrases Vocabulary –Contextual meaning of words

UNIT II Expressing Casual Relations in Speaking and Writing 9

Listening – Listening to longer technical talks and completing–gap filling exercises. Listening technical information from podcasts Speaking –Describing and discussing the reasons of accidents or disasters based on news reports Reading – Reading longer technical texts/Novels Writing – Writing responses to complaints; Problem solution Essay
Grammar –Subject – Verb Agreement, Infinitive and Gerunds Vocabulary – Adverbs.

UNIT III Problem Solving 9

Listening–Watching movie scenes/documentaries depicting a technical problem and suggesting solutions. Speaking – Group Discussion (based on case studies), – techniques and Strategies. Reading – Case Studies, excerpts from literary texts, news reports etc. Writing – Checklists, Argumentative Essay Grammar –Error correction; If conditional sentences Vocabulary – Compound Words, Sentence Completion.

UNIT IV Reporting of Events and Research 9

Listening – Listening Comprehension based on news reports and documentaries. Speaking – Interviewing, Presenting an oral report, Mini presentations on select topics Reading – Newspaper articles Writing –Industrial visit Report, Accident Report, Survey Report Grammar– Reported Speech, Modals Vocabulary–Conjunctions, use of prepositions.

UNIT V The Ability to Put Ideas or Information Cogently 9

Listening – Listening to TED Talks, Presentations, Formal job interviews Speaking – Mock Interview, Making presentations with visual aids Reading – Company profiles, Statement of Purpose, (SOP), an excerpt of interview with professionals Writing –Job / Internship application – Cover letter with Resume Grammar – Numerical adjectives, Relative Clauses Vocabulary–Idioms.

List of Exercises: 30 Periods

1. Listening /Reading Comprehension
2. Introducing Oneself
3. Summary of a Podcast
4. Mini Presentation on General topic (ICT tools)

5. Autobiography of a famous Personality
6. Narrating an unforgettable event
7. Drafting an Email (printed format)
8. Developing a story using given Vocabulary
9. Group Discussion
10. Mock Interview

TOTAL (THEORY AND PRACTICAL): 75 PERIODS

COURSE OUTCOMES: After the completion of the course, students will be able to

CO1: Compare and contrast products and ideas in technical texts.
CO2: Identify cause and effects in events, industrial processes through technical texts
CO3: Analyze problems in order to arrive at feasible solutions and communicate them orally and in the written format.
CO4: Report events and the processes of technical and industrial nature.
CO5: Present their opinions in a planned and logical manner, and draft effective resumes in context of job search.

TEXT BOOKS

1. English for Engineers & Technologists (2020 edition) Orient Blacks wan Private Ltd. Department of English, Anna University.
2. English for Science & Technology Cambridge University Press 2021. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.
3. Professional English-II, V.K. Publications, Dr.S.N. Mahalakshmi.Revised Edition 2023

REFERENCES

1. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
2. Improve Your Writing. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, New Delhi.
3. Learning to Communicate–Dr.V. Chellammal. Allied Publishers, New Delhi,2003

Course Code	**ELECTRONIC CIRCUITS**	L	T	P	C
EC4201		3	0	2	4

COURSE OBJECTIVES:

- To understand the principles and characteristics of feedback amplifiers, including gain, feedback factor, and stability.
- To analyze the frequency response of amplifiers, focusing on transistor characteristics, bandwidth, and Miller effect.
- To explore the operation and analysis of tuned amplifiers, covering coil losses, Q factors, and bandwidth considerations.
- To study oscillators, including their classification, Barkhausen criterion, and frequency stability.
- To learn about wave shaping techniques and multivibrator circuits, including pulse circuits and Schmitt Triggers.

UNIT I BJT AMPLIFIERS AND ITS FREQUENCY RESPONSE 9

Small Signal Hybrid π equivalent circuit of BJT – Early effect - Analysis of CE, CC and CB amplifiers using Hybrid π equivalent circuits– Frequency response of transistor amplifiers with

circuit capacitors – BJT frequency response – short circuit current gain - cut off frequency – fα, fβ and unity gain bandwidth – Miller effect.

UNIT II FEEDBACK AMPLIFIERS 9

Basic concept of feedback - Gain with feedback - Feedback factor - General characteristics of negative feedback amplifiers - Effect of negative feedback on input and output resistance; topologies of feedback amplifiers - Analysis of series-shunt, series-series, shunt-series and shunt-shunt feedback amplifiers - Nyquist criterion for stability of feedback amplifiers - Gain and phase margin.

UNIT III OSCILLATORS 9

Classification of Oscillators - Barkhausen criterion for oscillation - RC phase shift, Wien bridge - General form of LC oscillator - Hartley, Colpitts and Clapp oscillator - Ring oscillators - Crystal oscillators – Equivalent circuit of crystal - Frequency stability of oscillator.

UNIT IV TUNED AMPLIFIERS 9

Coil losses, Unloaded and loaded Q of tank circuits, Small signal tuned amplifiers - Analysis of capacitor coupled single tuned amplifier - Double tuned amplifier(Qualitative Analysis only) - Effect of cascading single tuned and double tuned amplifiers on bandwidth - Stagger tuned amplifiers - Comparison of tuned amplifiers - Stability

UNIT V WAVE SHAPING AND MULTIVIBRATOR CIRCUITS 9

Pulse circuits – attenuators – RC integrator and differentiator circuits – diode clampers and clippers –Multivibrators - Schmitt Trigger- UJT Oscillator.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS 30 PERIODS

1.Frequency Response of CE amplifiers with and without feedback
2.Feedback amplifiers-Frequency response, Input and output impedance.
3.RC Phase shift oscillator
4. Wien Bridge Oscillator
5.Hartley oscillator
6. Clippers and Clampers
7. Schmitt Trigger
8. Astable Multivibrator
9. UJT Relaxation Oscillator
9. Design of Amplifiers, Oscillators using Simulation package tool

TOTAL: 75 PERIODS

Course Outcomes:

At the end of the course the students will be able to
CO1: Understand feedback principles in amplifiers.
CO2: Evaluate amplifier frequency responses.
CO3: Analyze tuned amplifier characteristics.
CO4: Design and analyze feedback amplifiers and oscillators
CO5: Design and analysis of wave shaping circuits and multivibrator

Text Books:

1. Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits, Oxford University Press, Seventh Edition, 2016.

2. Salivahanan S and Suresh Kumar N, Electronic Devices and Circuits, McGraw Hill Education, Fourth Edition, 2017.

Reference Books:

1. Millman J, Halkias C and Chetan D. Parikh, Integrated Electronics, McGraw Hill Education (India) Private Ltd., Second Edition, 2015.
2. Robert L. Boylestad and Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education, Eleventh Edition, 2016
3.David A. Bell, Electronic Devices and Circuits, Oxford University Press, Fifth Edition, 2017.

Course Code	**CIRCUIT ANALYSIS**	L	T	P	C
EC4202		3	0	2	4

COURSE OBJECTIVES:

- To learn the basic concepts and behaviour of DC and AC circuits.
- To understand various methods of circuit/ network analysis using network theorems.
- To understand the transient and steady state response of the circuits subjected to DC excitations and AC with sinusoidal excitations.
- To study the transients and resonance in RL, RC and RLC circuits
- To learn the concept of coupling in circuits and topologies.

UNIT I CIRCUIT ANALYSIS 9

Components of electric Circuits, Charge, current, Voltage and Power, Voltage and Current Sources, Ohms Law, Kirchoff's Current Law, Kirchoff's voltage law, The single Node – Pair Circuit, series and Parallel Connected Independent Sources, Resistors in Series and Parallel, voltage and current division, Nodal analysis, Mesh analysis.

UNIT II NETWORK THEOREM AND DUALITY 9

Circuit Analysis techniques - Linearity and superposition, Thevenin and Norton Equivalent Circuits, Maximum Power Transfer, Delta-Wye Conversion. Duals, Dual circuits. Analysis using dependent current sources and voltage sources.

UNIT III SINUSOIDAL STEADY STATE ANALYSIS AND RESONANCE 9

Sinusoidal Steady – State analysis , Characteristics of Sinusoids, The Complex Forcing Function, The Phasor, Phasor relationship for R, L, and C, impedance and Admittance, Nodal and Mesh Analysis, Phasor Diagrams, AC Circuit Power Analysis, Instantaneous Power, Average Power, apparent Power and Power, Factor, Complex Power. Frequency Response, Parallel Resonance, Series Resonance, Quality Factor.

UNIT IV TRANSIENTS RESPONSE AND COUPLED CIRCUITS 9

Basic RL and RC Circuits, The Source- Free RL Circuit, The Source-Free RC Circuit, The Unit-Step Function, Driven RL Circuits, Driven RC Circuits, RLC Circuits, Self inductance - Mutual inductance - Dot rule - Coefficient of coupling .

UNIT V NETWORK TOPOLOGY AND TWO PORT NETWORKS 9

An introduction to Network Topology, Trees and General Nodal analysis, Links and Loop analysis, Two port networks, Z parameters, Y parameters, Transmission (ABCD) parameters, Hybrid(H), Parameters, Interconnection of two port networks, Symmetrical properties of T and π networks

TOTAL : 45 PERIODS

PRACTICAL EXERCISES: **30 PERIODS**

1. Verifications of KVL & KCL.
2. Verifications of Thevenin & Norton theorem.
3. Verification of Superposition Theorem.
4. Verification of maximum power transfer Theorem
5. Determination of Resonance Frequency of Series & Parallel RLC Circuits.

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Apply the basic concepts of circuit analysis such as Kirchoff's laws, mesh current and node voltage method for analysis of DC and AC circuits.

CO2: Apply suitable network theorems and analyze AC and DC circuits

CO3: Analyze steady state response of any R, L and C circuits and frequency response of parallel and series resonance circuits.

CO4: Analyze the transient response for any RC, RL and RLC circuits and coupled circuits

CO5: Design circuits with two-port parameters, Symmetry and reciprocity

Text Books:

1. Hayt Jack Kemmerly, Steven Durbin, "Engineering Circuit Analysis", Mc Graw Hill education, 9th Edition, 2018.

2.Charles K. Alexander & Mathew N.O.Sadiku, "Fundamentals of Electric Circuits", McGrawHill, 2nd Edition, 2003.

3.Joseph Edminister and Mahmood Nahvi, —Electric Circuits, Schaum's Outline Series, Tata McGraw Hill Publishing Company, New Delhi, Fifth Edition Reprint 2016.

References:

1. Robert.L. Boylestead, "Introductory Circuit Analysis", Pearson Education India, 12th Edition, 2014. David Bell, "Fundamentals of Electric Circuits", Oxford University press, 7thEdition, 2009.
2. John O'Malley Schaum's Outlines "Basic Circuit Analysis", The Mc Graw Hill companies, 2nd Edition, 2011.
3. Allan H.Robbins, Wilhelm C.Miller, —Circuit Analysis Theory and Practice‖, Cengage Learning, Fifth Edition, 1st Indian Reprint 2013.

Course Code	**Data Structures and Algorithms Using C**	L	T	P	C
CS4211		3	0	2	4

COURSE OBJECTIVES:

- To understand the basic concepts of linear data structures like arrays and linked lists.
- To grasp the concept of stacks and queues as a linear data structure and the operations upon them.
- To understand the fundamental concepts of hierarchical Tree data structures.
- To explore optimization strategies for indexing structures and graph algorithms.
- To understand the concept of searching for quick data retrieval, sorting for arranging data, hash functions strategies for optimized data storage.

UNIT I Lists 12

Abstract Data Types (ADTs) – List ADT – Array-based implementation – Linked list implementation – Singly linked lists – Circularly linked lists – Doubly-linked lists – Applications of lists – Polynomial ADT – Radix Sort – Multilists.

Coding Exercises:

1. Write a C programs to implement single linked list ADT to perform following operations.
   a) insert an element into a list.
   b) delete an element from list.
   c) search for a key element in list.
   d) count number of nodes in list.
2. Write a C programs to implement doubly linked list ADT to perform following operations.
   a) insert an element into a list at the end.
   b) delete middle element from list.
   c) print the element in reverse order.
3. Write a C programs to Perform Polynomial Addition using singly linked list.

Problems-solving Assignments:

1. Write a program to multiply every element of the linked list with 10.
2. Write a program to input an n digit number. Now, break this number into its individual digits and then store every single digit in a separate node thereby forming a linked list.

UNIT II Stacks and Queues 12

Stack ADT – Operations – Applications – Balancing Symbols – Evaluating arithmetic expressions- Infix to Postfix conversion – Function Calls – Queue ADT – Operations – Circular Queue – DeQueue – Applications of Queues.

Coding Exercises:

1. Write a C programs to implement a stack operations push, pop, top, and is Empty using a linked list.
2. Write a C programs to implement a queue operations enqueue, dequeue, front, is Empty using a linked list.
3. Write C programs to Convert Infix to Postfix Expression using Stack ADT.

Problems-solving Assignments:

1. Write a program to implement a stack that stores names of students in the class.
2. Write a program to implement a stack using a linked list
3. Write a program to create a queue which permits insertion at any vacant location at the rear end.

UNIT III Trees 12

Tree ADT – Tree Traversals – Binary Tree ADT – Expression trees – Binary Search Tree ADT- AVL Trees – Splay trees- Red Black Tree -Priority Queue (Heaps) – Binary Heap.

Coding Exercises:

1. Write a C programs to implement a binary search tree with the following operations:
   a. Insert an element into a binary search tree.
   b. Delete an element from a binary search tree.
   c. Search for a key element in a binary search tree.
2. Write a C programs that use recursive functions to traverse the given binary tree.
   a) Preorder b) inorder c) postorder.
3. Write C programs to implement an AVL Tree.

Problems-solving Assignments:
1. Write a C program for a Splay Tree for insertion and search operations.
2. Write a C program to implementation the insertion operation for a Red-Black Tree.
3. Write a C program a Max-Heap data structure operations insert(), extractMax(), and getMax().

UNIT IV Indexing and Graphs 12

Indexing-B-Tree – B+ Tree. Graph Definition – Representation of Graphs – Types of Graphs – Breadth-first traversal – Depth-first traversal – Bi-connectivity – Euler circuits – Topological Sort – Dijkstra's algorithm – Minimum Spanning Tree – Prim's algorithm – Kruskal's algorithm.

Coding Exercises:
1. Write a C program that demonstrates B-Tree operation insertion, search, and display.
2. Write a C program for Dijkstra's single source shortest path algorithm.
3. Write a C program for Prim's Minimum Spanning Tree (MST) algorithm.

Problems-solving Assignments:
1. Write a C program that demonstrates Breadth-First Traversal (BFS) in a graph using an adjacency list representation.
2. Write a C program that demonstrates topological sorting using Depth-First Search (DFS) on a directed acyclic graph.
3. Write a C program that demonstrates Kruskal's algorithm for finding the Minimum Spanning Tree (MST) of a graph.

UNIT V Searching, Sorting and Hashing Techniques 12

Searching – Linear Search – Binary Search. Sorting – Bubble sort – Selection sort – Insertion sort – Shell sort –. Merge Sort – Quick Sort. Hashing – Hash Functions – Separate Chaining – Open Addressing – Rehashing – Extendible Hashing.

Coding Exercises:
1. Write a C program to implement binary search using a recursive function.
2. Write a C program to implement the Insertion Sort algorithm.
3. Write a C program to implement the separate chaining technique in hashing.

Problems-solving Assignments:
1. Write a C program to implement the linear search algorithm using a nonrecursive approach.
2. Write a C program to implement the Quick Sort algorithm.
3. Write a C program to implement a hash table with rehashing.

TOTAL (THEORY AND PRACTICAL): 60 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES: After successful completion of the course, the students will be able to
CO1: Articulate linear data structures and legal operations permitted on them.
CO2: Implement stack and queue using array and linked list.
CO3: Articulate Tree data structures and legal operations permitted on them.

CO4: Understand the indexing and graph concepts and applications to solve different real time problems.
CO5: Apply a suitable algorithm for searching, sorting and hashing.

TEXT BOOKS

1. Mark Allen Weiss, — Data Structures and Algorithm Analysis in C, Second Edition, Pearson Education, 1996
2. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, —Fundamentals of Data Structures in C, Second Edition, University Press, 2008.
3. Data Structures Using C-Aaron M. Tenenbaum, Yedidyah Langsam, Moshe Augenstein, Pearson Education, 2018.

REFERENCES:

1. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, —Data Structures and Algorithms, Pearson Education, Revised Edition 2010.
2. Robert Kruse, C.L.Tondo, Bruce Leung, Shashi Mogalla, — Data Structures and Program Design in C, Second Edition, Pearson Education, 2007
3. Jean-Paul Tremblay and Paul G. Sorenson, —An Introduction to Data Structures with Applications, Second Edition, Tata McGraw-Hill, 1991.

Course Code	**C++ Programming**	L	T	P	C
CS4213		3	0	2	4

COURSE OBJECTIVES:

- To learn the concepts of object-oriented programming using C++
- To explore function overloading and constructors in C++
- To gain knowledge of the concepts inheritance and polymorphism in C++
- To gain comprehension about the concepts exception handling in C++
- To learn the concepts Files in C++

UNIT I OBJECT ORIENTED PROGRAMMING FUNDAMENTALS 9

C++ Programming features - Data Abstraction - Encapsulation - class - object - constructors – static members – constant members – member functions – pointers – references - Role of this pointer – Storage classes – function as arguments.

Coding Exercises:

Implement a C++ program to print half pyramid using '*'.
Write a C++ program to find the GCD (Greatest Common Divisor) of two numbers using a function.
Write a C++ program to check if a given number is a prime number.

Problems-solving Assignments:

Write a C++ program to calculate the factorial of a given positive integer using a loop.
Implement electricity bill using C++.

UNIT II FUNCTION OVERLOADING AND CONSTRUCTORS 9

Function Overloading – Overloading Constructors – Copy Constructors – Finding the address of

overloaded Function– Default Function Arguments– Function Overloading and Ambiguity.

Coding Exercises:

Implement a C++ program to create a class called “simple class”. Create a constructor and destructor for this class called simple class.
Implement a C++ program for a Copy Constructor. Create a Person class with a name and an age and create a copy constructor to create a new object with the same name and age as the source object.
Implement a C++ program for Overloading Functions with Different Number of Parameters for addition in a calculator.

Problems-solving Assignments:

Write a C++ program to sort an array of strings in alphabetical order Implement a recursive function to calculate the factorial of a given number using c++
Write a C++ program to reverse a linked list.

UNIT III INHERITANCE AND POLYMORPHISM 9

Inheritance: Base-Class Access Control – Inheritance and Protected Members – Inheriting Multiple Base Classes – Constructors, Destructors and Inheritance – Granting Access – Virtual Base Classes. Virtual functions and Polymorphism: Virtual Functions – Virtual Attribute and Inheritance – Virtual Functions and Hierarchy – Pure Virtual Functions – Using Virtual Functions – Early vs. Late Binding. Run-Time Type ID and Casting Operators: RTTI
Casting Operators – Dynamic Cast.

Coding Exercises:
Implement a C++ program for Inheritance for calculating the area of a triangle.
Implement a C++ program that demonstrates polymorphism using a basic example of shapes.

Problems-solving Assignments:

Design a class hierarchy for a university. Create a base class Person with attributes like name, age, and gender. Derive classes Student and Professor from the base class. Implement methods to display information about each person type. Use polymorphism to create an array of Person pointers containing both students and professors and display their information.

Create a base class called Employee with attributes like name and salary. Derive two classes, Manager and Worker, from the base class. The Manager class should have an additional attribute for bonus, while the Worker class should have an attribute for hours worked and an hourly wage. Implement virtual methods for calculating the total earnings (salary + bonus for managers, hourly wage * hours worked for workers). Create instances of managers and workers and display their total earnings.

UNIT IV TEMPLATES AND EXCEPTION HANDLING 9

Templates: Generic Functions – Applying Generic Functions – Generic Classes – Type name and Export Keywords – Power of Templates. Exception Handling: Fundamentals – Handling Derived Class Exceptions – Exception Handling Options – Understanding terminate() and unexpected() – uncaught exception() Function – Exception and bad exception Classes – Applying Exception Handling.

Coding Exercises:

1. Class Templates – Define a template for example stack. Define a template parameter typename T which will represent the data type that the stack will hold. Define the class methods push, pop, empty and size having their respective data types. Create two instance of the stack in the main function, one for integers and the other for double. Perform stack operations.

Create a max function template using template keyword. Create a template parameter using the declaration <typename T>. this template should act as place holder for the actual type that will be used when the function is instantiated. The max function created takes two parameters of the type T and should return the maximum of two values. Create a main function. This template should be used by calling both integer and double values.

In this program, the try block contains the code that might potentially raise an exception. In this case, it attempts to perform a division operation and throws a std::runtime_error exception if the denominator is zero. The catch block catches any exception of type std::exception (or its derived classes) and displays an error message.

Using c++ programming perform division based on user inputs for numerator and denominator. If the user enters a denominator of 0, a std::runtime_error exception must be thrown with a custom error message. The try block must contain the code that might throw an exception, and the catch block must catch the exception and display the error message using the what() function of the exception object. Regardless of whether an exception is thrown or not, the program must continue executing after the exception handling block.

Problems-solving Assignments:

Define a custom exception class called "Negative Number Exception." Write a program that takes an integer as input. If the input is negative, throw an instance of this custom exception. Use a try-catch block to catch and handle the custom exception, displaying an error message.

Create a program that performs a division of two integers, but this time within a loop that allows the user to keep trying until they provide valid input. Use nested try-catch blocks to handle exceptions at different levels of the program's execution.

UNIT V I/O STREAMS 9

File I/O-fstream and the File Classes-Opening and Closing a File-Reading and Writing Text Files-Unformatted and Binary I/O. Namespaces: Namespaces – std namespace.

Coding Exercises:

1. Implement a c++ program which includes the necessary header files: <iostream> for input/output operations and <fstream> for file stream operations. Use an ofstream object to write data to the file named "output.txt". There should be a check if the file is opened successfully. Use << operator to write data to the file, and use close() method for closing the file. Use ifstream object to read data from the same file, use close() method for closing the file. The program must return 0 to indicate successful execution.

Problems-solving Assignments:

- Write a C++ program to read student records from a file and calculate their total and

percentage
- Develop a program to read employee details from a file, sort them based on salary, and write the sorted data back to the fileFinal Project:
- Design a program to manage a library's inventory, allowing users to add, remove, and search for books, while also keeping track of borrowed and returned books.
- Develop a system that simulates basic bank account operations like deposits, withdrawals, and balance inquiries. You could use classes to model accounts.
- Design a simple inventory management system for a small store using structs and file handling. The program should allow users to add, update, and delete items in the inventory and display the current stock

TOTAL: 75 PERIODS

COURSE OUTCOMES:

On completion of this course, the students will be able to:

CO1 Implement basic concepts of structures, union and pointers using C++
CO2 Implement function overloading and constructors using C ++
CO3 Implement inheritance and polymorphism using C ++
CO4 Implement templates and exception handling using C ++
CO5 Implement I/O streams using C ++ and develop simple applications.

TEXTBOOKS:

1. Herbert Schildt, "C++: The Complete Reference", 5th Edition, Tata Mc-Graw Hill Publishers, 2014.
2. Paul Deitel, Harvey Deitel, "C++ How to Program", 8th Edition, Prentice Hall Publisher, 2016.
3. Trivedi, Bhushan "Programming with ANSI C++", 2nd Edition, Oxford University Press NASW Press, 2013.

REFERENCES:

1. Ira Pohl, "Object Oriented Programming using C++", 2nd Edition, Pearson Education, Reprint, 2004.
2. S. B. Lippman, Josee Lajoie, Barbara E. Moo, "C++ Primer", 4th Edition, Pearson Education, 2012.
3. Bjarne Stroustrup, "The C++ Programming language", 4th Edition, Pearson Education, 2013.

Course Code	**Tamils And Technology**	L	T	P	C
HS4201		1	0	0	1

UNIT I Weaving and Ceramic Technology 3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II Design and Construction Technology 3

Designing and Structural construction House & Designs in household materials during Sangam Age – Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram – Sculptures and Temples of Mamallapuram – Great Temples of Cholas and other worship places – Temples of Nayaka Period – Type study (Madurai Meenakshi Temple) – Thirumalai Nayakar Mahal – Chetti Nadu Houses, Indo – Saracenic architecture at Madras during British Period.

UNIT III **Manufacturing Technology** **3**

Art of Ship Building – Metallurgical studies – Iron industry – Iron smelting, steel – Copper and gold Coins as source of history – Minting of Coins – Beads making – industries Stone beads – Glass beads – Terracotta beads – Shell beads/ bone beats – Archeological evidences – Gem stone types described in Silappathikaram.

UNIT IV **Agriculture and Irrigation Technology** **3**

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry – Wells designed for cattle use – Agriculture and Agro Processing – Knowledge of Sea – Fisheries – Pearl – Conche diving – Ancient Knowledge of Ocean – Knowledge Specific Society.

UNIT V **Scientific Tamil & Tamil Computing** **3**

Development of Scientific Tamil – Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries –Sorkuvai Project.

TOTAL: 15 PERIODS

TEXT – CUM – REFERENCE BOOKS

1. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL
2. Social Life of the Tamils – The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
3. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
5. Keeladi – 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
6. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay)
7. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
8.Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL)

Course Code	**Employability Enhancement Skills – II**	L	T	P	C
ES4201		0	0	2	1

COURSE OBJECTIVES:

- To master time, distance, and speed concepts to facilitate problem-solving in various scenarios.
- To apply probability and statistics principles to analyze data and solve practical problems.
- To develop arithmetic and logical reasoning skills to enhance efficient problem-solving.
- To apply applied mathematics concepts to solve problems related to shapes, volumes, and angles.
- To enhance verbal and logical reasoning abilities to enable effective problem-solving in diverse scenarios.

UNIT I Time and Distance 6

Introduction – Speed: Late / Early / Usual Time – Average Speed – Chasing – Problems on Train: Crossing Pole, Crossing Platform, Train moving in same and different direction – Boats and Streams: Upstream, Downstream – Clock – Calendar.

UNIT II Probability and Statistics 6

Introduction – Algebra of Events – Addition theorem of Probability – Permutation and Combinations – Problems based on choosing the objects – Statistics: Range – frequency, Arithmetic Mean – Median – Mode – Variance – Standard Deviation – Measures of Dispersion – Coefficient of Variation.

UNIT III Arithmetic and Logical Reasoning 6

Introduction – Mathematical Operations – Blood Relations: Direct, Indirect, coded – Problems on Cubes and Dices: Face identification – Folding and cutting Images – Counting technique of figures – Distance & Direction

UNIT IV Applied Mathematics 6

Mensuration (2D&3D): Square, Rectangle, Triangle, Circle, Parallelogram, Rhombus, Trapezoid, Quadrilateral, Cube, Cuboid, Cylinder, Cone, Sphere, Miscellaneous – Trigonometry: Ratio, Identities, Heights and Distances – Algebra – Logarithm – Geometry.

UNIT V Verbal and Logical Reasoning 6

Introduction – Venn diagram – Syllogism – Data Sufficiency – Decision Making – Puzzle: Number Puzzle, Letter Puzzle – Ranking Test – Data Arrangement: Linear, Circular, Miscellaneous – Critical Reasoning.

TOTAL: 30 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES: After the completion of the course, students will be able to

CO1: Use their logical thinking and analytical abilities to solve Quantitative aptitude questions from company specific and other competitive tests.

CO2: Solve questions related to Time etc. from company specific and other competitive tests.

CO3: Illustrate and solve puzzle related questions from specific and other competitive tests

TEXT BOOKS:

1. "Quantitative Aptitude for Competitive Examinations" by R.S. Aggarwal – 2022"
2. "Teach Yourself Quantitative Aptitude" by Arun Sharma – 2017
3. "A modern approach verbal and non – verbal reasoning" by R.S. Aggarwal – 2017

REFERENCES:

1. "Shortcuts in Mathematics" by Akhilesh Khare – 2016
2. "Vedic maths for competitive exams" by Ravi Shankar – 2016
3. "Quantitative Aptitude for Competitive Examination" by Abhijit Guha – 2017

Semester III

Course Code	Mathematical Methods for Engineering (Common to B.E - CIVIL, MECH, MCT, EEE, ECE, EC(ACT) and EE(VLSI))	L	T	P	C
MA4301		3	1	0	4

COURSE OBJECTIVES:

The main objectives of this course are to:

- To familiarize the students with complex integration techniques and contour integration techniques which can be used in real integrals.
- To apply the concept of Laplace transforms in engineering problems.
- To introduce the concepts of Z transforms.
- To learn the basic concepts of Fourier series and Fourier transforms.
- To use the numerical techniques of differentiation and integration in engineering and technology disciplines.

UNIT I ANALYTIC FUNCTION & COMPLEX INTEGRATION 12

Analytic functions - Cauchy-Riemann equations (statement only) - Complex integration - Cauchy's integral theorem - Cauchy's integral formula - Taylor's and Laurent's series - Zeros - Singular points - Residues - Cauchy's residue theorem (statement only) - Evaluation of contour integrals on simple closed curves.

UNIT II LAPLACE TRANSFORMS 12

Existence conditions - Transforms of elementary functions - Transform of unit step function and unit impulse function - Basic properties - Shifting theorem - Transforms of derivatives and integrals - Initial and final value theorem - Inverse transforms - Convolution theorem - Transform of periodic functions - Application - solution of linear second order ordinary differential equations with constant coefficients.

UNIT III Z-TRANSFORMS 12

Elementary properties - Inverse Z-transform (using partial fraction and residues) - Initial and final value theorems - Convolution theorem - Formation of difference equations - Solution of difference equations using Z - transform.

UNIT IV FOURIER SERIES 12

Dirichlet's conditions – General Fourier series – Odd and even functions – Change of interval - Half range Sine series –Half range Cosine series – Complex form of Fourier series – Parseval's identity – Harmonic analysis.

UNIT V FOURIER TRANSFORMS 12

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to:

CO1: Evaluate real and complex integrals using the Cauchy's integral formula and residue theorem.

CO2: Apply Laplace transform and inverse transform of simple functions, properties, various related problems.
CO3: Understand the characteristics and properties of Z – transform.
CO4: Recognize the concepts of Fourier series and Fourier Transform and applying engineering problems.
CO5: Develop the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration in Engineering problems.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi,43rd Edition, 2014.
2. Kreyszig Erwin, "Advanced Engineering Mathematics", John WileyandSons,10th Edition, New Delhi, 2016.
3. Sankara Rao . K, "Numerical Methods for Scientists and Engineers", PHI Learning Pvt Ltd., New Delhi, 2007.

.

REFERENCES:

1. Weir, M.D and Joel Hass, "Thomas Calculus", 12th Edition, Pearson India, 2016
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3rd Edition, 2007.
3. Bali N., Goyal M. and Watkins C., Advanced Engineering Mathematics||, Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
4. O'Neil, P.V. Advanced Engineering Mathematics, Cengage Learning India Pvt., Ltd, New Delhi, 2007.
5. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.

S. Ponnusamy, "Foundations of Complex Analysis" 2nd Edition, Narosa Publishing House, 2014.

Course Code	**ANALOG AND DIGITAL COMMUNICATION**	L	T	P	C
VD4301		3	0	0	3

- **COURSE OBJECTIVES:**
- To introduce the concepts of various analog modulations and their spectral characteristics
- To understand the properties of random process.
- To understand the various band pass signaling schemes and Pulse Modulation Techniques.
- To study the limits set by Information Theory.
- To know the fundamentals of channel coding.

UNIT I **ANALOG MODULATION** 9

Amplitude Modulation- DSBSC, DSBFC, SSB, VSB - Modulation index, Spectra, Power relations and Bandwidth – AM Generation – DSBSC Generation, SSB Generation, VSB Generation, Pre-envelope & complex envelope, Superheterodyne Receiver, Phase and frequency modulation, Narrow Band and Wide band FM - FM modulation, FM Demodulation – FM to AM conversion, FM Discriminator - PLL as FM Demodulator

UNIT II **RANDOM PROCESS & SAMPLING** 9

Random variables, Random Process, Stationary Processes, Mean, Correlation & Covariance functions, Autocorrelation and Power Spectral Density, Ergodic Processes, Properties of white noise, Transmission of a Random Process Through a LTI filter.

Low pass sampling – Aliasing- Signal Reconstruction-Quantization - Uniform & non-uniform quantization - quantization noise - Nyquist criterion

UNIT III PULSE MODULATION 9

Types of Pulse modulation- PAM, PWM and PPM. Comparison of FDM and TDM. PCM, Prediction filtering and DPCM - Delta Modulation - ADPCM & ADM principles.

UNIT IV DIGITAL MODULATION TECHNIQUES 9

ASK- Modulator, Coherent ASK Detector, FSK- Modulator, Non- Coherent FSK Detector, BPSK- Modulator, Coherent BPSK Detection. Principles of QPSK, Differential PSK and QAM, Baseband Signal Receiver, Probability of Error, ML Detection, Matched filter receiver, Coherent Reception, ISI, Eye Diagrams.

UNIT V SOURCE AND ERROR CONTROL CODING 9

Entropy, Source Encoding Theorem, Shannon Fano Coding, Huffman Coding, Mutual Information, Channel Capacity, Error Control Coding, Linear Block Codes, Cyclic Codes, Convolutional codes - Viterbi Decoder.

TOTAL: 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Design Analog Modulation communication systems

CO2: Apply the concepts of Random Process to the design of Communication systems.

CO3: Describe the pulse communication systems

CO4: Analyze the spectral characteristics of band pass signaling schemes and their noise performance

CO5: Design error control coding schemes

Text Books:

1. J.G.Proakis, M.Salehi, —Fundamentals of Communication Systems, Pearson Education 2014.
2. Simon Haykin, —Communication Systems , 4th Edition, Wiley, 2014.

References:

1. J.G Proakis, —Digital Communication , 4th Edition, Tata Mc Graw Hill Company, 2001.
2. D.Roody, J.Coolen, —Electronic Communications, 4th edition PHI 2006.
3. H P Hsu, Schaum Outline Series - —Analog and Digital Communications TMH 2006.
4. B.P.Lathi, —Modern Digital and Analog Communication Systems 3rd Edition, Oxford University Press 2007.
5. A.Papoulis, —Probability, Random variables and Stochastic Processes , McGraw Hill, 3rd edition, 1991.

Course Code	CMOS VLSI DESIGN	L	T	P	C
VD4302		3	0	2	4

COURSE OBJECTIVES:

- To study the core principles of CMOS circuits and their inherent characteristics.
- To develop proficiency in designing and implementing combinational and sequential digital circuits.
- To explore architectural decisions and performance trade-offs inherent in circuit design.
- To discuss the implementation of circuits using CMOS technology, considering real-world applications and constraints.
- To introduce the design and implementation of digital circuits using programming tools.

UNIT I MOS TRANSISTOR THEORY 9

MOS Transistor, CMOS logic, Inverter, Pass Transistor, Transmission gate, Layout Design Rules, Gate Layouts, Stick Diagrams, Long-Channel I-V characteristics, C-V characteristics, Non ideal I-V Effects, DC Transfer characteristics, Scaling.

UNIT II COMBINATIONAL CMOS LOGIC CIRCUITS 9

RC Delay Model, Elmore Delay, Linear Delay Model, Logical effort, Parasitic Delay, Delay in Logic Gate, Static CMOS, Ratioed Circuits, Cascode Voltage Switch Logic, Dynamic Circuits, Domino, Dual Rail Domino, CPL, DCVSPG,DPL, Circuit Pitfalls. Static and Dynamic Power Dissipation.

UNIT III SEQUENTIAL CMOS LOGIC CIRCUITS 9

Static Latches and Registers, Dynamic Latches and Registers, Pipelining, Non Bistable Sequential Circuits. Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design.

UNIT IV INTERCONNECT, ARITHMETIC CIRCUITS AND MEMORY ARCHITECTURE 9

Interconnect Parameters – Capacitance, Resistance, and Inductance, Electrical Wire Models. Sequential digital circuits: adders, multipliers, shift registers, power and speed tradeoffs. Memory Architecture and Building Blocks,Memory Core and Memory Peripherals Circuitry.

UNIT V VERILOG HARDWARE DESCRIPTION LANGUAGE 9

Overview of digital design with Verilog HDL – Hierarchical modeling concepts– Modules and port definitions, Data Types and Operators – Gate level, Data flow and Behavioral Modeling-Realization of combinational and sequential circuits using Verilog– Test bench.

TOTAL: 45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

Digital Circuit Design using EDA Tools

1. Design an CMOS Inverter with given specifications.
2. Design the logic gates using CMOS and verify its functionality.
3. Comparison of Area, Power, Delay of CMOS, Pseudo NMOS, Dynamic, Domino Logic, CVSL logic of any combinational circuit
4. Design the following digital circuits and verify the functionality
   a) 3-8 decoder using MOS technology
   b) Two-input OR gate using two input NOR gate and inverter
5. Design of 6T SRAM cell using CMOS.

Digital System Design using HDL and FPGA

6. Design an Adder (Min 8 Bit) using HDL. Simulate it using Xilinx and implement it in FPGA.
7. Design a Multiplier (4 Bit Min) using HDL. Simulate it using Xilinx and implement in FPGA.
8. Design an ALU using HDL. Simulate it using Xilinx and implement in FPGA.
9. Design a Universal Shift Register using HDL. Simulate it using Xilinx and FPGA.
10. Design Finite State Machine (Moore/Mealy) using HDL. Simulate it using Xilinx and FPGA.
11. Design Memories using HDL. Simulate it using Xilinx Software and implement it in FPGA.

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Understand the structure, operation, and characteristics of CMOS circuits.

CO2: Develop skills in designing and implementing combinational and sequential digital circuits using CMOS technology.

CO3: Evaluate and optimize architectural decisions and performance trade-offs in circuit design.

CO4: Apply CMOS technology principles to design circuits for real-world applications, considering constraints.

CO5: Utilize programming tools for the design and implementation of digital circuits.

Text Books:

1. Neil H.E. Weste, David Money Harris —CMOS VLSI Design: A Circuits and Systems Perspective, 4th Edition, Pearson , 2017.
2. Jan M. Rabaey, Anantha Chandrakasan, Borivoje. Nikolic, Digital Integrated Circuits:A Design perspective, Second Edition , Pearson , 2016.
3. Samir Palnitkar, "Verilog HDL", 2nd Edition, Pearson Education, 2009.

References:

1. John P.Uyemura, Introduction to VLSI circuits and systems, John Wiley, 2016.
2. Kamran Eshraghian, Douglas A. Pucknell, Essentials of VLSI Circuits and Systems Prentice Hall of India, 2015.
3. Kang and Yusuf Leblebici, CMOS Digital Integrated Circuits, Tata McGraw Hill, 2014.

Course Code	MICROPROCESSORS AND MICROCONTROLLERS	L	T	P	C
EC4302		3	0	2	4

COURSE OBJECTIVES:

- To understand the Architecture of 8086 microprocessors.
- To learn the design aspects of I/O and Memory Interfacing circuits.
- To interface microprocessors with supporting chips.
- To study the Architecture of 8051 microcontrollers.
- To design a microcontroller-based system

UNIT I THE 8086 MICROPROCESSOR 9

Introduction to 8086 – Microprocessor architecture – Addressing modes - Instruction set and assembler directives – Assembly language programming – Modular Programming - Linking and Relocation - Stacks - Procedures – Macros – Interrupts and interrupt service routines – Byte and String Manipulation.

UNIT II 8086 SYSTEM BUS STRUCTURE 9

8086 signals – Basic configurations – System bus timing –System design using 8086 – I/O

programming – Introduction to Multiprogramming – System Bus Structure – Multiprocessor configurations – Coprocessor, Closely coupled and loosely Coupled configurations – Introduction to advanced processors.

UNIT III I/O INTERFACING 9

Memory Interfacing and I/O interfacing - Parallel communication interface – Serial communication interface – D/A and A/D Interface - Timer – Keyboard /display controller – Interrupt controller – DMA controller – Programming and applications Case studies: Traffic Light control, LED display , LCD display, Keyboard display interface and Alarm Controller.

UNIT IV MICROCONTROLLER 9

Architecture of 8051 – Special Function Registers(SFRs) - I/O Pins Ports and Circuits - Instruction set - Addressing modes - Assembly language programming.

UNIT V INTERFACING MICROCONTROLLER 9

Programming 8051 Timers - Serial Port Programming - Interrupts Programming – LCD & Keyboard Interfacing - ADC, DAC & Sensor Interfacing - External Memory Interface- Stepper Motor and Waveform generation - Comparison of Microprocessor, Microcontroller, PIC and ARM processors

TOTAL: 45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

8086 Programs using kits and MASM

1. Basic arithmetic and Logical operations
2. Move a data block without overlap
3. Code conversion, decimal arithmetic and Matrix operations.
4. Floating point operations, string manipulations, sorting and searching
5. Password checking, Print RAM size and system date
6. Counters and Time Delay

Peripherals and Interfacing Experiments

7. Traffic light controller
8. Stepper motor control
9. Digital clock
10. Key board and Display
11. Printer status
12. Serial interface and Parallel interface
13. A/D and D/A interface and Waveform Generation

8051 Experiments using kits and MASM

14. Basic arithmetic and Logical operations
15. Square and Cube program, Find 2's complement of a number
16. Unpacked BCD to ASCII

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Write ALP Programmes for fixed and Floating Point and Arithmetic operations
CO2: Interface different I/Os with processor
CO3: Generate waveforms using Microprocessors
CO4: Execute Programs in 8051
CO5: Explain the difference between simulator and Emulator

Text Books:

1. Yu-Cheng Liu, Glenn A.Gibson, "Microcomputer Systems: The 8086 / 8088 Family - Architecture, Programming and Design", Second Edition, Prentice Hall of India, 2007.

2. Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson education, 2011.

References:

1. Doughlas V.Hall, "Microprocessors and Interfacing, Programming and Hardware",TMH,2012

2. A.K. Ray, K.M.Bhurchandi, "Advanced Microprocessors and Peripherals" 3rd edition, Tata McGraw-Hill, 2012

Course Code	LINEAR INTEGRATED CIRCUITS	L	T	P	C
VD4303		3	0	2	4

COURSE OBJECTIVES:

- To identify the basic building blocks of linear integrated circuits.
- To explain the linear applications of operational amplifiers.
- To demonstrate the design of active filters and oscillators.
- To compare and contrast the theory and applications of Timers and PLL.
- To assess the theory of ADC, DAC, and concepts of waveform generation for practical applications.

UNIT I INTEGRATED CIRCUITS 9

Classification, chip size and circuit complexity, basic information of Op-amp, ideal and practical Op-amp, internal circuits, Op-amp characteristics, DC and AC Characteristics, 741 op-amp and its features, modes of operation-inverting, non-inverting, differential.

UNIT II OP-AMP AND APPLICATIONS 9

Basic information of Op-amp, instrumentation amplifier, ac amplifier, V to I and I to V converters, adder, subtractor, Sample & hold circuits, multipliers and dividers, differentiators and integrators, comparators, Schmitt trigger, Multivibrators, introduction to voltage regulators, features of 723

UNIT III ACTIVE FILTERS & OSCILLATORS 9

Introduction, 1st order LPF, HPF filters, Band pass, Band reject and all pass filters. Oscillator types and principle of operation - RC, Wien and quadrature type, waveform generators - triangular, sawtooth, square wave and VCO.

UNIT IV WAVEFORM GENERATORS & PHASE LOCKED LOOPS 9

Sine-wave generators, Multivibrators and Triangular wave generator, Saw-tooth wave generator, ICL8038 function generator, Timer IC 555, IC Voltage regulators – Three terminal fixed and adjustable voltage regulators - IC 723 general purpose regulator, Operation of the basic PLL, Closed loop analysis, Voltage controlled oscillator, Monolithic PLL IC 565, application of PLL for AM detection, FM detection, FSK modulation and demodulation and Frequency synthesizing and clock synchronization

UNIT V D-A AND A-D CONVERTERS 9

Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, and IC 1408 DAC, Different types of ADCs - parallel comparator type ADC, counter type

ADC, successive approximation ADC dual slope integration type ADC, DAC and ADC specifications.

TOTAL : 45 PERIODS

PRACTICAL EXERCISES: **30 PERIODS**

1. Inverting, non inverting and differential amplifiers.
2. Integrator and Differentiator.
3. Instrumentation amplifier.
4. Astable & Monostable multivibrators using Op-amp.
5. RC Phase shift oscillator and Wien Bridge Oscillator using op-amp.

(Schematic Design Experiments)

6. Design of Differential amplifiers (current source load and active current mirror load).
7. Design of Operational Amplifiers.
8. Design of comparator circuit using op-amp.
9. Design of active second order filters using Op-Amp (LPF, HPF, BPF and BSF).
10. Design of Schmitt trigger circuit using Op–Amps

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Recognize and describe the fundamental building blocks of linear integrated circuits.
CO2: Explain and apply the principles of operational amplifiers in linear applications.
CO3: Design and implement active filters and oscillators using appropriate techniques.
CO4: Analyze and evaluate the theory and practical applications of Timers and PLL.
CO5: Demonstrate proficiency in the theory of ADC, DAC, and waveform generation concepts for practical usage.

Text Books:

1. D.Roy Choudhry, Shail Jain, “Linear Integrated Circuits”, New Age International Pvt. Ltd., 2018, Fifth Edition. (Unit I – IV).
2. Sergio Franco, “Design with Operational Amplifiers and Analog Integrated Circuits”, 4th Edition, Tata Mc Graw-Hill, 2016 (Unit I – IV).
3. Nonlinear Dynamics - Integrability, Chaos and Patterns. Authors: M. Lakshmanan, S. Rajasekar. Publisher Springer Berlin, Heidelberg. Hardcover ISBN 978-3-540-43908-0 Published: 12 November 2002. (Unit V).

References:

1. Ramakant A. Gayakwad, “OP-AMP and Linear ICs”, 4th Edition, Prentice Hall / Pearson Education,2015.
2. S.Salivahanan & V.S. Kanchana Bhaskaran, “Linear Integrated Circuits”, TMH,2nd Edition, 4th Reprint, 2016.

Course Code	OBJECT ORIENTED PROGRAMMING IN JAVA	L	T	P	C
CS4311		3	0	2	4

COURSE OBJECTIVES:

- To understand Object Oriented Programming concepts and basics of Java programming language
- To know the principles of packages, inheritance and interfaces
- To develop a java application with threads and generics classes

- To define exceptions and use I/O streams
- To design and build Graphical User Interface Application using JAVAFX

UNIT I INTRODUCTION TO OOP AND JAVA 9

Overview of OOP – Object oriented programming paradigms – Features of Object Oriented Programming – Java Buzzwords – Overview of Java – Data Types, Variables and Arrays – Operators – Control Statements – Programming Structures in Java – Defining classes in Java – Constructors-Methods -Access specifiers - Static members- Java Doc comments

UNIT II INHERITANCE, PACKAGES AND INTERFACES 9

Overloading Methods – Objects as Parameters – Returning Objects –Static, Nested and Inner Classes. Inheritance: Basics– Types of Inheritance -Super keyword - Overriding – Dynamic Method Dispatch –Abstract Classes – final with Inheritance. Packages and Interfaces: Packages – Packages and Member Access –Importing Packages – Interfaces.

UNIT III EXCEPTION HANDLING AND MULTITHREADING 9

Handling basics – Multiple catch Clauses – Nested try Statements – Java's Built-in Exceptions – User defined Exception. Multithreaded Programming Method: Java Thread Model–Creating a Thread and Multiple Threads – Priorities – Synchronization – Inter Thread Communication-Suspending –Resuming, and Stopping Threads –Multithreading. Wrappers – Auto boxing.

UNIT IV I/O, GENERICS, STRING HANDLING 9

I/O Basics – Reading and Writing Console I/O – Reading and Writing Files. Generics: Generic Programming – Generic classes – Generic Methods – Bounded Types – Restrictions and Limitations. Strings: Basic String class, methods and String Buffer Class.

UNIT V JAVAFX EVENT HANDLING, CONTROLS AND COMPONENTS 9

JAVAFX Events and Controls: Event Basics – Handling Key and Mouse Events. Controls: Checkbox, Toggle Button – Radio Buttons – List View – Combo Box – Choice Box – Text Controls – Scroll Pane. Layouts – Flow Pane – HBox and VBox – Border Pane – Stack Pane – Grid Pane. Menus – Basics – Menu – Menu bars – MenuItem.

TOTAL : 45 PERIODS

LIST OF EXPERIMENTS: 30 PERIODS

1. Solve problems by using sequential search, binary search, and quadratic sorting algorithms (selection, insertion)
2. Develop stack and queue data structures using classes and objects.
3. Develop a java application with an Employee class with Emp_name, Emp_id, Address, Mail_id, Mobile_no as members. Inherit the classes, Programmer, Assistant Professor, Associate Professor and Professor from employee class. Add Basic Pay (BP) as the member of all the inherited classes with 97% of BP as DA, 10 % of BP as HRA, 12% of BP as PF, 0.1% of BP for staff club funds.
4. Generate pay slips for the employees with their gross and net salary.
5. Write a Java Program to create an abstract class named Shape that contains two integers and an empty method named printArea(). Provide three classes named Rectangle, Triangle and Circle such that each one of the classes extends the class Shape. Each one of the classes contains only the method printArea( ) that prints the area of the given shape.
6. Solve the above problem using an interface.
7. Implement exception handling and creation of user defined exceptions.
8. Write a java program that implements a multi-threaded application that has three threads. First thread generates a random integer every 1 second and if the value is even, the second

thread computes the square of the number and prints. If the value is odd, the third thread will print the value of the cube of the number.
9. Write a program to perform file operations.
10. Develop applications to demonstrate the features of generics classes.
11. Develop applications using JavaFX controls, layouts and menus.
12. Develop a mini project for any application using Java concepts.

TOTAL: 75 PERIODS

Course Outcomes:

Upon Completion of the course the students will be able to
CO1: Apply the concepts of classes and objects to solve simple problems
CO2: Develop programs using inheritance, packages and interfaces
CO3: Make use of exception handling mechanisms and multithreaded model to solve real world problems
CO4: Build Java applications with I/O packages, string classes, Collections and generics concepts
CO5: Integrate the concepts of event handling and JavaFX components and controls for developing GUI based applications

Text Books:

1. Herbert Schildt, "Java: The Complete Reference", 11th Edition, McGraw Hill Education, New Delhi, 2019
2. Herbert Schildt, "Introducing JavaFX 8 Programming", 1st Edition, McGraw Hill Education, New Delhi, 2015

References:

1. Cay S. Horstmann, "Core Java Fundamentals", Volume 1, 11th Edition, Prentice Hall, 2018.

Course Code	**EMPLOYABILITY ENHANCEMENT SKILLS – III: PROFESSIONAL COMMUNICATION AND TEAMWORK SKILLS**	L	T	P	C
ES4301		0	0	2	1

COURSE OBJECTIVES:

- To familiarize students with various forms of communication.
- To develop effective team communication skills.
- To enhance stakeholder communication skills.
- To cultivate ethical communication practices.
- To explore digital communication tools and trends.

UNIT I **6**

Introduction to Communication - Verbal Communication Skills: - Written Communication Skills - Nonverbal Communication - Interpersonal Communication

UNIT II **6**

Characteristics of Effective Teams - Team Building and Group Cohesion - Conflict Resolution - Decision Making in Teams - Cross-Cultural Communication

UNIT III **6**

Stakeholder Communication - Presentation Skills - Effective Meetings - Feedback and evaluation

UNIT IV **6**

Professional Codes of Conduct - Integrity in Communication - Addressing Ethical Challenges -

Analyzing real-world ethical communication dilemmas

UNIT V **6**

Digital Communication Tools - Social Media and Networking - Emerging Trends in Communication

TOTAL: 30 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Demonstrate proficiency in various forms of communication.
CO2: Exhibit strong team communication skills.
CO3: Display competence in stakeholder communication.
CO4: Apply ethical communication principles.
CO5: Utilize digital communication tools effectively.

Text Books:

1. Sharon J. Gerson and Steven M. Gerson. "Technical Communication: Process and Product", Pearson, 2014.
2. Karl A. Smith. "Teamwork and Project Management", McGraw-Hill Education, 2013.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Charles E. Harris Jr., Michael S. Pritchard, and Michael J. Rabins. "Engineering Ethics: Concepts and Cases", Cengage Learning, 2012.
5. Christoph Meinel and Harald Sack. "Digital Communication: Communication, Multimedia, Security", Springer, 2014.

References:

1. Katherine L. Adams and Gloria J. Galanes. "Communicating in Groups: Applications and Skills", McGraw Hill Education, 2018.
2. Lawrence Holpp. "Managing Teams: Strategies for Success", McGraw Hill, 1998.
3. Caroline Whitbeck (ed) "Ethics in Engineering Practice and Research", Cambridge University Press, 2011.

Semester IV

Course Code	ELECTROMAGNETIC FIELDS	L	T	P	C
EC4401		3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge on the basics of static electric field and the associated laws.
- To impart knowledge on the basics of static magnetic field and the associated laws.
- To give insight into coupling between electric and magnetic fields through Faraday's law, displacement current and Maxwell's equations.

- To gain the behaviour of the propagation of EM waves.
- To study the significance of Time varying fields.

UNIT I INTRODUCTION 9

Electromagnetic model, Units and constants, Review of vector algebra, Rectangular, cylindrical and spherical coordinate systems, Line, surface and volume integrals, Gradient of a scalar field, Divergence of a vector field, Divergence theorem, Curl of a vector field, Stoke's theorem, Null identities, Helmholtz's theorem, Verify theorems for different path, surface and volume.

UNIT II ELECTROSTATICS 9

Electric field, Coulomb's law, Gauss's law and applications, Electric potential, Conductors in static electric field, Dielectrics in static electric field, Electric flux density and dielectric constant, Boundary conditions, Electrostatics boundary value problems, Capacitance, Parallel, cylindrical and spherical capacitors, Electrostatic energy, Poisson's and Laplace's equations, Uniqueness of electrostatic solutions, Current density and Ohm's law, Electromotive force and Kirchhoff's voltage law, Equation of continuity and Kirchhoff's current law.

UNIT III MAGNETOSTATICS 9

Lorentz force equation, Ampere's law, Vector magnetic potential, Biot-Savart law and applications, Magnetic field intensity and idea of relative permeability, Calculation of magnetic field intensity for various current distributions Magnetic circuits, Behaviour of magnetic materials, Boundary conditions, Inductance and inductors, Magnetic energy, Magnetic forces and torques.

UNIT IV TIME-VARYING FIELDS AND MAXWELL's EQUATIONS 9

Faraday's law, Displacement current and Maxwell-Ampere law, Maxwell's equations, Potential functions, Electromagnetic boundary conditions, Wave equations and solutions, Time-harmonic fields, Observing the Phenomenon of wave propagation with the aid of Maxwell's equations.

UNIT V PLANE ELECTROMAGNETIC WAVES 9

Plane waves in lossless media, Plane waves in lossy media (low-loss dielectrics and good conductors), reflection and refraction, polarization, phase and Group velocity, Electromagnetic power flow and Poynting vector, Normal incidence at a plane conducting boundary, Normal incidence at a plane dielectric boundary.

TOTAL: 45 PERIODS

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Relate the fundamentals of vector, coordinate system to electromagnetic concepts.

CO2: Analyze the characteristics of Electrostatic field.

CO3: Interpret the concepts of Electric field in material space to solve the boundary conditions.

CO4: Explain the concepts and characteristics of Magneto Static field in material space and solve boundary conditions.

CO5: Determine the significance of time varying fields.

Text Books:

1. D.K. Cheng, Field and wave electromagnetics, 2nd ed., Pearson (India), 2002

2. M.N.O.Sadiku and Kulkarni, Principles of electromagnetics,6th ed. S.V. Oxford (Asian Edition), 2015

References:

1. Edward C. Jordan & Keith G. Balmain, Electromagnetic waves and Radiating Systems, Second Edition, Prentice-Hall Electrical Engineering Series, 2012.
2. W.H. Hayt and J.A. Buck, Engineering electromagnetics, 7th ed., McGraw-Hill (India), 2006
3.B.M.Notaros, Electromagnetics, Pearson: New Jersey, 2011

Course Code	COMPUTER ARCHITECTURE AND NETWORKS	L	T	P	C
VD4401		3	0	0	3

COURSE OBJECTIVES:

- To recall the basic structure and operations of a computer.
- To explain the fundamentals of pipelined execution.
- To apply the concepts of memory hierarchies, cache memories, and virtual memories.
- To analyze the concept of computer networks.
- To assess networking and inter-networking devices for their functionality and suitability in various scenarios.

UNIT I COMPUTER SYSTEM AND ARITHMETIC OPERATIONS 9

Functional Units — Basic Operational Concepts — Performance — Instructions: Language of the Computer — ALU: Logical operations — Fixed Point Addition and Subtraction — Multiplication — Division — Floating Point Representation — Floating Point Operations — Subword Parallelism.

UNIT II ADDRESSING MODES AND PIPELINING 9

Addressing and addressing modes, Machine Instructions: Operations and Operands, Representing instructions, Logical operations, control operations

Data-path and Control unit: Building a Datapath — A Simple Implementation scheme — An Overview of Pipelining — Pipelined Datapath and Control. Data Hazards: Forwarding versus Stalling, Control Hazards, Exceptions, Parallelism via Instructions.

UNIT III MEMORY & I/O SYSTEMS 9

Memory Hierarchy — memory technologies — cache memory — measuring and improving cache performance — virtual memory, TLB's — Accessing I/O Devices — Interrupts — Direct Memory Access — Bus structure — Bus operation — Arbitration — Interface circuits — USB.

UNIT IV COMPUTER NETWORKS 9

Networks — Network Types — Protocol Layering — TCP/IP Protocol suite — OSI Model — Physical Layer: Performance — Transmission media — Switching — Circuit-switched Networks — Packet Switching.

UNIT V NETWORK PROTOCOLS 9

Introduction —Data-Link Layer Protocols — HDLC — PPP — Media Access Control — Wired LANs. Network Layer Services, Network Layer Protocols. Transport Layer Protocols — Services — Port Numbers — User Datagram Protocol — Transmission Control Protocol — SCTP. WWW and HTTP — FTP — Email –Telnet –SSH — DNS — SNMP.

TOTAL : 45 PERIODS

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Understand the basics structure of computers, operations and instructions.

CO2: Understand pipelined execution and design control unit.

CO3: Understand the various memory systems and I/O communication.

CO4: Describe, analyze and compare a number of data link, network and transport layer

CO5: Analyzing key networking protocols and their hierarchical relationship in the conceptual model like TCP/IP and OSI

Text Books:

1. David A. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, Fifth Edition, Morgan Kaufmann / Elsevier, 2014.
2. Carl Hamacher, Zvonko Vranesic, Safwat Zaky and Naraig Manjikian, Computer Organization and Embedded Systems, Sixth Edition, Tata McGraw Hill, 2012.
3. Upper Saddle River, NJ: Stallings, William. "Data and Computer Communications", Pearson/Prentice Hall, 2007. Print.
4. A. S. Tanenbaum, "Computer Networks", Prentice-Hall of India 2008, 4th Edition.
5. Data Communications and Networking – Behrouz A. Forouzan, Fourth Edition TMH,20Computer Networks -- Andrew S Tanenbaum, 4th Edition, Pearson Education.

References:

1. William Stallings, Computer Organization and Architecture – Designing for Performance, Eighth Edition, Pearson Education, 2010.
2. John P. Hayes, Computer Architecture and Organization, 3rd Edition, Tata McGraw Hill, 2012.
3. John L. Hennessey and David A. Patterson, Computer Architecture – A Quantitative Approach , Morgan Kaufmann / Elsevier Publishers, Fifth Edition, 2012.
4. James J Kurose, Keith W Ross, "Computer Networks", Pearson Education.

Course Code	**ANALOG IC DESIGN**	L	T	P	C
VD4402		3	0	2	4

COURSE OBJECTIVES:

- To understand single-stage amplifier principles and design considerations.
- To analyze high-frequency behavior and noise characteristics of amplifiers.
- To comprehend negative feedback circuits and operational amplifier performance.
- To analyze stability and design frequency compensation techniques.
- To gain proficiency in logic circuit testing and fault detection.

UNIT I SINGLE STAGE AMPLIFIERS 9

Basic MOS physics and equivalent circuits and models, CS, CG and Source Follower, differential amplifier with active load, Cascode and Folded Cascode configurations with active load, design of Differential and Cascode Amplifiers – to meet specified SR, noise, gain, BW, ICMR and power dissipation, voltage swing, high gain amplifier structures, Basic Current Mirror, Active current mirror.

UNIT II HIGH FREQUENCY AND NOISE CHARACTERISTICS OF AMPLIFIERS 9

Miller effect, association of poles with nodes, frequency response of CS, CG and Source Follower, Cascode and Differential Amplifier stages, statistical characteristics of noise, noise in Single Stage amplifiers, noise in Differential Amplifiers.

UNIT III FEEDBACK AND SINGLE STAGE OPERATIONAL AMPLIFIERS 9

Properties and types of negative feedback circuits, effect of loading in feedback networks, operational amplifier performance parameters, single stage Op Amps, two-stage Op Amps, input range limitations, gain boosting, slew rate, power supply rejection, noise in Op Amps.

UNIT IV STABILITY, FREQUENCY COMPENSATION 9

Multipole Systems, Phase Margin, Frequency Compensation, Compensation Of Two Stage Op Amps, Slewing In Two Stage Op Amps, Other Compensation Techniques.

UNIT V ANALOG FAULT TESTING 9

Basic Concepts of Analog Fault Detection -Analog fault models- Parametric and Deviation faults- Analog Test Approaches Analog Test Waveforms DC Parametric Testing AC Parametric Testing

TOTAL : 45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. Design of Basic and Cascode Current Mirrors.
2. Design of Single stage amplifiers (common source with diode connected and current source load)
3. Design a Common drain amplifier and analyze its performance.
4. Design a Common gate amplifier and analyze its performance.
5. Design three stage and five stage ring oscillator circuits and compare its frequencies.
6. Design of Two stage Operational Amplifier.

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Design amplifiers to meet user specifications.
CO2: Analyse the frequency and noise performance of amplifiers.
CO3: Design and analyse feedback amplifiers and one stage op amps.
CO4: Analyse stability of op amp.
CO5: Testing experience of logic circuits.

Text Books:

1.Behzad Razavi, “Design Of Analog Cmos Integrated Circuits”, Tata Mcgraw Hill, 2001.
2.Parag K. Lala, “An Introduction to Logic Circuit Testing”, Morgan & Claypool Publishers, 2009.

References:

1.Willey M.C. Sansen, “Analog Design Essentials”, Springer, 2006.
2. VLSI Test Principles and Architectures: Design for Testability (The Morgan Kaufmann Series In Systems On Silicon) 2006
3.Phillip E.Allen, Douglas R .Holberg, “Cmos Analog Circuit Design”, Oxford University Press, 2nd Edition, 2002.
4.Jacob Baker “CMOS: Circuit Design, Layout, And Simulation, Wiley IEEE Press, 3rd Edition, 2010.

Course Code	SIGNAL PROCESSING TECHNIQUES	L	T	P	C
VD4403		3	0	2	4

COURSE OBJECTIVES:

- To understand the basic concepts, operations and types of signals and systems
- To analyse the periodic and aperiodic Continuous signals using Fourier transform and Laplace transform.
- To analyse the discrete time signal using DFT and discrete time system using Z-Transform.
- To design Analog IIR filter, Conversion of Analog filter to digital Filter.
- To design FIR filter using windowing technique.

UNIT I CLASSIFICATION OF SIGNALS AND SYSTEMS 9

Introduction to signal and systems, Real time Applications of Signals, Fundamental Signals-Unit impulse, Step, Ramp Various operations on signals- Time Shifting. Time reversal, Time Scaling, Amplitude Scaling, Signal Addition and Multiplication. Classification of Continuous and Discrete time signals- Periodic and Aperiodic, Even and Odd, Energy and Power, Deterministic and Random, Types of Systems- Linear and Nonlinear, Time Variant and invariant, Causal and Non-Causal, Static, and dynamic, Stable and unstable systems

UNIT II ANALYSIS OF CONTINUOUS TIME (CT) SIGNALS AND SYSTEMS 9

Fourier Transform and Inverse Fourier Transform, Properties of Fourier Transform, Fourier series for periodic signals, Analysis of LTI CT system using Fourier Transform, Frequency Response, Impulse Response and Step response, Laplace Transform and Inverse Laplace Transform, Region of Convergence (RoC) and Properties, Analysis of LTI CT system using Laplace Transform, Problems solving using properties of Laplace transform

UNIT III ANALYSIS OF DISCRETE TIME (DT) SIGNALS AND SYSTEMS 9

Z- Transform, Region of Convergence (RoC) and Properties, Analysis of DT system using Z-transform, Stability of a system, Inverse Z Transform using Partial fraction method, Discrete Fourier Transform (DFT) and Inverse Discrete Fourier Transform (IDFT), DTFT, Problems solving on DFT, Fast Fourier Transform (FFT) - Decimation in Time Fast Fourier Transform (DIT-FFT), Decimation in Frequency Fast Fourier Transform (DIF-FFT), Linear Convolution and Circular Convolution

UNIT IV INFINITE IMPULSE RESPONSE FILTERS 9

Characteristics of practical frequency selective filters. characteristics of commonly used analog filters - Butterworth filters, Chebyshev filters. Design of IIR filters from analog filters (LPF, HPF, BPF, BRF) - Approximation of derivatives, Impulse invariance method, Bilinear transformation. Frequency transformation in the analog domain. Structure of IIR filter - direct form I, direct form II, Cascade, parallel realizations

UNIT V FINITE IMPULSE RESPONSE FILTERS 9

Design of FIR filters - symmetric and Anti-symmetric FIR filters - design of linear phase FIR filters using Fourier series method - FIR filter design using windows (Rectangular, Hamming and Hanning window), Frequency sampling method. IR filter structures - linear phase structure, direct form realizations

TOTAL: 45 PERIODS

PRACTICAL EXERCISES: **30 PERIODS**

MATLAB / EQUIVALENT SOFTWARE PACKAGE/ DSP PROCESSOR BASED

IMPLEMENTATION

1. Generation of elementary Discrete-Time sequences
2. Linear and Circular convolutions
3. Auto correlation and Cross Correlation
4. Frequency Analysis using DFT
5. Design of FIR filters (LPF/HPF/BPF/BSF) and demonstrates the filtering operation
6. Design of Butterworth and Chebyshev IIR filters (LPF/HPF/BPF/BSF) and demonstrate the filtering operations
7. Study of architecture of Digital Signal Processor
8. Perform MAC operation using various addressing modes
9. Generation of various signals and random noise
10. Implement an Up-sampling and Down-sampling operation in DSP Processor

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Summarize the Classification of Signals and Systems and various operations on signals.

CO2: Apply Fourier transform and Laplace transform on solving continuous time signals and systems.

CO3: Apply Discrete Fourier Transform and Z-Transform on Discrete time signals and systems.

CO4: Design analog and digital Infinite Impulse Response Filters.

CO5: Design Finite Impulse Response Filters using different types of windowing techniques.

Text Books:

1. Oppenheim, Willsky and Hamid, “Signals and Systems”, 2nd Edition, Pearson Education, New Delhi, 2015.

2. John G. Proakis, Dimitris G.Manolakis, “Digital Signal Processing: Principles, Algorithms and Principles”, 4th Edition, Printice Hall of India, 2001.

References:

1. B. P. Lathi, “Principles of Linear Systems and Signals”, 2nd Edition, Oxford, 2009.

2. Alan V. Oppenheim, Ronald W. Schafer, John R. Buck., “Discrete-Time Signal Processing”, 2nd Edition, Pearson, 2011.

Course Code	**HARDWARE MODELING USING VHDL**	L	T	P	C
VD4404		3	0	2	4

COURSE OBJECTIVES:

- To know introduction to VHDL, its structure, data types and operators, logic synthesis.
- To Understand syntax and statement of Behavioral Modeling using VHDL language

- To illustrate Gate level modelling, Dataflow level modeling, in VHDL
- To introduce Advanced Topics in VHDL using Packages and libraries
- To understand the concept of Hardware Modelling using VHDL

UNIT I INTRODUCTION TO VHDL 9

Describing Hardware in VHDL – Hardware abstraction, basic terminology, Entity Declaration, Architecture body, configuration and package declaration, Data objects, Data Types, Operators

UNIT II BEHAVIORAL MODELING 9

Entity Declaration, Architecture Body, Behavioral Modeling - Process statement, Assignment statement, Loop control statements, Multiple Processes, Delay Models, Signal Drivers.

UNIT III DATAFLOW AND STRUCTURAL MODELING TECHNIQUES 9

Data Flow Modeling - Concurrent Assignment Statement, Multiple drivers, Conditional and Selected signal assignment statement, Block Statement, Concurrent assertion statement.
Structural Modeling – Component declaration and instantiation, resolving signal values.

UNIT IV PACKAGES AND LIBRARIES 9

Generics and Configuration, Subprogram, Overloading, Packages and Libraries, Design Libraries, Attributes, Generate Statements.

UNIT V HARDWARE MODELING 9

Modeling Simple Elements, Modeling - Regular Structures, delays and conditional operations, Modeling Synchronous Logic, State Machine Modeling, Interacting state machines, Modeling Moore and Mealy FSM.

TOTAL : 45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. Circuit implementation using VHDL (Dataflow, Gate level and Behavioral)
2. VHDL implementation of System Tasks and Functions
3. Design of ADDERS - Ripple carry adder – carry save adder – carry select/skip adderImplementation in VHDL gate-level or behavioural modelling - synthesis report and analysis
4. Realization of VLSI Multiplier (Braun and booth multiplier, Wallace Tree multiplier) - Implementation in VHDL gate-level or behavioural modelling-synthesis report and analysis.
5. Realisation of 1K x 8 RAM & ROM- 4K x 16 RAM & ROM – Realisation of 4 bit and high order bit ALU – Implementation in VHDL behavioural modelling – synthesis report with analysis.
6. Design and Simulation of Real Time Clock using Behavioral VHDL
7. FPGA implementation of Combinational and Sequential circuits.
8. FPGA implementation of Sequential circuits

Course Outcomes:

Upon Completion of the course the students will be able to
CO1: Understand the basics of Hardware Description Languages, Program structure and basic language elements of VHDL
CO2: Understand various statements and delay models of behavior modelling Using VHDL
CO3: Understand the gate level and structural level modelling using VHDL
CO4: Understand an advanced technique in VHDL
CO5: summarize various optimization methods, circuit design of Datapath and memory system

Text Book:
1. J.Bhaskar- VHDL Primer, Pearson Education Asia, 2001.
2. Digital System Design Using VHDL, by C.H. Roth and L.K. John, Thomson, Second Edition, 2016

Reference Books:
1. Fundamentals of Digital Logic with VHDL Design, Stephen Brown and Zvonko Vranesic, McGraw-Hill Higher Education.
2. VHDL: Programming by Example, Douglas Perry, McGraw-Hill Education, 4th Edition, 16 July 2002

Course Code	FUNDAMENTALS OF DATA SCIENCE AND MACHINE LEARNING	L	T	P	C
CS4511		3	0	2	4

COURSE OBJECTIVES:
- To understand the benefits, uses, and facets of Data Science.
- To master the Data Science process, from goal definition to data analysis and presentation.
- To perform and interpret correlation and regression analysis.
- To differentiate between learning algorithms and address overfitting, underfitting, and generalization.
- To build, train, and optimize neural networks, addressing deep learning challenges.

UNIT I INTRODUCTION TO DATA SCIENCE 9
Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation - Exploratory Data analysis – build the model– presenting findings and building applications - Data Mining - Data Warehousing – Basic Statistical descriptions of Data.

UNIT II DESCRIBING RELATIONSHIPS 9
Correlation –Scatter plots –correlation coefficient for quantitative data –computational formula for correlation coefficient – Regression –regression line –least squares regression line – Standard error of estimate – interpretation of r2 –multiple regression equations –regression towards the mean

UNIT III MACHINE LEARNING BASICS 9
Learning algorithms - supervised, unsupervised and reinforcement learning. Capacity, overfitting, underfitting and generalization - The no free lunch theorem - Bayesian decision theory, maximum likelihood estimation, maximum aposteriori estimation - Basic concepts of gradient descent optimization and Lagrange method.

UNIT IV ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING 9
Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization

UNIT V NEURAL NETWORKS 9
Perceptron - Multilayer perceptron, activation functions, network training – gradient descent optimization – stochastic gradient descent, error backpropagation, from shallow networks to

deep networks –Unit saturation (aka the vanishing gradient problem) – ReLU, hyperparameter tuning, batch normalization, regularization, dropout.

TOTAL: 45 PERIODS

LIST OF LAB EXPERIMENTS **30 PERIODS**

1. Implement naïve Bayes models
2. Implement Bayesian Networks
3. Build Regression models
4. Build decision trees and random forests
5. Build SVM models
6. Implement ensembling techniques
7.Implement clustering algorithms
8. Implement EM for Bayesian networks
9. Build simple NN models
10. Build deep learning NN models

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Understand the benefits, uses, and different facets of Data Science.
CO2: Master the Data Science process, including goal definition, data analysis, and presentation.
CO3: Perform and interpret correlation and regression analyses.
CO4: Differentiate between various learning algorithms and address issues of overfitting, underfitting, and generalization.
CO5: Build, train, and optimize neural networks while addressing deep learning challenges

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, “Artificial Intelligence – A Modern Approach”, Fourth Edition, Pearson Education, 2021.
2. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Fourth Edition, 2020.
3. David Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016

REFERENCES

1. Dan W. Patterson, “Introduction to AI and ES”, Pearson Education,2007
2. Kevin Night, Elaine Rich, and Nair B., “Artificial Intelligence”, McGraw Hill, 2008
3. Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education, 2006
4. Deepak Khemani, “Artificial Intelligence”, Tata McGraw Hill Education, 2013 (http://nptel.ac.in/)
5. Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.
6. Tom Mitchell, “Machine Learning”, McGraw Hill, 3rd Edition,1997.
7. Charu C. Aggarwal, “Data Classification Algorithms and Applications”, CRC Press, 2014
8. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, “Foundations of Machine Learning”, MIT Press, 2012.
9. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016

Course Code	EMPLOYABILITY ENHANCEMENT SKILLS – IV:	L	T	P	C
ES4401	LEADERSHIP AND PROJECT MANAGEMENT SKILLS	0	0	2	1

COURSE OBJECTIVES:

- To understand leadership within the context of project management.
- To differentiate between leadership and management roles.
- To learn project initiation processes and setting SMART objectives.
- To build high-performing teams through motivation, empowerment, and effective communication.
- To develop skills in project planning, estimation, resource allocation, risk management, and scheduling

UNIT I 6

Understanding Leadership - Introduction to Project Management - Leadership vs. Management - Project Initiation - Setting SMART Objectives

UNIT II 6

Building High-Performing Teams - Motivation Theories - Empowering Team Members - Leadership Communication - Handling Team Conflicts

UNIT III 6

Work Breakdown Structure (WBS) - Estimation Techniques - Gantt Charts and Network Diagrams - Resource Allocation - Risk Management

UNIT IV 6

Leading Project Teams - Monitoring and Controlling Progress - Change Management - Quality Management - Stakeholder Communication

UNIT V 6

Project Closure Activities - Lessons Learned - Celebrating Success - Transition Planning

TOTAL : 30 PERIODS

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Apply leadership principles to project management scenarios.

CO2: Distinguish between leadership and management functions in project environments.

CO3: Initiate projects effectively by setting SMART objectives.

CO4: Foster high-performing teams through motivation, empowerment, and conflict resolution.

CO5: Proficiently plan, schedule, and manage project activities, resources, risks, and stakeholder communications.

Text Books:

1. Peter G. Northouse. "Leadership: Theory and Practice", SAGE Publications, 2021.
2. Patrick Lencioni. "The Five Dysfunctions of a Team: A Leadership Fable", Jossey-Bass, 2011.
3. Robert K. Wysocki. "Effective Project Management: Traditional, Agile, Extreme", Wiley, 2019.

References:

1. Harold Kerzner. "Project Management: A Systems Approach to Planning, Scheduling, and Controlling", 10th edition, Wiley, 2009.

2. Gregory P. Shea and Cassie A. Solomon. "Leading Successful Change: 8 Keys to Making Change Work", Gildan Media, LLC, 2013.

Semester V

Course Code	TRANSMISSION LINES, WAVEGUIDES AND ANTENNA DESIGN	L	T	P	C
VD4501		3	0	0	3

COURSE OBJECTIVES:

- To introduce the various types of transmission lines and its characteristics
- To understand high frequency line, power and impedance measurements
- To impart technical knowledge in impedance matching using Smith Chart.
- To enhance the student knowledge in the area of various antenna designs.
- To introduce the basic knowledge of radiation mechanism and array antennas.

UNIT I INTRODUCTION TO TRANSMISSION LINES 9

General theory of Transmission lines - the transmission line - general solution - The infinite line - Wavelength, velocity of propagation - Waveform distortion - the distortion less line - Loading and different methods of loading - Line not terminated in Z_0 - Reflection coefficient - calculation of current, voltage, power delivered and efficiency of transmission - Input and transfer impedance - Open and short circuited lines - reflection factor and reflection loss.

UNIT II HIGH FREQUENCY TRANSMISSION LINES 9

Transmission line equations at radio frequencies - Line of Zero dissipation - Voltage and current on the dissipation less line, Standing Waves, Nodes, Standing Wave Ratio - Input impedance of the dissipation less line - Open and short circuited lines - Power and impedance measurement on lines - Reflection losses - Measurement of VSWR and wavelength.

UNIT III IMPEDANCE MATCHING IN HIGH FREQUENCY 9

Impedance matching: Quarter wave transformer, One Eighth wave line, Half wave line- Impedance matching by stubs- Single stub and double stub matching - Smith chart – Application of Smith chart, Solutions of problems using Smith chart - Single and double stub matching using Smith chart.

UNIT IV WAVEGUIDES AND ANTENNAS DESIGN ASPECTS 9

Characteristics of TE and TM waves, Transverse Electromagnetic waves, TM and TE waves in rectangular waveguides, TM and TE waves in Circular waveguides

Physical concept of radiation, Near- and far-field regions, Fields and Power Radiated by an Antenna, Antenna Pattern Characteristics, Antenna Gain and Efficiency, Aperture Efficiency and Effective Area, Antenna Noise Temperature and G/T, Impedance matching, Friis transmission equation, Link budget and link margin

UNIT V RADIATION MECHANISMS AND ANTENNA ARRAYS 9

Radiation Mechanisms of Linear Wire and Loop antennas, Aperture antennas, Reflector antennas, Microstrip antennas and Frequency independent antennas, Two-element array, Array factor, Pattern multiplication

TOTAL: 45 PERIODS

Course Format
Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading
Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:
Upon Completion of the course the students will be able to
CO1: Explain the characteristics of transmission lines and its losses.
CO2: Calculate the SWR and input impedance in high frequency transmission lines.
CO3: Analyze impedance matching by stubs using Smith Charts.
CO4: Apply the basic principles of waveguides and evaluate the parameters for various antennas.
CO5: Understand the basic knowledge of radiation mechanism and array antennas.

Text Books:
1.John D Ryder, "Networks lines and fields",Prentice Hall of India,New Delhi,2005.
2. John D Krauss, Ronald J Marhefka and Ahmad S. Khan, "Antennas and Wave Propagation: Fourth Edition, Tata McGraw-Hill, 2006.

References:
1. E.C.Jordan and K.G. Balmain, "Electromagnetic Waves and Radiating Systems", Prentice Hall of India, 2006.
2. G.S.N Raju "Electromagnetic Field Theory and Transmission Lines", Pearson Education, Ist edition 2005.
3. Constantine A.Balanis, "Antenna Theory Analysis and Design", Third edition, John Wiley India Pvt Ltd., 2005.

Course Code	**CONTROL SYSTEMS**	L	T	P	C
EC4502		3	0	0	3

COURSE OBJECTIVES:
- To understand the fundamental principles of control systems, including terminology, basic structure, and control theories.
- To analyze the time response of systems, including transient and steady-state behaviours, and design PID control systems.
- To interpret frequency response characteristics and design compensators using Bode plots and Nyquist plots.
- To evaluate stability using stability criteria such as Routh stability criterion and Nyquist stability criterion, and analyze root locus.
- To apply state variable methods for control system analysis, including state representation, conversion between transfer functions and state variable models, and digital control system design.

UNIT I SYSTEMS COMPONENTS AND THEIR REPRESENTATION 9

Control System: Terminology and Basic Structure-Feedforward and Feedback control theory-Electrical and Mechanical Transfer Function Models-Block diagram Models-Signal flow graphs models-DC and AC servo Systems-Synchronous -Multivariable control system

UNIT II TIME RESPONSE ANALYSIS 9

Transient response-steady state response-Measures of performance of the standard first order and second order system-effect on an additional zero and an additional pole-steady error constant and system- type number-PID control-Analytical design for PD, PI, PID control systems

UNIT III FREQUENCY RESPONSE AND SYSTEM ANALYSIS 9

Closed loop frequency response-Performance specification in frequency domain-Frequency response of standard second order system- Bode Plot - Polar Plot- Nyquist plots-Design of compensators using Bode plots- Cascade lead compensation-Cascade lag compensation-Cascade lag-lead compensation

UNIT IV CONCEPTS OF STABILITY ANALYSIS 9

Concept of stability-Bounded - Input Bounded - Output stability-Routh stability criterion-Relative stability- Root locus concept-Guidelines for sketching root locus-Nyquist stability criterion.

UNIT V CONTROL SYSTEM ANALYSIS USING STATE VARIABLE METHODS 9

State variable representation-Conversion of state variable models to transfer functions-Conversion of transfer functions to state variable models-Solution of state equations-Concepts of Controllability and Observability- Stability of linear systems-Equivalence between transfer function and state variable representations-State variable analysis of digital control system-Digital control design using state feedback

TOTAL : 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Compute the transfer function of different physical systems.

CO2: Analyse the time domain specification and calculate the steady state error.

CO3: Illustrate the frequency response characteristics of open & closed loop system response.

CO4: Analyse the stability using Routh and root locus techniques.

CO5: Illustrate the state space model of a physical system and discuss the concepts of sampled data control system

Text Books:

1. M.Gopal," Control System – Principles and Design", Tata McGraw Hill, 4th Edition, 2012.

References:

1. J.Nagrath and M.Gopal, "Control System Engineering", New Age International Publishers, 5th Edition, 2007.

2. K.Ogata, “Modern Control Engineering”, PHI, 5th Edition, 2012.
3. S.K.Bhattacharya, “Control System Engineering”, Pearson, 3rd Edition, 2013.
4. Benjamin.C.Kuo, “Automatic Control Systems”, Prentice Hall of India, 7th Edition,1995.

Course Code	MIXED SIGNAL IC DESIGN	L	T	P	C
VD4502		3	0	2	4

COURSE OBJECTIVES:

- To learn the principles and advanced systems of signal sampling.
- To understand sampling circuit design and sources of distortion.
- To study SC circuits and their non-idealities.
- To explore various ADC designs and key components.
- To learn about different DAC designs and their properties.

UNIT I SAMPLING 9

Introduction – sampling - Spectral properties of sampled signals - Oversampling – Anti-alias filter design. Time Interleaved Sampling - Ping-pong Sampling System - Analysis of offset and gain errors in Time Interleaved Sample and Hold.

UNIT II SAMPLING CIRCUITS 9

Sampling circuits- Distortion due to switch - Charge injection - Thermal noise in sample and holds - Bottom plate sampling - Gate bootstrapped switch -Nakagome charge pump. Characterizing Sample and hold - Choice of input frequency.

UNIT III SWITCHED CAPACITOR CIRCUITS 9

Switched Capacitor (SC) circuits– Parasitic Insensitive Switched Capacitor amplifiers - Non idealities in SC Amplifiers – Finite gain - DC offset - Gain Bandwidth Product. Fully differential SC circuits - DC negative feedback in SC circuits.

UNIT IV ANALOG TO DIGITAL CONVERTER ARCHITECTURES 9

Flash ADC - Regenerative latch - Preamp offset correction - Preamp Design - necessity of upfront sample and hold for good dynamic performance. Folding ADC - Multiple-Bit Pipeline ADCs and SAR ADC.

UNIT V DIGITAL TO ANALOG CONVERTER ARCHITECTURES 9

DAC spectra and pulse shapes - NRZ vs RZ DACs. DAC Architectures: Binary weighted - Thermometer DAC - Current steering DAC - Current cell design in current steering DAC – Charge. Scaling DAC - Pipeline DAC.

TOTAL : 45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

(Design with Schematic, Simulation, Layout, DRC, LVS)

1. Design the following analog circuits with the given specifications

a) Differential amplifier
b) Single stage op-amp
c) Two stage op-amp

2. Design a 4 bit R-2R based DAC for the given specification.
3. For the SAR based ADC, draw the mixed signal schematic and verify the functionality by completing ASIC Design flow.

4. Design a Phase Locked Loop for the given specification.
5. Design and test Voltage Controlled Oscillator for a given specification

Course Format
Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading
Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:
Upon Completion of the course the students will be able to
CO1: Understand the theory of discrete-time signal processing and its implementation using analog techniques.
CO2: Realize Sample and Hold Circuits using MOS by considering the non-idealities.
CO3: Analyze CMOS based Switched Capacitor Circuits.
CO4: Analyze the architectures of ADCs and DAC.
CO5: Understand the oversampling converter architecture.

Text Books:
1. Frank Ohnhauser, Analog-Digital Converters for Industrial Applications Including an Introduction to Digital-Analog Converters Springer Publishers, First Edition, 2015.
2. David Johns and Ken Martin, Analog Integrated Circuit Design, John Wiley & Sons Inc., 2012.

References:
1. Ahmed M.A.Ali, High Speed Data Converters IET Materials, Circuits & Devices, First Edition, 2016.
2. S.Pavan,R. Schreier and Gabor.C.Temes, Understanding Delta – Sigma Data Converters, IEEE Press, First Edition, 2017

Semester VI

Course Code	LOW POWER VLSI DESIGN	L	T	P	C
VD4601		3	0	0	3

COURSE OBJECTIVES:
- To learn the Low Power VLSI concepts and Power design.
- To gain Knowledge on the Low Voltage Low Power CMOS Circuit Design.
- To design the low voltage VLSI BiCMOS Circuit.
- To understand the low power CMOS static and Dynamic RAM Circuits.
- To understand the concept of power reduction in clock networks and Adiabatic.

UNIT I INTRODUCTION TO LOW POWER VLSI 9
Introduction, Needs for low power VLSI, Charging and Discharging Capacitance, Short circuit current of CMOS inverter, CMOS leakage current, Static Current, Basic Principles of Low power design, Low power Figure of Merits.

UNIT II LOW-VOLTAGE LOW-POWER CMOS CIRCUIT DESIGN 9

CMOS Inverter – Switching Characteristics, Power dissipation, capacitance estimation, CMOS static logic design – NAND/NOR Gates, Complex CMOS Logic gates, switching activity of static CMOS gates, Glitching power, Clocking, Low power circuit techniques.

UNIT III LOW-VOLTAGE BiCMOS CIRCUIT DESIGN 9

Conventional BiCMOS Logic – DC and Transient Switching Characteristics, Power Dissipation, Full swing with shunting devices, BiNMOSLogic Family – Gate design, logic gates, power supply voltage swing, Low – voltage BiCMOS families – Merged and Quasi complementary BiCMOS logic, Full swing CE complementary BiCMOS circuit, Bootstrapped BiCMOS

UNIT IV LOW-POWER CMOS RANDOM ACCESS MEMORY CIRCUITS 9

Static RAM – Basics of SRAMs, Static RAM Cells, Read/Write Operation, ATD circuits, Decoders, Bit line conditioning circuitry, Sense Amplifier, Output latch, Hierarchical word line for low power memory

Dynamic RAM – Basics of a DRAM, DRAM Memory cell, Read/Write Circuitry, low power techniques, Bit Line Capacitance reduction, Multi dividend word line, Half voltage generator, Back bias generator, self-Refresh technique

UNIT V ADVANCED TECHNIQUES 9

Power Reduction in Clock networks – Clock gating, Reduced swing clock, Oscillator Circuit for clock generation, Frequency Division and Multiplication, CMOS Floating Node, Low Power Bus, Delay Balancing, Adiabatic Computation, Pass Transistor Logic Synthesis, Asynchronous Circuits

TOTAL : 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Manifest the Knowledge of Low power VLSI and low power design.
CO2: Design CMOS logic and complex CMOS logic lates.
CO3: Design the various low voltage BiCMOS circuits.
CO4: Design the Low power CMOS static and dynamic RAM.
CO5: Apply low power technique concepts in various Applications.

Text Books:

1. Yeap, Gary K. Practical low power digital VLSI design. Springer Science & Business Media, 2012.

References:

1. Roy, Kaushik, and Sharat C. Prasad. Low-power CMOS VLSI circuit design. John Wiley & Sons, 2009.
2. Piguet, Christian. Low-power CMOS circuits: technology, logic design and CAD tools. CRC press, 2018.

Course Code	VLSI PHYSICAL DESIGN	L	T	P	C
VD4602		3	0	2	4

COURSE OBJECTIVES:

- To understand VLSI fundamentals, including layout rules and cell generation.
- To learn top-down placement techniques, focusing on partitioning and floorplanning.
- To master routing methodologies, including maze running and FPGA-specific techniques.
- To address performance issues, focusing on delay models and timing-driven placement.
- To apply single-layer routing and compaction techniques to minimize wire length and bends.

UNIT I INTRODUCTION TO VLSI TECHNOLOGY 9

Layout Rules-Circuit abstraction Cell generation using programmable logic array transistor chaining, Wein Berger arrays and gate matrices-layout of standard cells gate arrays and sea of gates, field programmable gate array(FPGA)-layout methodologies Packaging-Computational Complexity-Algorithmic Paradigms.

UNIT II PLACEMENT USING TOP-DOWN APPROACH 9

Partitioning: Approximation of Hyper Graphs with Graphs, Kernighan-Lin Heuristic Ratio cut partitioning with capacity and i/o constraints. Floor planning: Rectangular dual floorplanning hierarchical approach- simulated annealing- Floor plan sizing Placement: Cost function-forcedirected method- placement by simulated annealing partitioning placement- module placement on a resistive network – regular placement linear placement.

UNIT III ROUTING USING TOP DOWN APPROACH 9

Fundamentals: Maze Running- line searching- Steiner trees Global Routing: SequentialApproaches - hierarchical approaches - multi commodity flow based techniques - Randomised Routing- One Step approach - Integer Linear Programming Detailed Routing: Channel Routing -Switch box routing. Routing in FPGA: Array based FPGA- Row based FPGAs

UNIT IV PERFORMANCE ISSUES IN CIRCUIT LAYOUT 9

Delay Models: Gate Delay Models- Models for interconnected Delay- Delay in RC trees. Timing – Driven Placement: Zero Stack Algorithm- Weight based placement- Linear Programming Approach Timing riving Routing: Delay Minimization- Clock Skew Problem- Buffered Clock Trees.Minimization: constrained via Minimization unconstrained via Minimization- Other issues inMinimization

UNIT V SINGLE LAYER ROUTING, CELL GENERATION AND COMPACTION 9

Planar subset problem(PSP)- Single Layer Global Routing- Single Layer detailed Routing- Wirelength and bend minimization technique – Over The Cell (OTC) Routing Multiple chip Modules(MCM)- programmable Logic Arrays- Transistor chaining- Weinberger Arrays- Gatematrix layout- 1D compaction- 2D compaction.

TOTAL: 45 PERIODS

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Understand VLSI fundamentals: layout rules, circuit abstraction, and cell generation.
CO2: Master top-down placement and routing techniques for efficient VLSI design.
CO3: Optimize circuit performance through analysis and effective delay minimization.
CO4: Apply advanced single-layer routing and compaction for efficient wire length reduction.
CO5: Develop problem-solving skills for effective VLSI design and layout.

Text Books:

1. Sherwani, Naveed A.. Algorithms for VLSI Physical Design Automation. United states: Springer, 2014.
2. Sait, Sadiq M.., Youssef, Habib. VLSI Physical Design Automation: Theory and Practice. Singapore: World Scientific, 2001.
3. Andrew B. Kahng, Jens Lienig, Igor L. Markov, Jin Hu, "VLSI Physical Design: From Graph Partitioning to Timing Closure", Springer Science & Business Media, 2011.

References:

1. Sung Kyu Lim, "Practice Problems in VLSI physical design Automation", Springer,2010.
2. Charles J . Alpert, Dinesh P. Mehta, Sachin S. Sapatnekar, Handbook of Algorithms for Physical Design Automation. United Kingdom: CRC Press, 2019.

Course Code	VLSI TESTING	L	T	P	C
VD4603		3	0	0	3

COURSE OBJECTIVES:

- To recall the role of testing in VLSI circuits and classify various physical faults.
- To understand test generation algorithms for combinational circuits, including controllability and observability concepts.
- To apply test generation techniques for sequential circuits, including ad-hoc and structured Design-for-Testability (DFT) methods.
- To analyze Built-In Self Test (BIST) architectures and evaluate test pattern generation techniques.
- To evaluate the Boundary Scan Standard and its components for describing boundary scan architecture.

UNIT I INTRODUCTION TO TESTING 9

Role of testing VLSI circuits, VLSI trends affecting testing, Physical Faults, Stuck-at Faults, Stuck open Faults, Permanent, Intermittent and Pattern Sensitive Faults, Delay Faults. Fault Modeling - Functional Testing, Structural Testing, Types of Fault Models, Stuck-at Faults, Bridging Faults, cross point faults, Fault Equivalence, Fault Dominance

UNIT II TEST GENERATION FOR COMBINATIONAL CIRCUIT 9

Controllability, Observability, Test generation algorithms, Path Sensitization Methods, Roth's D-Algorithm, Boolean Difference, PODEM Algorithm

UNIT III TEST GENERATION FOR SEQUENTIAL CIRCUITS 9

Test generation based on circuit structure, Ad-hoc, Structured DFT- Scan method, Scan Design Rules, Overheads of Scan Design, partial scan methods, multiple chain scan methods

UNIT IV BUILT IN SELF TEST 9

Built-In self-Test, test pattern generation for BIST, Pseudo-Random Pattern Generation, response compaction - Parity checking, Ones counting, Transition Count, Signature analyzer, Circular BIST, BIST Architectures

UNIT V BOUNDARY SCAN STANDARD 9

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

TOTAL: 45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. Design a 4 bit counter and synthesis using the technology file to generate netlist file
2. Perform the scan insertion by applying the scan constraints analysis the scan path
3. Apply the scan constraints, analyze and fix the DRCs by using the scan golden rules
4. Perform the scan compression with the compression ratio of 10.
5. Perform the Scan compression with exact internal scan chain length configuration
6. Insert the On Chip Clock Controller and analyze the design
7. Read the scan inserted netlist and run the ATPG
8. With the Chain serial and parallel pattern, simulate and analyze the waveform.
9. With the Scan serial and parallel pattern, simulate and analyze the waveform.

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Improves the knowledge level in the domain of VLSI Design and Test.
CO2: Enhances the creativity to develop new ATPG Algorithms.
CO3: Evaluate the significance of sequential test pattern generation.
CO4: Analyze the challenges involved in BIST.
CO5: Summarize the significance of Boundary Scan.

Text Books:

1. P. K. Lala, "Digital Circuit Testing and Testability", Academic Press, 2002.
2. M.L. Bushnell and V.D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwar Academic Publishers, 2004.

References:

1. I.M.Abramovici, M.A.Breuer and A.D.Friedman, 'Digital system and Testable design", Jaico Publishing House
2. N.K. Jha and S.G. Gupta, "Testing of Digital Systems", Cambridge University Press,2003.

Semester VII

Course Code	BUSINESS MANAGEMENT	L	T	P	C
HS4701		3	0	0	3

COURSE OBJECTIVES:

- To understand management fundamentals, organizational structures, and managerial roles.
- To explore planning, organizing, directing, and controlling functions within organizations.
- To discuss human values, ethics, and their significance in engineering.
- To analyze global issues like environmental ethics and corporate social responsibility.
- To examine engineers' roles in multinational corporations and professional ethics.

UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATION 9

Definition of Management– Manager Vs Entrepreneur- Types of managers - Managerial roles and skills – Evolution of Management– Types of Business organization- Sole proprietorship,

partnership, company-public and private sector enterprises- Organization culture and Environment – Current trends and issues in Management.

UNIT II PLANNING AND ORGANISING 9

Planning : Nature and purpose of planning – Planning process – Types of planning – Strategic Management – Planning Tools and Techniques – Decision making steps and process Organising : Nature and purpose – Formal and informal organization – Organization chart – Organization structure – Types – Line and staff authority – Departmentalization – delegation of authority – Centralization and decentralization –Human Resource Management.

UNIT III DIRECTING AND CONTROLLING 9

Directing : Foundations of individual and group behaviour– Motivation – Motivation theories– Job satisfaction – Job enrichment – Leadership – types and theories of leadership – Communication – Process of communication.

Controlling : System and process of controlling – Budgetary and non - Budgetary control techniques – Use of computers and IT in Management control –Control and performance – Direct and preventive control – Reporting.

UNIT IV HUMAN VALUES AND ENGINEERING ETHICS 9

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence– Introduction to Yoga and meditation for professional excellence and stress management. Senses of ‗Engineering Ethics – Variety of moral issues – Types of inquiry – Moral dilemmas –Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

UNIT V GLOBAL ISSUES 9

Professional Rights – Employee Rights – Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

TOTAL : 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Understanding of managerial functions like planning, organizing, staffing, leading & controlling.

CO2: Understand management concept of Planning and organizing.

CO3: Understand management concept of Directing and Controlling.

CO4: Describe the human values with regard to the individual lifestyle for the society and Explain the role of ethics to the engineering field.

CO5: Discuss the global issues of professional ethics in engineering and Experiment the professional ethics in engineering-based product development

Text Books:

1. Govindarajan M, Natarajan S, Senthil Kumar V. S, —Engineering Ethics , Prentice Hall of India, New Delhi, 2004.
2. Mike W. Martin and Roland Schinzinger, —Ethics in Engineering , Tata McGraw Hill, New Delhi, 2003.
3. Stephen P. Robbins & Mary Coulter, "Management", 10th Edition, Prentice Hall (India) Pvt. Ltd., 2009.
4. JAF Stoner, Freeman R.E and Daniel R Gilbert "Management", 6th Edition, Pearson Education, 2004.

References:

1. Stephen A. Robbins & David A. Decenzo & Mary Coulter, "Fundamentals of Management" 7th Edition, Pearson Education, 2011.
2. Laura P. Hartman and Joe Desjardins, —Business Ethics: Decision Making for Personal Integrity and Social Responsibility Mc Graw Hill education, India Pvt. Ltd., New Delhi, 2013.

Course Code	FPGA ARCHITECTURE AND APPLICATIONS	L	T	P	C
VD4701		3	0	0	3

COURSE OBJECTIVES:

- Understand the features and programming of Programmable Logic Devices (PLDs) like ROM, PLA, PAL, CPLD, and FPGA, and their applications.
- Explore Field Programmable Gate Arrays (FPGAs), including logic blocks, routing architecture, and design flow, with case studies.
- Learn about advanced FPGAs like Xilinx Virtex and ALTERA Stratix, and Finite State Machines (FSM) design principles.
- Study FSM architectures and advanced concepts like One_Hot state machines and Petri nets.
- Understand system-level design concepts and digital front-end design tools for FPGAs, and learn about design flow using mentor graphics/Xilinx EDA tool.

UNIT I PROGRAMMABLE LOGIC DEVICES 9

ROM, PLA, PAL, CPLD, FPGA Features, Architectures and Programming. Applications and Implementation of MSI circuits using Programmable logic Devices

UNIT II INTRODUCTION TO FPGA ARCHITECTURE 9

Field Programmable Gate Arrays- Logic blocks, routing architecture, design flow, technology mapping for FPGAs, Case studies Xilinx XC4000 & ALTERA's FLEX 8000/10000 FPGAs

UNIT III DESIGNING WITH ADVANCED FPGA 9

Xilinx Virtex and ALTERA Stratix. Finite State Machines (FSM): Top Down Design, State Transition Table, State assignments for FPGAs Realization of state machine charts using PAL, Alternative realization for state machine charts using microprogramming, linked state machine, encoded state machine

UNIT IV **FSM ARCHITECTURES** 9

Architecture Centered around non registered PLDs, Design of state machines centered around shift registers, One_Hot state machine, Petrinets for state machines-Basic concepts and properties, Finite State Machine-Case study.

UNIT V **SYSTEM LEVEL DESIGN** 9

Controller, data path designing, Functional partition, Digital front end digital design tools for FPGAs. System level design using mentor graphics/Xilinx EDA tool (FPGA Advantage/Xilinx ISE), Design flow using FPGAs.

TOTAL : 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:

Upon Completion of the course the students will be able to

CO1:Demonstrate understanding of Programmable Logic Devices (PLDs) and their features.

CO2: Apply knowledge of Field Programmable Gate Arrays (FPGAs) in design and implementation.

CO3: Understand advanced FPGA concepts like Xilinx Virtex and ALTERA Stratix, and Finite State Machines (FSM) design.

CO4: Design and implement FSM architectures effectively using PLDs and FPGAs.

CO5: Apply system-level design concepts and utilize EDA tools for FPGA design flow.

Text Books:

1. Field Programmable Gate Array Technology - S. Trimberger, Edr, 1994, Kluwer Academic publications.
2. Engineering Digital Design - Richard F.Tinder, 2nd Edition, Academic press.
3. Fundamentals of logic design-Charles H. Roth, 4th Edition Jaico Publishing House.

References:

1. Digital Design Using Field Programmable Gate Array, P.K. Chan & S. Mourad, 1994, Prentice Hall.
2. Field programmable gate array, S. Brown, R.J. Francis, J. Rose, Z.G. Vranesic, 2007, BS

Course Code	**ASIC DESIGN**	L	T	P	C
VD4702		3	0	0	3

COURSE OBJECTIVES:

The course is aimed to

- To understand different types of ASICs and their design flow.
- To explore programmable ASIC technologies and architectures.
- To analyze advanced FPGA architectures and embedded systems.
- To learn logic synthesis, placement, and routing techniques.
- To implement high-performance algorithms in ASIC and SoC designs.

UNIT I INTRODUCTION TO ASICs 9

Types of ASICs - Design flow - CMOS transistors - Combinational Logic Cell – Sequential logic cell - Data path logic cell - Transistors as Resistors - Transistor Parasitic Capacitance- Logical effort.

UNIT II PROGRAMMABLE ASICs, LOGIC CELLS AND I/O CELLS 9

Anti fuse - static RAM - EPROM and EEPROM technology - Actel ACT - Xilinx LCA –Altera FLEX - Altera MAX DC & AC inputs and outputs - Clock & Power inputs - Xilinx I/O blocks.

UNIT III PROGRAMMABLE ASIC ARCHITECTURE 9

Architecture and configuration of Spartan / Cyclone and Virtex / Stratix FPGAs – Micro-Blaze / Nios based embedded systems – Signal probing techniques

UNIT IV LOGIC SYNTHESIS, PLACEMENT AND ROUTING 9

Logic synthesis - ASIC floor planning- placement and routing – power and clocking strategies.

UNIT V HIGH PERFORMANCE ALGORITHMS FOR ASICs/ SOCs 9

DAA and computation of FFT and DCT. High performance filters using delta-sigma modulators. Case Studies: Digital camera, SDRAM, High speed data standards.

TOTAL : 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Identify and classify various types of ASICs.
CO2: Utilize programmable ASIC technologies in custom designs.
CO3: Configure and utilize advanced FPGA architectures.
CO4: Execute logic synthesis and optimize power and clock distribution.
CO5: Apply high-performance algorithms in ASIC and SoC designs.

Text Books:

1. M.J.S. Smith, —Application Specific Integrated Circuits, Pearson Education, 2008
2. Wayne Wolf, —FPGA-Based System Design, Prentice Hall PTR, 2009.
3. Farzad Nekoogar and Faranak Nekoogar, —From ASICs to SOCs: A Practical Approach , Prentice Hall PTR, 2003
4. D.R. Smith and P.D. Franzon, Verilog Styles for Synthesis, (Pearson Education), 2000.

References:

1. Thomas and Moorby, The Verilog Hardware Description Language‘, 3rd edition, Kluwer Academic. ISBN 0-7923-9723-1.
2. Kilts, Advanced FPGA Design, (Wiley), ISBN 978-0-05437-6
3. H. Bhatnagar, Advanced ASIC Chip Synthesis Using Synopsys Design Compiler, Physical Compiler, and PrimeTime”, 2012

APPENDIX A: PROFESSIONAL ELECTIVES

Vertical 1 Semiconductor Chip Design	Vertical 2 Signal Processing	Vertical 3 Embedded Systems and IoT
Semiconductor Device Fabrication	Adaptive Signal Processing	Real Time Operating Systems
Nanoscale Devices and Circuit Design	Speech Signal Processing	IoT And Industry 4.0
Memory Design and Testing	VLSI Digital Signal Processing Systems	Communication Protocol and Standards
System On Chip Design	AR/VR	ARM Architecture and Programming
Design Verification of VLSI Circuits	DSP Architectures	Edge Data Analytics
Scripting Languages for VLSI Design Automation	Brain Computer Interface and Applications	Embedded Programming

Vertical 4: Artificial Intelligence and Data Science	Vertical 5 Communication Systems	Vertical 6 Deep Tech
Data Analytics and Visualization	Wireless Broadband Networks	Machine Learning for Electronic Design
Deep Learning	Ad-Hoc and Wireless Sensor Networks	Baseband systems on FPGA
Natural Language Processing	5G Technologies	Quantum Computing
Reinforcement Learning	Advanced 5G Techniques	High Performance Computing
Big Data Analytics	Massive MIMO Networks	mm Wave Communication
Generative Artificial Intelligence	Advanced Wireless Communication Techniques	High Speed Switching & Networking

Vertical 1: Semiconductor Chip Design

Course Code	SEMICONDUCTOR DEVICE FABRICATION	L	T	P	C
VD4V11		3	0	0	3

COURSE OBJECTIVES:

- To understand semiconductor manufacturing processes and the types and standards of clean rooms.
- To master photolithographic processes, photomask fabrication, and compare positive and negative photoresists.
- To learn the thermal oxidation process of silicon, including modeling and the masking properties of silicon dioxide.
- To comprehend diffusion processes, mathematical models, and ion implantation technology, including selective implantation and annealing.
- To explore thin film deposition, metal interconnections, packaging, and factors affecting yield.

UNIT I CRYSTAL GROWTH 9

Introduction to Semiconductor Manufacturing and fabrication, Clean Room types and Standards, Physics of the Crystal growth, wafer fabrication and basic properties of silicon wafers.

UNIT II LITHOGRAPHY 9

Photolithographic Process, Photomask Fabrication, Comparison between positive and negative photoresists, Exposure Systems, Characteristics of Exposure Systems, E-beam Lithography, X-ray lithography.

UNIT III THERMAL OXIDATION OF SILICON 9

Oxidation Process, Modeling Oxidation, Masking Properties of Silicon Dioxide, Technology of Oxidation, Si-SiO2 Interface

UNIT IV DIFFUSION AND ION IMPLANTATION 9

Diffusion Process, Mathematical Model for Diffusion, Constant, Diffusion Coefficient, Successive Diffusions, Diffusion Systems, Implantation Technology, Mathematical Model for Ion Implantation, Selective Implantation, Channeling, Lattice Damage and Annealing, Shallow Implantations

UNIT V THIN FILM DEPOSITION, CONTACTS, PACKAGING AND YIELD 9

Chemical Vapor Deposition, Physical Vapor Deposition, Epitaxy, Metal Interconnections and Contact Technology, Silicides and Multilayer-Contact Technology, Copper Interconnects and Damascene Processes, Wafer Thinning and Die Separation, Die Attachment, Wire Bonding, Packages, Yield.

TOTAL: 45 PERIODS

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Understand semiconductor manufacturing and clean room standards.
CO2: Master photolithography, including photomask fabrication and comparing photoresists.
CO3: Learn silicon's thermal oxidation process, modeling, and masking properties.
CO4: Comprehend diffusion, ion implantation, and annealing.
CO5: Explore thin film deposition, metal interconnections, packaging, and yield factors.

Text Books:

1. S.M. Sze, VLSI technology, Tata McGraw-Hill, Second Edition, 2017.
2. R.C. Jaeger, Introduction to microelectronic fabrication, Prentice Hall, Second Edition, 2013.

References:

1. S.A. Campbell, The science and engineering of microelectronics fabrication, Oxford University Press, UK, Second Edition, 2012.
2. Simon M. Sze, Gary S. May Fundamentals of Semiconductor Fabrication, Wiley, 2011.

Course Code	NANOSCALE DEVICES AND CIRCUIT DESIGN	L	T	P	C
VD4V12		3	0	0	3

COURSE OBJECTIVES:

- To understand the significance of CMOS scaling in semiconductor technology.
- To gain expertise in multigate MOSFET theory and its application in analog and digital circuits.
- To investigate materials properties crucial for designing microsensors.
- To learn concepts essential for realizing microsensors and actuators.
- To understand the working principles of interface circuits for various sensors.

.

UNIT I INTRODUCTION TO NOVEL MOSFETS 9

MOSFET scaling, short channel effects, quantum effects, volume inversion, threshold voltage, SOI MOSFET, multigate transistors, single gate, double gate, triple gate, surround gate, Silicon Nanowire transistors

UNIT II NANOSCALE DEVICES AND CIRCUIT DESIGN 9

Photolithographic Process, Photomask Fabrication, Comparison between positive and negative photoresists, Exposure Systems, Characteristics of Exposure Systems, E-beam Lithography, X-ray lithography.

UNIT III NANOWIRE FETS 9

Silicon nanowire MOSFETs, evaluation of I-V characteristics, I-V characteristics for non-degenerate carrier statistics, I-V characteristics for degenerate carrier statistics, electronic conduction in molecules, general model for ballistic nano transistors, CNT-FETs

UNIT IV DIGITAL CIRCUIT DESIGN USING MULTI-GATE DEVICES 9

Digital circuits design, impact of device performance on digital circuits, leakage performance trade off, multi VT devices and circuits, SRAM design

UNIT V CARBON NANOTUBE FET 9

CNT-FET, CNT memories, CNT based switches, logic gates, CNT based RF devices, CNT based RTDs, CNTFET based applications

TOTAL : 45 PERIODS

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Gain a comprehensive understanding of semiconductor manufacturing processes and clean room standards.

CO2: Master photolithography techniques, including photomask fabrication and comparison of photoresists.

CO3: Learn the thermal oxidation process of silicon and its modeling, along with the masking properties of silicon dioxide.
CO4: Comprehend diffusion processes, mathematical models, and ion implantation technology, including selective implantation and annealing.
CO5: Explore thin film deposition, metal interconnections, packaging methodologies, and factors affecting yield.

Text Books:

1. J P Colinge, FINFETs and other Multi-gate Transistors, Springer, Germany, 2010.
2. B.G.Park, S.W. Hwang &Y.J.Park, Nanoelectronic Devices, Pan Stanford Publisher, Singapore, 2012.

References:

1. N. Collaert, CMOS Nanoelectronics: Innovative Devices, Architectures and Applications, Reprint Pan Stanford publisher, Singapore, 2012.
2. Niraj K. Jha, Deming Chen, Nanoelectronic Circuit Design, Springer London, First Edition, 2011.

Course Code	MEMORY DESIGN AND TESTING	L	T	P	C
VD4V13		3	0	0	3

COURSE OBJECTIVES:

- To understand SRAM and DRAM architectures for robust memory systems.
- To learn about ROMs, PROMs, EPROMs, EEPROMs, and Flash memories for reliable memory design.
- To familiarize with fault modeling and testing methodologies for comprehensive memory system verification.
- To understand BIST methods for efficient fault detection in memory systems.
- To explore reliability issues and radiation hardening techniques for resilient memory systems.

UNIT I VOLATILE MEMORIES 9

SRAM – SRAM Cell structures, MOS SRAM Architecture, MOS SRAM cell and peripheral circuit operation, SOI technology, Advanced SRAM architectures and technologies, soft error failure in SRAM, Application specific SRAMs, DRAM – DRAM technology development, CMOS DRAM, DRAM cell theory and advanced cell structures, BICMOS DRAM, soft error failure in DRAM, Advanced DRAM design and architecture, Application specific DRAM.

UNIT II NON-VOLATILE MEMORIES 9

Masked ROMs, High density ROM, PROM, Bipolar ROM, CMOS PROMS, EPROM, Floating gate EPROM cell, One time programmable EPROM, EEPROM, EEPROM technology and architecture, Non-volatile SRAM, Flash Memories (EPROM or EEPROM), advanced Flash memory architecture.

UNIT III MEMORY TESTING AND PATTERNS 9

General Fault Modeling – Read Disturb Fault Model – Precharge Faults – False Write Through Data Retention Faults – Decoder Faults. Megabit DRAM Testing Nonvolatile Memory Modeling and Testing-IDDQ Fault Modeling and Testing Application Specific Memory Testing – Zero/one Pattern – Exhaustive Test Patterns – Walking, Matching and Galloping – Pseudo Random Pattern – CAM pattern.

UNIT IV **DESIGN FOR TEST AND BIST** 9

RAM Built-In Self – Test (BIST)-Weak Write Test mode – Bit Line Contact Resistance – PFET Test – Shadow Write and Shadow Read.

UNIT V **RELIABILITY AND RADIATION EFFECTS** 9

General Reliability Issues-RAM Failure Modes and Mechanism-Nonvolatile Memory Reliability-Design for Reliability Radiation Effects-Single Event Phenomenon (SEP)- Radiation Hardening Techniques Radiation Hardening Process and Design Issues-Radiation Hardened Memory Characteristics.

TOTAL: 45 PERIODS

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Design SRAMs and DRAMs.

CO2: Design NVRAMs and Flash Memories.

CO3: Model memory faults, select suitable testing patterns and develop testing patterns.

CO4: Incorporate DFT and BIST techniques for semiconductor memory testing.

CO5: Improve the reliability of semiconductor memories, simulate and model radiation effects and, perform radiation hardening.

Text Books:

1. K.Sharma, Advanced Semiconductor Memories: Architecture, Design and Applications, John Wiley, 2014.

2. Roberto Gastaldi and Giovanni Campardo In Search of the Next Memory: Inside the Circuitry from the Oldest to the Emerging Non-Volatile Memories, Springer, 2017.

References:

1. Alberto Bosio, Luigi Dilillo, Patrick Girard, Serge Pravossoudovitch, Arnaud Virazel, Advanced Test Methods for SRAMs: Effective Solutions for Dynamic Fault Detection in Nanoscaled Technologies, Springer, 2010.

2. Hao Yu and YuhaoWang, Design Exploration of Emerging Nano-scale Non-volatile Memory, Springer, 2014.

3. Takayuki Kawahara (Editor), Hiroyuki Mizuno (Editor), Green Computing with Emerging Memory: Low-Power Computation for Social Innovation, Springer, 2012.

Course Code	**SYSTEM ON CHIP DESIGN**	L	T	P	C
VD4V14		3	0	0	3

COURSE OBJECTIVES:

- To understand the architecture of present-day SoCs and the design issues associated with them and learn about hardware-software codesign and core libraries used in SoC design.
- To master the design methodology for logic, memory, and analog cores in SoCs, including guidelines for design reuse.
- To gain proficiency in SystemC for SoC design, focusing on switched capacitor circuits and their non-idealities.
- To explore SoC and NoC interconnection structures, including bus-based structures and network on chip (NoC) topologies.
- To learn about timing optimization and interface logic model design and analysis for SoC design.

UNIT I INTRODUCTION 9

Architecture of the present-day SoC - Design issues of SoC- Hardware-Software Co design – Core Libraries – EDA Tools.

UNIT II DESIGN METHODOLOGY FOR LOGIC, MEMORY AND ANALOG CORES 9

SoC Design Flow – guidelines for design reuse – Introduction- Efficiency of application specific hardware- Target architectures for HW/SW partitioning -System Integration, Embedded memories – design methodology for embedded memories – Specification of analog cores.

UNIT III INTRODUCTION TO SYSTEM C FOR SOC DESIGN 9

Switched Capacitor (SC) circuits– Parasitic Insensitive Switched Capacitor amplifiers - Non idealities in SC Amplifiers – Finite gain - DC offset - Gain Bandwidth Product. Fully differential SC circuits - DC negative feedback in SC circuits.

UNIT IV SOC AND NOC INTERCONNECTION STRUCTURES 9

SoC Interconnection Structures- Bus-based Structures- AMBA Bus.Network on Chip -NoC Interconnection Structures-Topologies- routing- flow control- network components (router/switch, network interface, Links).

UNIT V STA FOR SOC DESIGN 9

Timing paths and its Timing Optimization- Slow to High and High to low frequency timing path Half cycle timing path- Latch time borrowing- Interface Logic Model design and analysis for SoC design.

TOTAL: 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Demonstrate an ability to identify, formulate and treat complex issues in the field of system-on-chip from a holistic perspective.
CO2: Improve the performance of SoC based design by various advanced techniques.
CO3: Apply SystemC for system design.
CO4: Use interconnection structures in a SoC / NoC based system design.
CO5: Apply static timing analysis for a SoC based design.

Text Books:

1. Michael J. Flynn, Wayne Luk,Computer System Design: System on chip,Wiley-Blackwell, First Edition, 2011.
2. J. Bhasker, RakeshChadha,STA for Nanometer design – A practical approach, Springer, First Edition, 2010

References:

1. Jose L. Ayala, Communication Architectures for Systems-on-Chip, CRC Press, 1st Edition, 2011.

2. Laung-Terng Wang, Charles E. Stroud, Nur A. Touba, System-on-Chip Test Architectures: Nanometer Design for Testability, Morgan Kaufmann, First Edition, 2010.
3. Ahmed Jerraya and Wayne Wolf, Multiprocessor Systems-on-Chips (Systems on Silicon Series), Morgan Kaufmann, First Edition, 2010.

Course Code	DESIGN VERIFICATION OF VLSI CIRCUITS	L	T	P	C
VD4V15		2	0	2	3

COURSE OBJECTIVES:

- To understand System Verilog basics, including data types, control flow, and procedural statements.
- To learn object-oriented programming concepts such as encapsulation, polymorphism, and inheritance.
- To master SV constraints and arrays for effective testbench development.
- To explore interprocess communication, interfaces, clocking blocks, and coverage in SV.
- To develop a comprehensive SV verification environment with verification blocks.

UNIT I BASICS OF SYSTEM VERILOG 9

Introduction to System Verilog (SV), Difference between Verilog and SV, SV Data types: 2 State Data types (bit, byte, int, long_int, short_int), 4 State Data types (integer, real, real,time, logic, reg), User defined data types (Struct, enum, string, typedef), attributes-operators, expressions, procedural statements, and control flow

UNIT II OBJECT ORIENTED PROGRAMMING AND METHODS 9

OOPs, Encapsulation, Polymorphism, Inheritance, Built-in Methods: Randomization, Pre & Post Randomize, Object Creation (new), User-Defined Methods: print method, copy methods (copy by handle, Shallow copy, Deep Copy)

UNIT III SV CONSTRAINTS AND ARRAYS 9

Simple Constraints, Weighted Distributed Constraint, Implication Operator Based Constraint, Variable Order Based Constraint, Static Array and Dynamic Arrays (Dynamic, Associative and Queue Array)

UNIT IV INTERPROCESS COMMUNICATION, INTERFACE AND COVERAGE 9

IPC, Semaphore, Mailbox, Events, Interface, Virtual Interface, Modport, Clocking Block, Coverage, Functional Coverage, Code Coverage, Cross Coverage, Coverage option

UNIT V SV VERIFICATION ENVIRONMENT 9

SV Verification Blocks , Generator Block: Bus Functional Model (BFM) Block, Interface Block, Monitor Block, Assertion Block, Environment Block, Program Block

TOTAL: 45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. Introduction to testing and verification tool.
2. Verilog coding for Testing and verification.
3. Verilog coding for Tasks, Functions and Computer Directives.
4. Implementing Object-oriented programming concepts using Verilog.
5. Experiments on Device Under Test.

6. Write Verilog/VHDL test bench for functional verification of a given Design-Under Test (DUT).
7. Write a code to demonstrate transaction methods.
8. Write a code to demonstrate stimulus generator class.
9. Write code to verify Design-Under Test (DUT) using SV and UVM.

Course Format
Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading
Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:
Upon Completion of the course the students will be able to
CO1: Utilize mathematical tools for physical design problems
CO2: Expose to hierarchical modeling concepts and the necessary knowledge to perform partitioning algorithms
CO3: Design a compact IC using floor planning methodologies
CO4: Design a compact IC using placement methodologies
CO5: Analyze the routing process to achieve the performance of the digital design

Text Books:
1. Chris Spear and Greg Tumbush, System Verilog for Verification, Third Edition, Springer US ,2012.
2. Stuart Sutherland, Simon Davidmann , Peter Flake, "SystemVerilog for Design", Second Edition, Springer New York, NY,2006.

References:
1. S.Palnitkar, Verilog HDL:A Guide to Digital Design and Synthesis, Prentice Hall, 2nd edition, 2003.

Course Code	**SCRIPTING LANGUAGES FOR VLSI DESIGN AUTOMATION**	L	T	P	C
VD4V16		3	0	0	3

COURSE OBJECTIVES:
- To understand TCL fundamentals, including syntax, variables, and control structures.
- To learn advanced TCL topics like regular expressions, namespaces, and event-driven programming.
- To master TK fundamentals and widget management.
- To gain proficiency in Perl basics, including scalar data, arrays, and control structures.
- To explore advanced Perl concepts such as file manipulation, process management, and modules.

UNIT I **TCL BASICS** 9
Tool Command Language (TCL) fundamentals, language syntax, variables, expressions-String processing –TCL Lists-control structure command - Procedure and scope-TCL arrays, Working with files and Programs

UNIT II **ADVANCED TOPICS IN TCL** **9**

Quoting issues and Regular expressions-Script libraries and Packages-Reflection and debugging-Namespaces-Internationalization-Event driven programming-Socket programming

UNIT III **TOOL KIT BASICS** 9

TK(Tool Kit) fundamentals-The pack geometry manager, The grid geometry manager, The place geometry manager, Binding commands to events-TK widgets

UNIT IV **PERL BASICS** 9

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

UNIT V **ADVANCED CONCEPTS OF PERL** 9

Directory access-File and Directory Manipulation-Process Management-Packages and Modules.

TOTAL : 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Develop proficiency in fundamental concepts of the Tool Command Language (TCL), including syntax, variables, expressions, and control structures.

CO2: Learn to effectively utilize TCL for string processing, list manipulation, and file handling tasks.

CO3: Gain expertise in advanced TCL topics such as regular expressions, script libraries, and event-driven programming.

CO4: Master the fundamentals of the Tool Kit (TK) and its widget management techniques.

CO5: Develop a strong understanding of Perl programming basics, including scalar data, arrays, control structures, and regular expressions.

Text Books:

1. John K. Ousterhout, Ken Jones, “Tcl and the Tk Toolkit”, Pearson Education, Second Edition, 2010.
2. Larry Wall, Tom Christiansen, John Orwant, “Programming PERL”, Oreilly Publications, Fourth Edition, 2012.

References:

1. Chromatic “Modern Perl “Fourth Edition, 2015.
2. Naveed Sherwani, Algorithms for VLSI physical design Automation, Kluwer Academic Publishers, 2013.

Vertical 2: Signal Processing

Course Code	ADAPTIVE SIGNAL PROCESSING	L	T	P	C
VD4V21		3	0	0	3

COURSE OBJECTIVES:

- To provide an in-depth coverage of the adaptive filter theory.
- To provide the mathematical framework for the understanding of adaptive statistical signal processing.
- To know the basic tools of vector spaces and discrete-time stochastic process.
- To introduce various types of adaptive filters and their properties will be studied, specifically convergence, tracking, robustness and computational complexity.
- Learn to apply adaptive filter theory using prescribed case studies.

UNIT I STOCHASTIC PROCESSES AND SPECTRUM ESTIMATION 9

Statistical characteristics of a stochastic process-Non-Parametric methods - Correlation method - Co-variance estimator - Performance analysis of estimators – Unbiased consistent estimators - Periodogram estimator - Barlett spectrum estimation - Welch estimation - Model based approach - AR, MA, ARMA Signal modeling - Parameter estimation using Yule-Walker method.

UNIT II WIENER FILTERS 9

Optimum Filtering-The normal equations and the Wiener filter-Minimum mean square error estimation and the orthogonality principle-Wiener-Hopf equations- Linear prediction-forward Linear Prediction-Backward linear prediction-Levinson-Durbin algorithm.

UNIT III GRADIENT-BASED ADAPTIVE FILTERS 9

Basic idea of the steepest descent algorithm- The steepest descent algorithm applied to wiener filter – Stability of the steepest descent algorithm- The LMS algorithm-LMS adaptive algorithm Method of Least Squares-Data windowing-Properties of LS Estimates-MVDR spectrum estimation. Recursive Least Squares (RLS)-Exponentially weighted RLS-Convergence analysis-Sliding window RLS.

UNIT IV KALMAN FILTERS & TRACKING 9

Statement of the kalman filtering problem-The innovation process- Estimation– Filtering -Initial conditions. Variants of the kalman filter-The Extended Kalman filter-Criteria for tracking assessment-Tracking performance of the LMS and RLS algorithms- Comparison.

UNIT V APPLICATIONS 9

Channel equalization-Echo cancellation- De-convolution- Adaptive noise cancellation-Adaptive interference cancellation. Case study.

TOTAL: 45 PERIODS

Course Outcomes:

Upon Successful Completion of the course the students will be able to

CO1: Gain a solid foundation in adaptive filter theory, focusing on designing filters that can self-optimize through learning from processes.

CO2: Be able to implement adaptive filters effectively, applying both time and frequency domain concepts with computational tools.

CO3: Understand and apply stochastic processes to enhance the design and efficiency of adaptive filters.
CO4: Acquire skills in developing adaptive filter algorithms, with a focus on their mathematical basis and practical application.
CO5: Apply adaptive filter techniques to real-world problems, such as echo cancellation, noise reduction, and signal clarification, demonstrating their practical utility.

Text Books:

1. Simon Haykin, "Adaptive Filter Theory", Pearson Education, Fourth Edition, 2003.
2. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", Wiley, 2008.

References:

1. Ali.H.Sayed, "Fundamentals of Adaptive Filtering", John Wiley & Sons, 2003.
2.Paulo S. R. Diniz, "Adaptive Filtering Algorithms and Practical Implementation", Springer, 2011.
3. Lino Garcia, "Adaptive Filtering Applications", InTech, Published, 2011.
4. Kong-Aik Lee, Woon-SengGan, Sen M. Kuo, "Subband Adaptive Filtering: Theory and Implementation", Wiley, 2009.

Course Code	SPEECH SIGNAL PROCESSING	L	T	P	C
VD4V22		3	0	0	3

COURSE OBJECTIVES:

- To understand the mechanism of human speech production and its discrete-time model.
- To acquire knowledge of articulatory, acoustic, and auditory phonetics, including spectrographic analysis and speech sound categorization.
- To understand the significance of speech features in applications and different distortion measures such as cepstral coefficients and Mel Frequency Cepstral Coefficients (MFCCs).
- To explore various speech coding techniques including waveform coding, parametric speech coding, and transform domain coding, along with standards like G.726 for ADPCM and Code Excited Linear Prediction (CELP) based vocoders.
- To learn about speech enhancement algorithms and synthesizer technologies including Text-to-Speech systems (TTS), concatenative synthesis, and HMM-based synthesis.

UNIT I FUNDAMENTALS OF SPEECH 9

The Human speech production mechanism, Discrete-Time model of speech production, Speech perception - human auditory system, Phonetics - articulatory phonetics, acoustic phonetics, and auditory phonetics, Categorization of speech sounds, Spectrographic analysis of speech sounds, Pitch frequency, Pitch period measurement using spectral and cepstral domain, Formants, Evaluation of Formants for voiced and unvoiced speech.

UNIT II SPEECH FEATURES AND DISTORTION MEASURES 9

Significance of speech features in speech-based applications, Speech Features – Cepstral Coefficients, Mel Frequency Cepstral Coefficients (MFCCs), Perceptual Linear Prediction (PLP), Log Frequency Power Coefficients (LFPCs), Speech distortion measures–Simplified distance measure, LPC-based distance measure, Spectral distortion measure, Perceptual distortion measure.

UNIT III SPEECH CODING 9

Need for speech coding, Waveform coding of speech – PCM, Adaptive PCM, DPCM, ADPCM, Delta Modulation, Adaptive Delta Modulation, G.726 Standard for ADPCM, Parametric Speech Coding – Channel Vocoders, Linear Prediction Based Vocoders, Code Excited Linear Prediction (CELP) based Vocoders, Sinusoidal speech coding techniques, Hybrid coder, Transform domain coding of speech

UNIT IV SPEECH ENHANCEMENT 9

Classes of Speech Enhancement Algorithms, Spectral-Subtractive Algorithms – Multiband Spectral Subtraction, MMSE Spectral Subtraction Algorithm, Spectral Subtraction Based on Perceptual Properties, Wiener Filtering - Wiener Filters in the Time Domain, Wiener Filters in the Frequency Domain, Wiener Filters for Noise Reduction, Maximum-Likelihood Estimators, Bayesian Estimators, MMSE and Log-MMSE Estimator, Subspace Algorithms.

UNIT V SPEECH SYNTHESIS AND APPLICATION 9

A Text-to-Speech systems (TTS), Synthesizers technologies – Concatenative synthesis, Use of Formants for concatenative synthesis, Use of LPC for concatenative synthesis, HMM-based synthesis, Sine wave synthesis, Speech transformations, Watermarking for authentication of a speech, Emotion recognition from speech

TOTAL: 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Understand speech production mechanisms and discrete-time models.

CO2: Acquire knowledge of articulatory, acoustic, and auditory phonetics.

CO3: Recognize the significance of speech features and distortion measures.

CO4: Explore various speech coding techniques and standards.

CO5: Learn about speech enhancement algorithms and synthesizer technologies.

Text Books:

1.Shaila D. Apte, Speech and Audio Processing, Wiley India (P) Ltd, New Delhi, 2012

2. Philipos C. Loizou, Speech Enhancement Theory and Practice, Second Edition, CRC Press, Inc., United States, 2013

References:

1.Rabiner L. R. and Juang B. H, Fundamentals of speech recognition, Pearson Education, 2003

2.Thomas F. Quatieri, Discrete-time speech signal processing - Principles and practice, Pearson, 2012

Course Code	VLSI DIGITAL SIGNAL PROCESSING SYSTEMS	L	T	P	C
VD4V23		3	0	0	3

COURSE OBJECTIVES:

- To introduce DSP systems, typical algorithms, and data flow concepts.
- To explore pipelining and parallel processing in digital filters for performance enhancement and power reduction.
- To teach algorithmic techniques for strength reduction in filters and transforms.
- To provide knowledge on advanced digital filter architectures and fast convolution algorithms.
- To explain numerical strength reduction and various pipelining techniques for digital systems optimization.

UNIT I PIPELINING AND PARALLEL PROCESSING OF DIGITAL FILTERS 9

Introduction to DSP systems –Typical DSP algorithms, Data flow and Dependence graphs – critical path, Loop bound, iteration bound, Longest path matrix algorithm, Pipelining and Parallel processing in filters, Pipelining and Parallel processing for low power

UNIT II ALGORITHMIC STRENGTH REDUCTION TECHNIQUE I 9

Retiming – definitions and properties, Unfolding – an algorithm for unfolding, properties of unfolding, sample period reduction and parallel processing application, Algorithmic strength reduction in filters and transforms – 2-parallel FIR filter, 2-parallel fast FIR filter, DCT architecture, rank-order filters, Odd-Even merge-sort architecture, parallel rank-order filters.

UNIT III ALGORITHMIC STRENGTH REDUCTION TECHNIQUE -II 9

Fast convolution – Cook-Toom algorithm, modified Cook-Toom algorithm, Pipelined and parallel recursive filters – Look-Ahead pipelining in first-order IIR filters, Look-Ahead pipelining with power of-2 decomposition, Clustered look-ahead pipelining, Parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters.

UNIT IV BIT-LEVEL ARITHMETIC ARCHITECTURES 9

Bit-level arithmetic architectures – parallel multipliers with sign extension, parallel carry-ripple and carry-save multipliers, Design of Lyon‟s bit-serial multipliers using Horner‟s rule, bit-serial FIR filter, CSD representation, CSD multiplication using Horner‟s rule for precision improvement, Distributed Arithmetic fundamentals and FIR filters

UNIT V NUMERICAL STRENGTH REDUCTION, WAVE AND ASYNCHRONOUS PIPELINING 9

Numerical strength reduction – subexpression elimination, multiple constant multiplication, iterative matching, synchronous pipelining and clocking styles, clock skew in edge-triggered single phase clocking, two-phase clocking, wave pipelining. Asynchronous pipelining bundled data versus dual rail protocol.

TOTAL: 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Understand and explain basic DSP principles, including data flow and dependence graphs.
CO2: Apply pipelining and parallel processing techniques in digital filter design.
CO3: Utilize algorithmic strength reduction techniques for filter and transform optimization.
CO4: Design advanced digital filter architectures with bit-level arithmetic and fast convolution.
CO5: Implement numerical strength reduction and pipelining techniques to optimize digital systems.

Text Books:

1. 1. Keshab K. Parhi, " VLSI Digital Signal Processing Systems, Design and implementation ", Wiley, Interscience, 2007.
2. 2. U. Meyer – Baese, " Digital Signal Processing with Field Programmable Gate Arrays", Springer, Second Edition, 2004.

References:

1. Emmanuel C. Ifeachor, Barrie W.Jervis, second edition „Digital Signal processing- A Practical Approach‟ Pearson education Ltd., 2002
2. P. Ramesh Babu, "Digital Signal Processing", Sixth Edition, Scitech publications, Chennai, 2014.

Course Code	**AR / VR**	L	T	P	C
VD4V24		3	0	0	3

COURSE OBJECTIVES:

- To understand Virtual Reality fundamentals, applications, and scientific landmarks in 3D computer graphics.
- To explore interactive techniques, geometric transformations, and generic VR systems.
- To examine visual computation in VR, including animation and physical simulation.
- To gain insights into augmented and mixed reality, covering taxonomy and challenges.
- To explore multiple input and output interfaces in VR, including hardware and software components.

UNIT I INTRODUCTION OF VIRTUAL REALITY 9

Introduction, Fundamental Concept and Components of Virtual Reality. Primary Features and Present Development on Virtual Reality. Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Virtuality and Immersion, Current trends and state of the art in immersive technologies, developing platforms and consumer devices. Scientific Landmark 3D Computer Graphics: Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory, Simple 3D modelling, Illumination models, Reflection models, Shading algorithms

UNIT II INTERACTIVE TECHNIQUES IN VIRTUAL REALITY 9

Introduction, From 2D to 3D, 3D space curves, 3D boundary representation Geometrical Transformations: Introduction, Frames of reference, Modeling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems.

UNIT III VISUAL COMPUTATION IN VIRTUAL REALITY 9

Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object inbetweening, free from deformation, particle system. Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.

UNIT IV AUGMENTED AND MIXED REALITY 9

Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.

UNIT V MULTIPLE MODELS OF INPUT AND OUTPUT INTERFACE IN VIRTUAL REALITY 9

Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modeling virtual world, Physical simulation, VR toolkits, Introduction to VRML, Input -- Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus & 3D Scanner etc. Output -- Visual /Auditory/ Haptic Devices.

TOTAL : 45 PERIODS

Course Outcomes:

After learning the course, the students should be able to:

CO1: Demonstrate understanding and design of VR/AR technology relates to human perception and cognition

CO2: Ability to design 3D interaction techniques

CO3: Demonstrate understanding of fundamental computer vision, computer graphics and human-computer interaction techniques related to VR/AR

CO4: Demonstrate insights to key application areas for VR/AR

CO5: Able to create applications of VR to the conduct of scientific research, training, and industrial design.

Text Books:

1. Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006.
2. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.
3. Anand R., "Augmented and Virtual Reality", Khanna Publishing House, Delhi.

References:

1. Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
2. John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007.
3. Grigore C. Burdea, Philippe Coiffet , "Virtual Reality Technology", Wiley Inter Science, 2nd Edition, 2006.
4. Grigore C. Burdea, Philippe Coiffet , Virtual Reality Technology, Wiley 2016
5. Dieter Schmalstieg and Tobias Höllerer, Augmented Reality: Principles & Practice, Pearson Education India, 2016
6. Kent Norman (Ed), Wiley Handbook of Human Computer Interaction, Wiley 2017

Course Code	DSP ARCHITECTURES	L	T	P	C
VD4V25		3	0	0	3

COURSE OBJECTIVES:

- To understand the structure of multipliers and the principles of pipelining.
- To study and analyze the architecture and features of the TMS320C5X processor.
- To study and analyze the architecture and features of the TMS320C6X processor.
- To explore and evaluate the ADSP processors.
- To learn about advanced Digital Signal Processing (DSP) processors and their applications.

UNIT I INTRODUCTION TO BCI 9

Multiplier and Multiplier accumulator – Modified Bus Structures and Memory access in PDSPs – Multiple access memory – Multi-port memory – VLIW architecture- Pipelining – Special Addressing modes in P-DSPs – On chip Peripherals.

UNIT II TMS320C5X PROCESSOR 9

Architecture – Assembly language syntax - Addressing modes – Assembly language Instructions - Pipeline structure, Operation – Block Diagram of DSP starter kit – Application Programs for processing real time signals.

UNIT III TMS320C6X PROCESSOR 9

Architecture of the C6x Processor - Instruction Set - DSP Development System: Introduction– DSP Starter Kit Support Tools- Code Composer Studio - Support Files - Programming Examples to Test the DSK Tools – Application Programs for processing real time signals.

UNIT IV ADSP PROCESSORS 9

Architecture of ADSP-21XX and ADSP-210XX series of DSP processors- Addressing modes and assembly language instructions – Application programs –Filter design, FFT calculation.

UNIT V ADVANCED PROCESSORS 9

Architecture of TMS320C54X: Pipe line operation, Code Composer studio – Architecture of TMS320C6X - Architecture of Motorola DSP563XX – Comparison of the features of DSP family processors.

TOTAL: 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:

Upon Completion of the course the students will be able to

CO1. Describe the structure of multipliers and the principles of pipelining.
CO2. Analyze the architecture and features of the TMS320C5X processor.
CO3. Analyze the architecture and features of the TMS320C6X processor.
CO4. Evaluate the architecture and features of ADSP processors.
CO5. Understand and apply advanced Digital Signal Processing (DSP) processors.

Text Books:

1. Avtar Singh and S. Srinivasan, Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx, cengage Learning India Private Limited, Delhi 2012
2. B. Venkataramani and M. Bhaskar, "Digital Signal Processors – Architecture,
3. Programming and Applications" – Tata McGraw – Hill Publishing Company Limited. New Delhi, 2003.

References:

1. Rulph Chassaing, Digital Signal Processing and Applications with the C6713 and C6416DSK, A JOHN WILEY & SONS, INC., PUBLICATION, 2005
2. User guides Texas Instrumentation, Analog Devices, Motorola

Course Code	BRAIN COMPUTER INTERFACE AND APPLICATIONS	L	T	P	C
VD4V26		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of Brain-Computer Interface (BCI) systems and their potential applications.
- To study event-related potentials and sensory motor rhythms for BCI analysis.
- To learn to compute features suitable for effective BCI implementation.
- To develop skills to design classifiers for BCI systems.
- To gain practical knowledge to implement BCI systems for various applications.

UNIT I INTRODUCTION TO BCI 9

Fundamentals of BCI – Structure of BCI system – Classification of BCI – Invasive, Non-invasive and Partially invasive BCI – EEG signal acquisition - Signal Preprocessing – Artifacts removal.

UNIT II ELECTROPHYSIOLOGICAL SOURCES 9

Sensorimotor activity – Mu rhythm, Movement Related Potentials – Slow Cortical Potentials- P300 -Visual Evoked Potential - Activity of Neural Cells - Multiple Neuromechanisms.

UNIT III FEATURE EXTRACTION METHODS 9

Time/Space Methods – Fourier Transform, PSD – Wavelets – Parametric Methods – AR,MA,ARMA models – PCA – Linear and Non-Linear Features.

UNIT IV FEATURE TRANSLATION METHODS 9

Linear Discriminant Analysis – Support Vector Machines - Regression – Vector Quantization– Gaussian Mixture Modeling – Hidden Markov Modeling – Neural Networks.

UNIT V APPLICATIONS OF BCI 9

Functional restoration using Neuroprosthesis - Functional Electrical Stimulation, Visual Feedback and control - External device control, Case study: Brain actuated control of mobile Robot.

TOTAL: 45 PERIODS

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Gain an understanding of the core principles underlying Brain-Computer Interface (BCI) systems and their wide-ranging applications.

CO2: Explore event-related potentials and sensory motor rhythms for the analysis and interpretation of BCI signals.

CO3: Acquire the ability to calculate and extract features suitable for the efficient implementation of BCIs.

CO4: Develop expertise in crafting classifiers specifically designed for BCI systems.

CO5: Attain practical knowledge essential for the successful implementation of BCI systems across diverse application domains.

Text Books:

1. Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010.

References:

1 R. Spehlmann, "EEG Primer", Elsevier Biomedical Press, 1981.

2. Arnon Kohen, "Biomedical Signal Processing", Vol I and II, CRC Press Inc, Boca Rato, Florida, 1986.

Vertical 3: Embedded Systems and IoT

Course Code	REAL TIME OPERATING SYSTEMS	L	T	P	C
VD4V31		2	0	2	3

COURSE OBJECTIVES:

- To expose the students to the fundamentals of interaction of OS with a computer and User computation.
- To teach the fundamental concepts of how processes are created and controlled with the OS.
- To study programming logic of modeling Process based on range of OS features.
- To compare types and Functionalities in commercial OS, application development using RTOS.
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired.

UNIT I INTRODUCTION TO OPERATING SYSTEMS 9

Basic of Operating system – Evolution of operating system – Hardware review- Types of Operating system - Operating system concepts - Systems calls – Operating system structure.

UNIT II PROCESSES AND THREADS 9

RTOS Architecture – RTOS Task and Task state, Process Synchronization, Message queues, shared memory, Mail boxes, pipes, Critical section, Semaphores, mutex, priority inversion and ceiling, circular and swinging buffers.

UNIT III TASK MANAGEMENT AND RTOS SCHEDULING 9

Process and Threads, Process Control Block, Process Attributes, Interrupt processing, memory management, Priority based scheduling, Rate-Monotonic scheduling, Earliest Deadline first scheduling

UNIT IV **REALTIME KERNEL** 9

Principles, Kernel, Monolithic and Microkernel, Design issues, Polled Loop Systems, RTOS Porting to a Target, Comparison and Basic study of various RTOS like VX works Linux supportive RTOS.

UNIT V **FREE RTOS CONCEPTS** 9

Overview of Free RTOS – Architecture – Advanced Free RTOS concepts – Implementation of Task Scheduling, Queue Management, mutex,Semaphore with Free RTOS.

TOTAL : 45 PERIODS

PRACTICAL EXERCISES: **30 PERIODS**

1. Task Creation and Management

Exercise: Create tasks to blink LEDs at different rates using vTaskDelay and manage task priorities with vTaskPrioritySet.

2. Mutexes and Task Synchronization

Exercise: Create two tasks accessing a shared resource. Use mutexes (xSemaphoreCreateMutex, xSemaphoreTake, xSemaphoreGive) to prevent race conditions.

3. Semaphore and Event Group Usage

Exercise: Implement a scenario where one task waits for an event signaled by another using semaphores (xSemaphoreCreateBinary, xSemaphoreGive, xSemaphoreTake) and event groups (xEventGroupCreate, xEventGroupSetBits, xEventGroupWaitBits).

4. Interrupt Service Routines (ISRs) and Queues

Exercise: Set up an interrupt-driven scenario with an external button press. Use an ISR to add data to a queue (xQueueSendFromISR) and a task to process it (xQueueReceive).

5. Task Priorities and Scheduler

Exercise: Create tasks with different priorities and observe scheduling. Dynamically change priorities with vTaskPrioritySet to simulate real-time constraints.

6. Memory Management and Dynamic Memory Allocation

Exercise: Allocate and deallocate memory using pvPortMalloc and vPortFree. Monitor heap usage and handle memory fragmentation and allocation failures.

7. Software Timers and Task Synchronization

Exercise: Implement periodic tasks using software timers (xTimerCreate, xTimerStart, xTimerStop) for task synchronization and event triggering.

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Understand Operating System structures and types.

CO2: Analyze the operating systems tasks and its assess to the resources.

CO3: Analyze the scheduling, disciplining of various processes execution.
CO4: Demonstrate commercial RTOS Suite features to work on real time processes design.
CO5: Develop Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in RTOS and embedded automation design.

Text Books:

1. Herma K., Real Time Systems, Design for distributed Embedded Applications, 2021, 2nd edition, Springer, USA
2. Tanenbaum, Andrew, Modern Operating Systems, 2015, 4th ed., Pearson Prentice Hall, USA

References:

1. Ivan Cibrario Bertolotti, Politecnico di Torino and Gabriele Manduchi, Real-Time Embedded Systems: Open-Source Operating Systems Perspective, 2022, 1st ed., CRC Press, USA.
2. Lyla B. Das, Embedded Systems an Integrated Approach, 2022, 1st ed., Pearson Education
3. Karim Yaghmour, Building Embedded Linux System, O reilly Pub,2023
4. Mukesh Sighal and N G Shi, Advanced Concepts in Operating System, McGraw Hill,2022

Course Code	IoT AND INDUSTRY 4.0	L	T	P	C
VD4V32		3	0	0	3

COURSE OBJECTIVES:

- To provide the overview about evolution and importance of Industrial IoT in the era of Industry 4.0
- To introduce the Industrial IoT reference architectures and Business models in industrial automation systems
- To understand the on-site key technologies for the requirement of a smart factory
- To get the knowledge of Industrial IoT data Analytics
- To apply the technologies of Industrial IoT in various Industries as case studies.

UNIT I INTRODUCTION AND KEY TECHNOLOGIES 9

Industrial revolutions. Cyber physical systems and Next generation sensors. On-site key technologies in Industry 4.0, AR-VR, Big data Analytics, Smart factories and Lean Manufacturing system.

UNIT II INDUSTRIAL AUTOMATION AND IOT 9

Evolution of IT and OT convergence. Industrial sensing, Industrial Processes and Industrial Network. Business models and IIRA Reference architecture of IIOT, Industrial internet Consortium (IIC).

UNIT III INDUSTRIAL DATA TRANSMISSION AND COMPUTING 9

Foundation Fieldbus, Profibus, CC-link, MODBUS, Digital STROM, CAN, Device Net, ISA 100.11a, Wireless HART, NB-IoT. Edge and Fog Computing solutions. Cloud services.

UNIT IV DATA ANALYTICS AND SECURITY 9

Necessity of Analytics and IIOT Data Analytics. Machine Learning and Data Science applications in Industries. Artificial Intelligence for IIOT, IoT Security- Vulnerabilities, Threat Analysis, Security model for IoT.

UNIT V **APPLICATIONS OF IIOT** 9

Healthcare Applications, Inventory Management and Quality Control. Case studies in Manufacturing Industry, Automotive Industry, Mining Industry, Textile Industry.

TOTAL : 45 PERIODS

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Understand about the evolution of Industry 4.0 in smart factories and cyber physical systems.

CO2: Identify the process of industrial automation system network and control.

CO3: Illustrate the reference architectural models and business models with key enabling technologies

CO4: Analyse the data of the industrial IoT systems with security.

CO5: Apply the technologies to various sectors and case study the application of Industrial IoT in smart industries.

Text Books:

1. Industry 4.0: The Industrial Internet of Things, by Alasdair Gilchrist (Apress), 2017.
2. Industrial Internet of Things: Cyber manufacturing Systems, by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer), 2017

References:

1. Hands-On Industrial Internet of Things: Create a powerful Industrial IoT by Giacomo Veneri, Antonio Capasso, Packt, 2018.
2. Misra, Sudip, Chandana Roy, and Anandarup Mukherjee. Introduction to industrial Internet of Things and industry 4.0. CRC Press, 2021.
3. Ustundag, Alp, and Emre Cevikcan. Industry 4.0: managing the digital transformation. Springer, 2017.
4. Ortiz, Jes Hamilton. "Industry 4.0: Current status and future trends." (2020).

Course Code	**COMMUNICATION PROTOCOL AND STANDARDS**	L	T	P	C
VD4V33		3	0	0	3

COURSE OBJECTIVES:

- To analyze the components and need for communication in ECU
- To analyze the functions and frame format of CAN protocols
- To analyze the concept of LIN Bus, MOD bus and FlexRay protocols
- To analyze the functions of OBD communication in inter vehicle communication
- To understand the Autosar Standard and its architecture

UNIT I **INTRODUCTION** **9**

Introduction to ECU Functions and Components, Need for Communication in ECU, Types of Communication, Onboard Communication, Diagnostic Communication, Measurement and Calibration, In Vehicle Cybersecurity Issues and Challenges.

UNIT II **Basic Protocols** 9

Basic functionality of GPIO ,UART, I^2C - Bus Architecture , Communication process, Advanced features , SPI - Bus Architecture ,Communication Process, Advanced features.

UNIT III **Automotive & Industrial Protocols** 9

Introduction to CAN,CAN controller block diagram and working- Electrical properties-CAN signalling and data rates, CAN data frame format, Error Handling mechanism - Software for CAN controller interfacing-CAN development tools- Basics of LIN bus protocol, Basics of MODBUS protocol.

UNIT IV **HIGH-LEVEL COMMUNICATION PROTOCOLS** 9

Onboard Communication J1939, Introduction, Key Characteristics, J1939 Standard and Layer Model, J1939 PGN and SPN, J1939 Transport Protocol, OBD II, OBD vs ISO OSI Layers, OBD Connectors, OBD Services, OBD Parameter ID (PIDs), OBD Connectors

UNIT V **AUTOSAR ARCHITECTURE** 9

Introduction to Autosar Standard and Consortium, Need for Autosar Architecture, Virtual Function Bus, Layered Architecture Model, Microcontroller Abstraction Layer, ECU Abstraction Layer, Service layer, Autosar example

TOTAL : 45 PERIODS

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Choose the suitable ECU components for different communication
CO2: Analyze the performance of CAN protocols
CO3: Analyze the performance of LINBus, MODbus and FlexRay protocols
CO4: Illustrate the architecture of OBD communication
CO5: Illustrate the architecture of Autosar Standard

Text Books:

1. Olaf Pfeiffer, Andrew Ayre and Christian Keydel, Embedded networking with CAN and CANopen, Copperhill Technologies Corporation, 2022

References:

1. Reference: www.can cia.org
2. SGS-Thompson, Lin Application note AN1278, SGS Thompson Ltd. 2022
3. Modbus-IDA, MODBUS application protocol specification, Modbus IDA, 2016
4. Siemens, Profibus network manual, Siemens manual, 2019
5. Xiu Ji, Profibus in practice: System Architecture and Design, CRC press, 2015

Course Code	**ARM ARCHITECTURE AND PROGRAMMING**	L	T	P	C
VD4V34		3	0	0	3

COURSE OBJECTIVES:

- To understand the embedded system based on ARM processor and its hardware (ARM processor Core).
- To understand the techniques and rules for writing efficient C code and optimizing ARM assembly code.
- To discuss various Cache technologies and Architecture that surrounds the ARM cores and MMU.
- To Understand the architecture of ARM CORTEX-M3
- To understand Smart OS and video conferencing systems

UNIT I **ARM ARCHITECTURE** 9

ARM Design Philosophy, Registers, Program Status Register, Instruction Pipeline, Interrupts and Vector Table, Architecture Revision, ARM Processor Families.

UNIT II **ARM PROGRAMMING MODEL – I** 9

Instruction Set: Data Processing Instructions, Addressing Modes, Branch, Load –Store Instructions, PSR Instructions, Conditional Instructions.

UNIT III **ARM PROGRAMMING MODEL – II** 9

Thumb Instruction Set: Register Usage, Other Branch Instructions, Data Processing Instructions, Single-Register and Multi Register Load-Store Instructions, Stack, Software Interrupt Instructions

UNIT IV **ARM PROGRAMMING** 9

Cache Architecture, Polices, Flushing and Caches, MMU, Page Tables, Translation, Access Permissions, Context Switch.

UNIT V **ARM CORTEX M3** 9

ARM Cortex-M3 Processor –Architecture- Instruction Set Development-The Thumb-2 Technology and Instruction Set Architecture-CORTEX-M3 Applications.

TOTAL: 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:

Upon Successful Completion of the course the students will be able to

CO1: Understand the basics of ARM architecture and how different ARM processors work.
CO2: Write efficient code using ARM's instruction sets and addressing modes.
CO3: Manage and optimize memory and processes using ARM's system-level features.
CO4: Develop applications for ARM Cortex-M3 processors, utilizing its specific features.
CO5: Apply their knowledge to design and implement embedded systems using ARM technology.

Text Books:

1. ARM System Developer's guide –Andrew N. SLOSS, ELSEVIER Publications, 2016
2. ARM Assembly Language – William Hohl, CRC Press, ISBN:978-81-89643-04-1

References:

1. Embedded Systems: A Contemporary Design Tool- James K. Peckol,ELSEVIER Publications 2022 ARM System-on-chip Architecture by Steve Furber, Pearson Education, 6E, 2022

Course Code	EDGE DATA ANALYTICS	L	T	P	C
VD4V35		3	0	0	3

COURSE OBJECTIVES:

- To learn the techniques and components of Edge Computing.
- To study about various data collection and preprocessing for edge devices
- To apply different data analytics techniques for different problems
- To study about different data visualization and Interpretation
- To learn about data security and privacy techniques.

UNIT I INTRODUCTION TO EDGE DATA ANALYTICS 9

Overview of Edge Computing and its significance; Role of Edge Data Analytics in real-time decision-making; Challenges and opportunities in Edge Data Analytics; Edge computing architectures and deployment models - distinction between edge, fog, and cloud layers, edge clouds, mobile edge computing (MEC), and industrial edge computing; Edge devices and sensors for data collection- GPU , TPU based hardware accelerators.

UNIT II EDGE DATA COLLECTION AND PREPROCESSING 9

Data collection techniques at the edge (e.g., IoT devices, sensors) Edge data preprocessing and filtering algorithms Data compression and aggregation techniques for resource-constrained devices Edge-based data cleaning and quality assurance Edge data integration and synchronization with cloud or central servers

UNIT III EDGE DATA ANALYTICS TECHNIQUES 9

Machine learning algorithms for edge data analysis (e.g., classification, regression) Statistical analysis methods for real-time data streams Edge-based anomaly detection and outlier identification Time-series analysis and forecasting at the edge Distributed and parallel computing techniques for edge analytics

UNIT IV EDGE DATA VISUALIZATION AND INTERPRETATION 9

Visualization techniques for edge data analytics Real-time dashboards and data monitoring at the edge Visualization of streaming data from multiple edge devices Interactive visualization tools for edge analytics Visual storytelling and decision support through edge data visualization

UNIT V EDGE DATA SECURITY AND PRIVACY 9

Security challenges in edge data analytics Secure communication protocols for edge devices Privacy-preserving techniques for edge data collection and analysis Access control and authentication in edge computing environments Legal and ethical considerations in edge data analytics

TOTAL: 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES:

On completion of this course, the students will be able to:

CO1: Able to understand edge data analytics, including data preprocessing, real-time analytics, distributed computing, and edge computing architectures.
CO2: Able to learn data collection methods and preprocessing techniques specifically designed for edge devices
CO3: Able to learn will gain hands-on experience in developing real-time analytics algorithms for edge devices
CO4: Able to will learn techniques to optimize edge data analytics for resource-constrained environments
CO5: Able to analyze the security and privacy challenges associated with edge data analytics

TEXTBOOKS:
1."Edge Analytics: A Comprehensive Guide for Internet of Things Data Analytics" by Satyajit Das and Taposh Dutta Roy (Published in 2018)
2."Edge Analytics in the Internet of Things: A Hands-on Introduction with Raspberry Pi and Edge Computing" by Madhura Jayaratna (Published in 2020)

REFERENCES:
1."Edge Analytics for Internet of Things: A Comprehensive Guide to Building Intelligent IoT Solutions" by Kaushik Das (Published in 2019)
2."Edge Computing for Data Analytics: Achieve Local Analytics and AI on Edge Devices" by Chi Harold Liu (Published in 2021)
3."Practical Industrial Internet of Things Security: A practitioner's guide to securing connected industries and supply chains" by Sravani Bhattacharjee, Debashis De, and Mohammad Saiful Islam (Published in 2022)

Course Code	EMBEDDED PROGRAMMING	L	T	P	C
VD4V36		2	0	2	3

COURSE OBJECTIVES:
The course is aimed to
- To understand the concept of embedded system design and analysis.
- To learn the architecture of ARM processors.
- To evaluate the Programming of ARM processor
- To expose the basic concepts of embedded programming.
- To apply real time operating systems

UNIT I INTRODUCTION TO EMBEDDED SYSTEM DESIGN 9
Complex systems and microprocessors– Embedded system design process –Design example: Model train controller- Design methodologies- Design flows - Requirement Analysis – Specifications-System analysis and architecture design – Quality Assurance techniques - Designing with computing platforms – consumer electronics architecture – platform-level performance analysis

UNIT II ARM PROCESSOR AND PERIPHERALS 9
ARM level Architecture Versions – ARM Architecture – Instruction Set – Stacks and Subroutines – Features of the LPC214X Family – Peripherals – The Timer Unit – Pulse Width Modulation Unit – UART – Block Diagram of ARM9 and ARM Cortex M3 MCU.

UNIT III EMBEDDED PROGRAMMING 9

Components for embedded programs- Models of programs- Assembly, linking and loading – compilation techniques- Program performance analysis –Performance optimization-Program validation and testing.

ARM Peripherals programming in Embedded C-GPIO-Serial Communication-Timer-ADC

UNIT IV REAL TIME SYSTEMS 9

Structure of a Real Time System –– Estimating program run times – Task Assignment and Scheduling – Fault Tolerance Techniques – Reliability, Evaluation – Clock Synchronisation.

UNIT V PROCESSES AND OPERATING SYSTEMS 9

Introduction – Multiple tasks and multiple processes – Multirate systems- Preemptive real time operating systems- Priority based scheduling- Interprocess communication mechanisms – Evaluating operating system performance- power optimization strategies for processes – Example Real time operating systems-POSIX-Windows CE. - Distributed embedded systems – MPSoCs and shared memory multiprocessors. – Design Example - Audio player, Engine control unit – Video accelerator.

TOTAL: 45 PERIODS

TOTAL: 30 PERIODS

LIST OF EXPERIMENTS:

1. Study of ARM evaluation system
2. Interfacing ADC and DAC.
3. Interfacing LED and PWM.
4. Interfacing Real time clock and serial port.
5. Interfacing keyboard and LCD.
6. Interfacing EPROM and interrupt.
7. Mailbox.
8. Interrupt performance characteristics of ARM and FPGA.
9. Flashing of LEDS.
10. Interfacing stepper motor and temperature sensor.
11. Implementing zigbee protocol with ARM

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Summarize Architecture and programming of ARM processors.
CO2: Applying the concepts of embedded systems and its features.
CO3: Analyze various Real Time Operating systems used in Embedded Systems.
CO4: Design the flow & Techniques to develop Software for embedded system networks.
CO5: Analyze Real-time applications using embedded System Products

Text Books:

1. Marilyn Wolf, “Computers as Components - Principles of Embedded Computing System Design”, Third Edition “Morgan Kaufmann Publisher (An imprint from Elsevier), 2012.
2. Jane W.S.Liu,‖ Real Time Systems‖, Pearson Education, Third Indian Reprint, 2003.

References:

1. LylaB.Das, Embedded Systems: An Integrated Approach, Pearson Education 2013.
2. Raj Kamal, Embedded system: Architecture Programming and Design, TMH Publication, Second Edition, 2008.

Vertical 4: Artificial Intelligence and Data Science

Course Code	DATA ANALYTICS AND VISUALIZATION	L	T	P	C
CS4V41		2	0	2	3

COURSE OBJECTIVES:

- To understand the fundamental concepts and processes of data science.
- To learn to articulate relationships within datasets effectively.
- To utilize Python libraries for data wrangling and visualization to analyze and interpret data.
- To study basic inferential statistics, sampling distributions, and data analytics processes.
- To apply descriptive data analytics techniques to analyze and interpret datasets effectively.

UNIT I INTRODUCTION 6

Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation - Exploratory Data analysis – build the model– presenting findings and building applications - Data Mining - Data Warehousing – Basic Statistical descriptions of Data.

UNIT II DESCRIBING DATA 6

Basics of Numpy arrays –aggregations –computations on arrays –comparisons, masks, boolean logic – fancy indexing – structured arrays – Data manipulation with Pandas – data in Types of Data - Types of Variables -Describing Data with Tables and Graphs –Describing Data with Averages - Describing Variability - Normal Distributions and Standard (z) Scores.

DESCRIBING RELATIONSHIPS: Correlation –Scatter plots –correlation coefficient for quantitative data –computational formula for correlation coefficient – Regression –regression line –least squares regression line – Standard error of estimate – interpretation of r2 –multiple regression equations –regression towards the mean

UNIT III PYTHON LIBRARIES FOR DATA WRANGLING 6

Indexing and selection – operating on data – missing data – Hierarchical indexing – combining datasets – aggregation and grouping – pivot tables

DATA VISUALIZATION: Importing Matplotlib – Line plots – Scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three-dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn.

UNIT IV DESCRIPTIVE ANALYTICS AND INFERENTIAL STATISTICS 6

DESCRIPTIVE ANALYTICS - Frequency distributions – Outliers –interpreting distributions – graphs – averages - describing variability – interquartile range – variability for qualitative and ranked data - Normal distributions – z scores –correlation – scatter plots – regression – regression line – least squares regression line – standard error of estimate – interpretation of r2 – multiple regression equations – regression toward the mean.

INFERENTIAL STATISTICS - populations – samples – random sampling – Sampling distribution-standard error of the mean - Hypothesis testing – z-test – z-test procedure –decision rule – calculations – decisions – interpretations - one-tailed and two-tailed tests – Estimation – point estimate – confidence interval – level of confidence – effect of sample size.

UNIT V ANALYSIS OF VARIANCE AND PREDICTIVE ANALYTICS 6

ANALYSIS OF VARIANCE - T-test for one sample – sampling distribution of t – t-test procedure – t-test for two independent samples – p-value – statistical significance – t-test for two related

samples. F-test – ANOVA – Two-factor experiments – three f-tests – two-factor ANOVA – Introduction to chi-square tests.
PREDICTIVE ANALYTICS - Linear least squares – implementation – goodness of fit – testing a linear model – weighted resampling. Regression using Stats Models – multiple regression – nonlinear relationships – logistic regression – estimating parameters – Time series analysis – moving averages – missing values – serial correlation – autocorrelation. Introduction to survival analysis.

TOTAL NUMBER OF PERIODS INCLUDING LAB: 60 PERIODS

SAMPLE LIST OF EXPERIMENTS NUMBER OF PRACTICAL PERIODS: 30

1. Download, install and explore the features of NumPy, SciPy, Jupyter, Statsmodels and Pandas packages, Scipy, Matplotlib, Pandas, statmodels, seaborn, plotly, bokeh
2. Working with Numpy arrays
3. Working with Pandas data frames
4. Reading data from text files, Excel and the web and exploring various commands for doing descriptive analytics on the Iris data set.
5. Use the diabetes data set from UCI and Pima Indians Diabetes data set for performing the following:

a. Univariate analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis.
b. Bivariate analysis: Linear and logistic regression modeling
c. Multiple Regression analysis
d. Also compare the results of the above analysis for the two data sets.

6. Apply and explore various plotting functions on UCI data sets.

a. Normal curves

6. Perform Z-test
8. Perform T-test
9. Perform ANOVA
10. Building and validating linear models
11. Building and validating logistic models
12. Time series analysis

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES:

On completion of this course, the students will be able to:
CO1:Define the data science process Understand different types of data descriptions for data science process
CO2:Gain knowledge on relationships between data and use the Python Libraries for Data Wrangling
CO3:Apply visualization Libraries in Python to interpret and explore data
CO4:Perform various statistical analyses to make statistical inferences and explain the end-to-end data analytics pipeline
CO5: Build, validate and communicate data analytical models for complex engineering problems

TEXTBOOKS:

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, 2016.
2. Robert S. Witte and John S. Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017. Padeepz App Padeepz App 69
3. Jake VanderPlas, "Python Data Science Handbook", O'Reilly, 2016.

REFERENCES:

1. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press,2014.
2. Peter Bruce, Andrew Bruce, and Peter Gedek, "Practical Statistics for Data Scientists", Second Edition, O'Reilly Publishers, 2020.
3. Charles R. Severance, "Python for Everybody: Exploring Data in Python 3", Shroff Publishers, 2017
4. Bradley Efron and Trevor Hastie, "Computer Age Statistical Inference", Cambridge University Press, 2016

Course Code	DEEP LEARNING	L	T	P	C
CS4V43		2	0	2	3

COURSE OBJECTIVES:

- To understand the basic ideas and principles of neural networks and concepts of deep learning.
- To study Convolutional Neural Networks with image processing facilities like TensorFlow and Keras.
- To study Recurrent Neural Networks with speech processing models
- To study Deep Reinforcement Learning and the use of real-time applications.
- To understand and implement deep learning architectures.

UNIT I FUNDAMENTALS OF DEEP LEARNING 6

Introduction to Neural Network – Feed Forward Neural Nets – Tensorflow - Deep Learning Fundamentals: Fundamental deep learning concepts, deep learning algorithms, and their types

UNIT II CONVOLUTIONAL NEURAL NETWORK 6

Convolutional Neural Networks – Filters – Strides and Padding – The structure of a convolutional network – Improving the performance of CNNs - Multilevel Convolution – Computer Vision with Convolutional Networks – Advanced Computer Vision

UNIT III RECURRENT NEURAL NETWORK 6

Recurrent Neural Networks: Introduction – Recursive Neural Networks – Bidirectional RNNs – Deep Recurrent Networks - Complete Autoencoder, Regularized Autoencoder, Stochastic Encoders and Decoders, Contractive Encoders – Language Modelling – Sequence to sequence learning – Speech Recognition

UNIT IV DEEP REINFORCEMENT LEARNING 6

Reinforcement Learning Theory – Markov Decision process – Monte Carlo methods – Temporal Difference methods – Value functions – Q learning – Deep Q-learning – Policy gradient methods – Model-based methods -Actor-Critic Methods

UNIT V DEEP LEARNING IN AUTONOMOUS VEHICLES 6

Autonomous Vehicles Introduction – Imitation driving policy – Driving policy with ChaufferNet – DL in Cloud

TOTAL NUMBER OF PERIODS INCLUDING LAB: 60

SAMPLE LIST OF EXPERIMENTS NUMBER OF PRACTICAL PERIODS: 30

1. Implement a feedforward neural network using TensorFlow to classify handwritten digits from the MNIST dataset.
2. Design a convolutional neural network with appropriate filters and padding to classify images from the CIFAR-10 dataset.
3. Compare the performance of different stride values in convolutional layers on a given image recognition task.
4. Explore the impact of multilevel convolutions on improving the accuracy of a CNN for object detection in computer vision.
5. Build a recurrent neural network model to generate text sequences and analyze its performance in language modeling.
6. Develop a bidirectional RNN architecture for sentiment analysis on movie reviews dataset and compare it with a unidirectional RNN.
7. Implement a deep reinforcement learning agent using Q-learning to solve a simple grid world problem.
8. Evaluate the performance of Deep Q-learning algorithm on the CartPole environment in OpenAI Gym.
9. Design an autonomous driving policy using imitation learning and assess its performance in a simulated environment.
10. Investigate the feasibility of deploying a deep learning model for autonomous driving on cloud infrastructure, considering latency and scalability aspects.

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES:

On completion of this course, the students will be able to:

CO1: Understand the foundational principles of deep learning.

CO2: Proficiently apply Convolutional Neural Networks (CNNs) and their variants to various applications.

CO3: Utilize Recurrent Neural Networks (RNNs) for implementing autoencoders and generative models in relevant contexts.

CO4: Gain a comprehensive understanding of deep reinforcement learning techniques.

CO5: Analyze and apply key computational processes in deep learning to construct and train neural networks for different tasks.

TEXTBOOKS:

1. Eugene Charniak, “Introduction to Deep Learning," MIT Press, 2018.
2. Ivan Vasilev, Daniel Slater, Gianmario Spacagna, Peter Roelants, Valentino Zocca, “Python Deep Learning," Packt Publishing Ltd, 2019.

REFERENCES:

1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, " Deep Learning," MIT Press, 2017.
2. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach" O'Reilly Media, 2017.
3. Umberto Michelucci "Applied Deep Learning: A Case-based Approach to Understanding Deep Neural Networks" Apress, 2018.
4. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective" The MIT Press, 2012.

Course Code	NATURAL LANGUAGE PROCESSING	L	T	P	C
CS4V44		2	0	2	3

COURSE OBJECTIVES:

- To learn the mathematical foundations and basics of Natural Language Processing.
- To understand the text data processing technologies for processing text data.
- To understand the role of Information Retrieval and Information Extraction in Text Analytics.
- To acquire knowledge of text data analytics using language models.
- To learn about NLP Tools and real-time examples of NLP.

UNIT I INTRODUCTION TO NATURAL LANGUAGE PROCESSING 6

Natural Language Processing – Linguistic Background – Mathematical Foundations – Morphological Analysis – Tokenization – Stemming – Lemmatization – Boundary Determination.

UNIT II TEXT DATA ANALYSIS 6

Reading unstructured data – Representing text data – Part of speech tagging – Syntactic representation – Text similarity – WordNet-based similarity – Shallow parsing – Semantic representation.

UNIT III INFORMATION RETRIEVAL AND EXTRACTION 6

Information Retrieval: Design features of Information Retrieval Systems-Classical, Nonclassical, Alternative Models of Information Retrieval – Information extraction – Named Entity Recognition – Relation Identification - Template filling.

UNIT IV LANGUAGE MODELLING 6

Language model – Probabilistic Models – n-gram language models- Hidden Markov Model- Topic Modelling - Graph Models -Feature Selection and classifiers -Rule-based Classifiers - Maximum entropy classifier – Clustering-Word and Phrase-based Clustering.

UNIT V NLP TOOLS AND APPLICATIONS 6

Tools: Natural Language Toolkit, Apache OpenNLP. Applications of Text Analytics – Applications in social media - Life science - Legal Text – Visualization - Case studies.

TOTAL NUMBER OF PERIODS INCLUDING LAB: 60

SAMPLE LIST OF EXPERIMENTS NUMBER OF PRACTICAL PERIODS: 30

1. Implement tokenization and compare the effectiveness of stemming versus lemmatization in improving text preprocessing for sentiment analysis.

2. Develop a part-of-speech tagging system using NLTK and evaluate its accuracy on a corpus of news articles.
3. Explore various text similarity metrics, including WordNet-based similarity, for clustering news headlines into topics.
4. Build an information retrieval system using classical and nonclassical models and compare their performance on a dataset of scientific papers.
5. Implement a named entity recognition model using Apache OpenNLP and assess its accuracy on legal text documents.
6. Investigate different approaches for relation identification in biomedical texts and evaluate their precision and recall.
7. Construct a language model using n-gram models and compare its performance with a hidden Markov model on a corpus of tweets.
8. Apply topic modeling techniques to extract themes from a collection of customer reviews and visualize the results using t-SNE.
9. Develop a rule-based classifier to categorize legal documents into different types and measure its accuracy against a maximum entropy classifier.
10. Utilize word and phrase-based clustering algorithms to identify patterns in social media conversations and analyze their implications for marketing strategies.

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES:

On completion of this course, the students will be able to:

CO1: Understand the mathematical foundations and basics of Natural Language Processing.

CO2:Process text data at the syntactic and semantic level.

CO3:Extract key information from text data.

CO4:Analyze text content to provide predictions related to a specific domain using language processing.

CO5:Design an innovative application using NLP components.

TEXTBOOKS:

1. Christopher D. Manning and Hinrich Schutze, “Foundations of Statistical Natural Language Processing," MIT Press, 1999;
2. Steven Struhl, “Practical Text Analytics: Interpreting Text and Unstructured Data for Business Intelligence”, Kogan Page, 2015.
3. Steven Bird, Ewan Klein and Edward Loper, “Natural Language Processing with Python”, 1st Edition, O'Reilly Media, 2009.

REFERENCES:

1. Matthew A. Russell, “Mining the Social Web," O'Reilly Media, 2013;
2. Daniel Jurafsky and James H. Martin “Speech and Language Processing," 3rd edition, Prentice Hall, 2009.
3. NitinIndurkhya, Fred J. Damerau “Handbook of Natural Language Processing," Second Edition, CRC Press, 2010.

Course Code	REINFORCEMENT LEARNING	L	T	P	C
CS4V46		2	0	2	3

COURSE OBJECTIVES:

- To explore the historical development and interdisciplinary connections of Reinforcement Learning.
- To gain a deep understanding of Markov Decision Processes (MDPs)
- To focus on iterative policy evaluation and iteration, and understanding the convergence properties.
- To understand Monte Carlo methods for model-free prediction and control. application in reinforcement learning tasks.
- To familiarize with function approximation methods and their applications in reinforcement learning.

UNIT I INTRODUCTION 6

Introduction- Origin and history of Reinforcement Learning research. Its connections with other related fields and with different branches of machine learning. Probability Primer - Brush up of Probability concepts - Axioms of probability, concepts of random variables, PMF, PDFs, CDFs, Expectation. Concepts of joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence.

UNIT II MARKOV DECISION PROCESS 6

Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP). Introduction to and proof of Bellman equations for MRPs along with proof of existence of solution to Bellman equations in MRP. Introduction to Markov decision process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations.

UNIT III PREDICTION AND CONTROL BY DYNAMIC PROGRAMING 6

Overview of dynamic programming for MDP, definition and formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration, Banach fixed point theorem, proof of contraction mapping property of Bellman expectation and optimality operators, proof of convergence of policy evaluation and value iteration algorithms, DP extensions.

UNIT IV MONTE CARLO METHODS FOR MODEL FREE PREDICTION AND CONTROL 6

Overview of Monte Carlo methods for model-free RL, First visit and every visit Monte Carlo, Monte Carlo control, On-policy and off-policy learning, Importance sampling. **TD Methods** Incremental Monte Carlo Methods for Model Free Prediction, Overview TD(0), TD(1) and TD(λ), k-step estimators, unified view of DP, MC, and TD evaluation methods, TD Control methods - SARSA, Q-Learning and their variants.

UNIT V FUNCTION APPROXIMATION METHODS 6

Getting started with the function approximation methods, Revisiting risk minimization, gradient descent from Machine Learning, Gradient MC and Semi-gradient TD(0) algorithms, Eligibility trace for function approximation, Afterstates, Control with function approximation, Least squares, Experience replay in deep Q-Networks.

Policy Gradients - Getting started with policy gradient methods, Log-derivative trick, Naive

REINFORCE algorithm, bias and variance in Reinforcement Learning, Reducing variance in policy gradient estimates, baselines, advantage function, actor-critic methods.

TOTAL NUMBER OF PERIODS INCLUDING LAB: 60

SAMPLE LIST OF EXPERIMENTS **NUMBER OF PRACTICAL PERIODS: 30**

1. Simulation of a Markov Chain: Simulate a simple Markov chain to demonstrate its properties and transitions between states.
2. Bellman Equation Implementation: Implement the Bellman equation for a Markov reward process in a simple environment to understand its application in reinforcement learning.
3. Policy Evaluation with Dynamic Programming: Implement policy evaluation using iterative methods like policy iteration or value iteration for a simple Markov decision process.
4. Monte Carlo Prediction: Implement first-visit Monte Carlo prediction to estimate state values in a grid world environment without a model.
5. Q-Learning Implementation: Implement the Q-learning algorithm for solving a simple grid world problem, demonstrating the exploration-exploitation trade-off.
6. Function Approximation with Linear Regression: Implement linear regression as a function approximation method in reinforcement learning to approximate state-action values.
7. Actor-Critic Method Implementation: Implement an actor-critic algorithm to learn policies and value functions concurrently, demonstrating the advantage of bootstrapping.
8. Gradient Descent in Function Approximation: Implement gradient descent for updating parameters in a function approximation method like neural networks for Q-value estimation.
9. Experience Replay in Deep Q-Networks: Implement experience replay in a deep Q-network (DQN) to improve learning efficiency and stability.
10. Policy Gradient Method Implementation: Implement a policy gradient method like REINFORCE to learn a policy in a simple environment, analyzing bias and variance in the estimates.

COURSE OUTCOMES:

On completion of this course, the students will be able to:

CO1:Attain comprehensive understanding of RL's historical evolution and interdisciplinary connections, alongside fundamental Probability concepts.

CO2:Achieve deep comprehension of MDPs, emphasizing terminology, properties, and Bellman equations for optimal decision-making.

CO3:Master Dynamic Programming techniques for MDP prediction and control tasks, understanding convergence properties.

CO4:Gain thorough understanding of Monte Carlo methods for model-free RL, proficiently implementing First visit and every visit techniques.

CO5:Familiarize with function approximation methods, gradient descent, eligibility traces, experience replay, policy gradient methods, and actor-critic architectures in RL applications.

TEXTBOOKS:

1. Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning: An Introduction", , 2nd Edition.
2. Sutton, R. S., & Barto, A. G. (2018). Reinforcement learning: An introduction (2nd ed.). MIT Press.

REFERENCES:

1. Leon-Garcia, A. (2008). Probability, statistics, and random processes for electrical engineering. Prentice Hall.
2. Murphy, K. P. (2012). Machine learning: A probabilistic perspective. MIT Press.

Course Code	BIG DATA ANALYTICS	L	T	P	C
CS4V47		2	0	2	3

COURSE OBJECTIVES:

- To attain proficiency in big data's evolution and applications for insightful analysis.
- To acquire proficiency in NoSQL databases, Cassandra, for efficient data management.
- To develop expertise in MapReduce and YARN for scalable data processing.
- To obtain foundational knowledge in Hadoop, including HDFS and data analysis.
- To gain practical skills in Hadoop tools like HBase, Pig, and Hive for effective data processing.

UNIT I UNDERSTANDING BIG DATA 6

Introduction to big data – convergence of key trends – unstructured data – industry examples of big data – web analytics – big data applications– big data technologies – introduction to Hadoop – open source technologies – cloud and big data – mobile business intelligence – Crowd sourcing analytics – inter and trans firewall analytics.

UNIT II NOSQL DATA MANAGEMENT 6

Introduction to NoSQL – aggregate data models – key-value and document data models – relationships – graph databases – schemaless databases – materialized views – distribution models – master-slave replication – consistency - Cassandra – Cassandra data model – Cassandra examples – Cassandra clients

UNIT III MAP REDUCE APPLICATIONS 6

MapReduce workflows – unit tests with MRUnit – test data and local tests – anatomy of MapReduce job run – classic Map-reduce – YARN – failures in classic Map-reduce and YARN – job scheduling – shuffle and sort – task execution – MapReduce types – input formats – output formats.

UNIT IV BASICS OF HADOOP 6

Data format – analyzing data with Hadoop – scaling out – Hadoop streaming – Hadoop pipes – design of Hadoop distributed file system (HDFS) – HDFS concepts – Java interface – data flow – Hadoop I/O – data integrity – compression – serialization – Avro – file-based data structures - Cassandra – Hadoop integration.

UNIT V HADOOP RELATED TOOLS 6

Hbase – data model and implementations – Hbase clients – Hbase examples – praxis. Pig – Grunt – pig data model – Pig Latin – developing and testing Pig Latin scripts.

Hive – data types and file formats – HiveQL data definition – HiveQL data manipulation – HiveQL queries.

TOTAL NUMBER OF PERIODS INCLUDING LAB: 60

SAMPLE LIST OF EXPERIMENTS **NUMBER OF PRACTICAL PERIODS: 30**

1. Downloading and installing Hadoop; Understanding different Hadoop modes. Startup scripts, Configuration files.
2. Hadoop Implementation of file management tasks, such as Adding files and directories, retrieving files and Deleting files
3. Implement of Matrix Multiplication with Hadoop Map Reduce
4. Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm.
5. Installation of Hive along with practice examples.
6. Installation of HBase, Installing thrift along with Practice examples
7. Practice importing and exporting data from various databases.

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES:

On completion of this course, the students will be able to:

CO1:Describe big data and use cases from selected business domains.
CO2:Explain NoSQL big data management.
CO3:Install, configure, and run Hadoop and HDFS.
CO4:Perform map-reduce analytics using Hadoop.
CO5:Use Hadoop-related tools such as HBase, Cassandra, Pig, and Hive for big data analytics.

TEXTBOOKS:

1. Michael Minelli, Michelle Chambers, and AmbigaDhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
2. Eric Sammer, "Hadoop Operations", O'Reilley, 2012.

REFERENCES:

1. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.
2. Lars George, "HBase: The Definitive Guide", O'Reilley, 2011.
3. Eben Hewitt, "Cassandra: The Definitive Guide", O'Reilley, 2010.
4. Alan Gates, "Programming Pig", O'Reilley, 2011.

Course Code	**GENERATIVE ARTIFICIAL INTELLIGENCE**	L	T	P	C
CS4V48		2	0	2	3

COURSE OBJECTIVES:

The main objectives of this course are to:

- To understand the principles and theory behind generative AI.
- To gain practical experience in developing generative AI models.
- To analyze and evaluate the ethical and societal implications of generative AI.
- To apply generative AI techniques to real-world problems and domains.
- To apply the latest developments and trends in the field of generative AI.

UNIT I INTRODUCTION TO GENERATIVE AI 6

Overview of Generative AI and its applications – Difference between generative and discriminative models – Historical perspective and key milestones – Ethical and societal implications.

UNIT II PROBABILITY AND STATISTICS FOR GENERATIVE AI 6

Probability distributions and their role in generative models – Maximum Likelihood Estimation (MLE) – Bayesian Inference and Maximum a Posteriori (MAP) estimation – Generative models as probabilistic models

UNIT III GENERATIVE MODEL 6

Introduction to Autoencoders – Variational Autoencoders (VAE) – Generative Adversarial Networks (GAN) – Flow-based models – Practical implementation and hands-on exercises (using TensorFlow, PyTorch, Jupyter Notebook, Keras, etc).

UNIT IV APPLICATIONS OF GENERATIVE AI 6

Image generation and manipulation – Text generation and natural language processing – Anomaly detection and data augmentation – Style transfer and artistic applications – Real-world use cases (Art & Design, Medical Imaging, Content creation, Chatbots, Virtual Assistants, Cybersecurity, etc.) and industry examples. Guest Lectures by Industry Experts, and Researchers

UNIT V EVALUATION AND ETHICAL CONSIDERATIONS 6

Metrics for evaluating generative models (e.g., Inception Score, FID) – Ethical concerns in generative AI, including bias and fairness – Privacy and security considerations – Future trends and emerging technologies in Generative AI.

TOTAL NUMBER OF PERIODS INCLUDING LAB: 60

SAMPLE LIST OF EXPERIMENTS NUMBER OF PRACTICAL PERIODS: 30

1. Image Generation with Generative Adversarial Networks (GANs)

- Implement a basic GAN architecture using TensorFlow or PyTorch.
- Train the GAN on a dataset of images (e.g., CIFAR-10, CelebA).
- Experiment with different architectures (e.g., DCGAN, WGAN) and hyperparameters to observe their effects on image quality and convergence speed.

2. Text Generation with Recurrent Neural Networks (RNNs)

- Implement a character-level or word-level RNN using a framework like TensorFlow or PyTorch.
- Train the RNN on a large corpus of text data (e.g., Shakespearean texts, Wikipedia articles).
- Explore different RNN architectures (e.g., vanilla RNN, LSTM, GRU) and training techniques (e.g., teacher forcing, beam search) for text generation.

3. Music Generation with Variational Autoencoders (VAEs)

- Implement a VAE architecture using TensorFlow or PyTorch.
- Train the VAE on a dataset of MIDI files or audio samples.
- Investigate techniques for generating novel music sequences by sampling from the learned latent space of the VAE.

4. Style Transfer with Neural Style Transfer Algorithms:

- Implement neural style transfer algorithms such as Gatys et al.'s method or Johnson et al.'s method using TensorFlow or PyTorch.
- Experiment with different content and style images to observe the transfer of artistic styles.

5. Data Augmentation with Generative Models

- Utilize generative models (e.g., GANs, VAEs) to augment training data for classification tasks.
- Train a classifier (e.g., CNN) on a dataset augmented with generated samples and compare its performance with a classifier trained on the original dataset.

6. Video Generation with Generative Adversarial Networks (GANs)

- Extend GAN architectures to generate video sequences.
- Train the GAN on a dataset of video clips (e.g., action recognition datasets, video game recordings).
- Evaluate the generated video sequences in terms of realism and diversity.

7. Anomaly Detection with Generative Models

- Train a generative model (e.g., VAE) on a dataset containing only normal instances.
- Use the trained generative model to reconstruct instances from both normal and anomalous data.
- Devise anomaly detection techniques based on reconstruction errors or latent space distances.

8. Domain Adaptation with Generative Adversarial Networks (GANs)

- Implement domain adaptation techniques using GANs to transfer knowledge from a labeled source domain to an unlabeled target domain.
- Train the GAN to generate target domain samples that are indistinguishable from source domain samples.
- Evaluate the effectiveness of the adapted model on the target domain tasks.

COURSE OUTCOMES:

On completion of this course, the students will be able to:

CO1:Understand the fundamental principles and applications of Generative Artificial Intelligence and distinguish between generative and discriminative models.

CO2:Apply probability and statistics concepts to analyze and model data, with a focus on their role in generative models.

CO3:Implement and evaluate various generative models, including Autoencoders, Variational Autoencoders (VAE), and Generative Adversarial Networks (GANs).

CO4:Apply generative AI techniques to solve real-world problems, including image generation, text generation, and artistic applications.

CO5:Evaluate generative models using appropriate metrics and critically analyze the ethical implications, privacy concerns, and societal impact of generative AI technologies.

TEXTBOOKS:

1. David Foster, "Generative Deep Learning", Second Edition, O'Reilly Media, 2023.
2. Jakub Langr and Vladimir Bok, "GANs in Action: Deep learning with Generative Adversarial Networks" Manning, 2019.
3. Jacob Emerson, "Ripples of Generative AI", IngramSpark, 2023.

REFERENCES:

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

2. Hannes Hapke, Cole Howard, Hobson Lane "Natural Language Processing in Action", Manning, 2019.
3. Alberto Chierici, "The Ethics of AI", New Degree Press, 2021.
4. Andreas C. Müller, Sarah Guido, "Introduction to Machine Learning with Python", O'Reilly Media, 2017.
5. Eric Matthes, "Python Crash Course", Third Edition, No Starch Press, 2023.

Vertical 5: Communication Systems

Course Code	WIRELESS BROADBAND NETWORKS	L	T	P	C
VD4V51		3	0	0	3

COURSE OBJECTIVES:

- To learn about the technical, economic, and service advantages of next-generation networks (NGNs).
- To understand the basic architecture of a next-generation network (NGN) with reference to its components and functionalities.
- To explore various NGN services and their implementations.
- To study the role of the P Multimedia Sub-System (IMS), network attachment, and admission control functions within NGNs.
- To compare and contrast different methods of providing connection-oriented services over NGNs for a comprehensive understanding.

UNIT I EVOLUTION OF WIRELESS NETWORKS 9

Review of cellular standards, migration and advancement of GSM architecture and CDMA architecture, WLAN – IEEE 802.11and HIPERLAN, Bluetooth.

UNIT II WIRELESS PROTOCOLS 9

Mobile network layer- Fundamentals of Mobile IP, data forwarding procedures in mobile IP, IPv4, IPv6, IP mobility management, IP addressing - DHCP, Mobile transport layer-Traditional TCP, congestion control, slow start, fast recovery/fast retransmission, classical TCP improvements Indirect TCP, snooping TCP, Mobile TCP

UNIT III 3G EVOLUTIONS 9

IMT-2000 - W-CDMA, CDMA 2000 – radio & network components, network structure, packet-data transport process flow, Channel Allocation, core network, interference-mitigation techniques, UMTS-services, air interface, network architecture of 3GPP, UTRAN – architecture, High Speed Packet Data-HSDPA, HSUPA.

UNIT IV 4G AND BEYOND 9

Introduction to LTE-A – Requirements and Challenges, network architectures – EPC, E-UTRAN architecture - mobility management, resource management, services, channel -logical and transport channel mapping, downlink/uplink data transfer, MAC control element, PDU packet formats, scheduling services, random access procedure.

UNIT V LAYER-LEVEL FUNCTIONS 9

Characteristics of wireless channels - downlink physical layer, uplink physical layer, MAC scheme - frame structure, resource structure, mapping, synchronization, reference signals and

channel estimation, SC-FDMA, interference cancellation –CoMP, Carrier aggregation, Services - multimedia broadcast/multicast, location-based services.

TOTAL: 45 PERIODS

Course Format
Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading
Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:
Upon Completion of the course the students will be able to
CO1: Understand the evolution of wireless networks, including cellular standards, WLAN, and Bluetooth.
CO2: Gain proficiency in wireless protocols like Mobile IP, IPv4, IPv6, and DHCP.
CO3: Acquire knowledge of 3G and 4G technologies, including W-CDMA, CDMA 2000, LTE-A.
CO4: Familiarize with network architectures and packet-data transport processes in 3G and 4G networks.
CO5: Develop competence in layer-level functions such as MAC schemes, interference cancellation, and services like multimedia broadcast and location-based services.

Text Books:
1. Kaveh Pahlavan, "Principles of wireless networks", Prentice-Hall of India, 2008.

References:
1. Vijay K.Garg, "Wireless Network Evolution- 2G & 3G" Pearson, 2013.
2. Clint Smith,P.E, Dannel Collins, "3G Wireless Networks" 2nd edition, Tata McGraw-Hill, 2008.
3. Jochen H.Schiller, "Mobile Communications", 2/e, Pearson, 2014.
4. Sassan Ahmadi, "LTE-Advanced – A practical systems approach to understanding the 3GPP LTE Releases 10 and 11 radio access technologies", Elsevier, 2014.

Course Code	AD-HOC AND WIRELESS SENSOR NETWORKS	L	T	P	C
VD4V52		3	0	0	3

COURSE OBJECTIVES:
- To design and implement Ad hoc and Wireless Sensor Networks effectively.
- To apply appropriate routing algorithms considering network and user requirements.
- To analyze and address issues related to physical and MAC layer protocols.
- To mitigate transport layer and security vulnerabilities in network design.
- To develop basic modules and utilize operating systems for Wireless Sensor Networks.

UNIT I AD HOC NETWORKS INTRODUCTION AND ROUTING PROTOCOLS 9
Elements of Ad hoc Wireless Networks, Issues in Ad hoc wireless networks, Example commercial applications of Ad hoc networking, Ad hoc wireless Internet, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classifications of Routing Protocols, Table

Driven Routing Protocols - Destination Sequenced Distance Vector (DSDV), On–Demand Routing protocols –Ad hoc On–Demand Distance Vector Routing (AODV).

UNIT II SENSOR NETWORKS – INTRODUCTION & ARCHITECTURES 9

Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks, WSN application examples, Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes, Network Architecture - Sensor Network Scenarios, Transceiver Design Considerations, Optimization Goals and Figures of Merit.

UNIT III WSN NETWORKING CONCEPTS AND PROTOCOLS 9

MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols and Wakeup Concepts - S-MAC, The Mediation Device Protocol, Contention based protocols - PAMAS, Schedule based protocols – LEACH, IEEE 802.15.4 MAC protocol, Routing Protocols Energy Efficient Routing, Challenges and Issues in Transport layer protocol.

UNIT IV SENSOR NETWORK SECURITY 9

Network Security Requirements, Issues and Challenges in Security Provisioning, Network Security Attacks, Layer wise attacks in wireless sensor networks, possible solutions for jamming, tampering, black hole attack, flooding attack. Key Distribution and Management, Secure Routing – SPINS, reliability requirements in sensor networks.

UNIT V SENSOR NETWORK PLATFORMS AND TOOLS 9

Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms – Tiny OS, nes C, CONTIKIOS, Node-level Simulators – NS2 and its extension to sensor networks, COOJA, TOSSIM, Programming beyond individual nodes – State centric programming.

TOTAL: 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Develop understanding of Ad hoc networks and Wireless Sensor Networks.

CO2: Implement suitable routing algorithms considering network and user requirements.

CO3: Analyze physical and MAC layer protocols, identifying associated issues.

CO4: Demonstrate knowledge of transport layer and security issues in Ad hoc and sensor networks.

CO5: Gain familiarity with operating systems used in Wireless Sensor Networks, and create basic modules.

Text Books:

1. C. Siva Ram Murthy and B. S. Manoj, “Ad Hoc Wireless Networks Architectures and Protocols”, Prentice Hall, PTR, 2004.

2. Holger Karl, Andreas willig, “Protocol and Architecture for Wireless Sensor Networks”, John Wiley publication, Jan 2006.

References:

1. Feng Zhao, Leonidas Guibas, “Wireless Sensor Networks: an information processing approach”, Elsevier publication, 2004.
2. Charles E. Perkins, “Ad Hoc Networking”, Addison Wesley, 2000.
3. I.F. Akyildiz, W. Su, Sankarasubramaniam, E. Cayirci, "Wireless sensor networks: a survey , computer networks", Elsevier, 2002, 394 - 422.

Course Code	5G TECHNOLOGIES	L	T	P	C
VD4V53		2	0	2	3

COURSE OBJECTIVES:

- To gain deep knowledge of 5G evolution, spectrum needs, and use cases.
- To develop expertise in 5G RAN architecture, protocols, and physical procedures.
- To differentiate traditional RAN from Open RAN and understand their implications.
- To acquire practical skills in managing 5G network interference, mobility, and quality-of-service.
- To prepare for future advancements in wireless communication technologies beyond 5G.

UNIT I EVOLUTION OF WIRELESS COMMUNICATION AND CELLULAR TECHNOLOGIES 9

Historical background, Frequency Reuse and the Cellular Concept Mobile Radio Propagation, Environment Co- Channel Interference and Noise. 5G RADIO SPECTRUM: 5G spectrum landscape and requirements, Spectrum access modes and sharing scenarios, 5G spectrum technologies. 5G USE CASES AND SYSTEM CONCEPT: Use cases and requirements, 5G system concept

UNIT II 5G RAN OVERVIEW 9

Overall System Architecture, frame structure, physical channels and signals, physical layer procedures (MIMO, Power control, link adaptation, beam forming, massive MIMO). Radio Interface Architecture:5G architecture options, core network architecture, RAN architecture

UNIT II 5G OPEN RAN OVERVIEW 9

RAN to Open RAN Transition-Benefits- Overall Architecture of Open RAN-3GPP vs open RAN Functions/Nodes-5G Service-based Architecture- Implications of Open RAN for Internet of Things and 6G- AI-enabled RAN and Open RAN Interfaces- Use Case Details and Requirements

UNIT IV 5G RADIO PROTOCOLS 9

Details of 5G Radio Protocol layers: RLC, MAC, PDCP, RRC layers Interfaces of 5G Network (Ng, Xn, F1 interfaces), Quality-of-Service Handling, Radio Protocol Architecture, User-Plane Protocols, Control-Plane Protocols

UNIT V MOBILITY AND HANDOFF MANAGEMENT IN 5G 9

Network deployment types, Interference management in 5G, Mobility management in 5G.

TOTAL:45 PERIODS

PRACTICAL EXERCISES **30 PERIODS**

1.5G Communications Link Analysis with Ray Tracing using MATLAB
2.Wireless Connectivity in the 5G Era for WLAN using MATLAB
3.MIMO Wireless System Design for 5G using MATLAB
4.5G Waveforms generation using MATLAB
5.5G Beamforming Design
6.Frame Structure of 5G technology
7.Numerology in 5G
8.Spatial Multiplexing and Hybrid Beam forming for 5G Wireless Communications
9.MATLAB Project on Massive MIMO System Implementation with Perfect CSI
10.Case Study: Factors affecting deployment of 5G in Indian scenario

Course Outcomes:

At the end of the course, students will demonstrate the following specific abilities:
CO1: Understand 5G technologies, including evolution, spectrum needs, and applications.
CO2: Master 5G RAN architecture, protocols, and implementation.
CO3: Differentiate traditional RAN from Open RAN and understand their impacts.
CO4: Gain practical skills in managing 5G networks for interference, mobility, and quality.
CO5: Prepare for future advancements in wireless communication beyond 5G.

Text Books:

1. Afif Osseiran, Jose F Monserrat, Patrick Marsch, "5G Mobile and Wireless Communications Technology", Cambridge University Press, 2016
2. Saad Z. Asif, "5G Mobile Communications Concepts and Technologies", CRC Press, Taylor & Francis Group, First Edition, 2018
3. Erik Dahlman, Stefan Parkvall, JohanSkold,"5G NR: The Next Generation Wireless Access Technology", Academic Press, 2018
4. Behrouz A. Forouzan, "DATA COMMUNICATIONS AND NETWORKING", McGraw Hill, Fourth Edition, 2007
5. Harri Holma, Antti Toskala, Takehiro Nakamura, "5G Technology 3GPP NEW RADIO", John Wiley & Sons First Edition, 2020

References:

1. Gordon L. Stuber, "Principles of Mobile Communication", KLUWER ACADEMIC PUBLISHERS, 2nd Edition, 2002
2. Joseph C. Liberti, Theodore S. Rappaport, "Smart Antennas for Wireless Communications", Prentice Hall PTR, 1999
3. Ying Zhang, "Network Function Virtualization Concepts and Applicability in 5G Networks", John Wiley & Sons, 2018

Course Code	**ADVANCED 5G TECHNIQUES**	L	T	P	C
VD4V54		3	0	0	3

COURSE OBJECTIVES:

• To learn about the registration management and reachability procedures in 5G networks.
• To study the session establishment, security protocols, and handover procedures in 5G.
• To understand various use cases of 5G technology and their applications.
• To gain knowledge about the deployment aspects of 5G networks, including architecture and implementation strategies.

• To examine the performance metrics and characteristics of 5G networks to ensure efficient operation and optimization.

UNIT I REGISTRATION AND MOBILITY MANAGEMENT PROCEDURES 9

Registration Management procedures-General Registration, Registration with AMF re-allocation, Deregistration procedures -UE-initiated Deregistration, Network-initiated Deregistration, Service Request procedures - UE Triggered Service Request, Network Triggered Service Request, UE Configuration Update-UE Configuration Update procedure for access and mobility management related , UE Configuration Update procedure for transparent UE Policy delivery, Reachability procedures-UE Reachability Notification Request procedure , UE Activity Notification procedure.

UNIT II Session, Security and Handover management procedures 9

Session Management procedures- PDU Session Establishment, PDU Session Modification, PDU Session Release. User Profile management procedures, ME Identity check procedure, Security procedures, Handover procedures – Xnbasedinter NG – RAN handover – Xnbasedinter NG - RAN handover without User Plane function re-allocation, Xnbasedinter NG - RAN handover with insertion of intermediate UPF, Xnbasedinter NG-RAN handover with re-allocation of intermediate UPF

UNIT III Use Cases 9

Terminology to be used in connection with the use cases, Key Performance Indicators, Key Quality Indicators (KQIs), Services and service categories, Detailed characteristics, requirements, and KPIs of the use cases- Assisted, cooperative and tele-operated driving, Time-critical factory processes and logistics optimization (industry and smart airports), Non time-critical processes and logistics (factories and smart cities), Long range connectivity in remote areas with smart farming application, Outdoor hotspots and smart offices with AR/VR and media applications, Live Event Experience, Health/wellness monitoring, Smart grid, connected lighting and energy infrastructure, Ad-hoc airborne platforms for disasters and emergencies

UNIT IV 5G Deployment Aspects 9

Introduction, Spectrum Resources, Spectrum Reframing and Dynamic Spectrum Sharing, Network Density, Mobile Data Traffic Growth, Mobile Data Volume, Traffic Asymmetry Base Station Site Solution, Electromagnetic Field (EMF) Considerations, Network Synchronization and Coordination Requirements, Main Interference Scenarios in TDD System, TDD Frame Configuration Options, Cell Size and Random Access Channel, Guard Period and Safety Zone, Intra-Frequency Operation, Inter-Operator Synchronization

UNIT V 5G Performance 9

Introduction Peak Data Rates, Practical Data Rates, Latency, Link Budgets, Massive MIMO and Beamforming Algorithms, Packet Scheduling Algorithms, Spectral Efficiency and Capacity, Network Energy Efficiency, Traffic and Device Density, Ultra-Reliability for Mission-Critical Communication

TOTAL: 45 PERIODS

Course Outcomes:

At the end of the course, students will demonstrate the following specific abilities:

CO1: Understand registration management and reachability procedures in 5G networks.

CO2: Acquire knowledge about session establishment, security protocols, and handover

procedures in 5G.
CO3: Demonstrate proficiency in understanding 5G use cases and their applications.
CO4: Gain expertise in 5G deployment aspects, including architecture and implementation strategies.
CO5: Master the understanding of 5G performance metrics and characteristics for optimization.

Text Books:

1. Afif Osseiran, Jose F Monserrat, Patrick Marsch, "5G Mobile and Wireless Communications Technology", Cambridge University Press, 2016
2. Saad Z. Asif, "5G Mobile Communications Concepts and Technologies", CRC Press, Taylor & Francis Group, First Edition, 2018
3. Erik Dahlman, Stefan Parkvall, JohanSkold,"5G NR: The Next Generation Wireless Access Technology", Academic Press, 2018
4. Behrouz A. Forouzan, "DATA COMMUNICATIONS AND NETWORKING", McGraw Hill, Fourth Edition,2007
5. Harri Holma, Antti Toskala, Takehiro Nakamura, "5G Technology 3GPP NEW RADIO", John Wiley & Sons First Edition,2020

References:

1. Gordon L. Stuber, "Principles of Mobile Communication", KLUWER ACADEMIC PUBLISHERS, 2nd Edition, 2002
2. Joseph C. Liberti, Theodore S. Rappaport, "Smart Antennas for Wireless Communications", Prentice Hall PTR, 1999
3. Ying Zhang, "Network Function Virtualization Concepts and Applicability in 5G Networks", John Wiley & Sons, 2018

Course Code	MASSIVE MIMO NETWORKS	L	T	P	C
VD4V55		3	0	0	3

COURSE OBJECTIVES:

- To gain knowledge about massive MIMO networks.
- To understand the massive MIMO propagation channels.
- To learn about channel estimation in single cell and multicell massive MIMO systems.
- To comprehend the concepts of massive MIMO deployment in the context of single cell and multicell deployment.

UNIT I MASSIVE MIMO NETWORKS 9

Definition of Massive MIMO, Correlated Rayleigh Fading, System Model for Uplink and Downlink, Basic Impact of Spatial Channel Correlation, Channel Hardening and Favourable Propagation, Local Scattering Spatial Correlation Model

UNIT II THE MASSIVE MIMO PROPAGATION CHANNEL 9

Favorable Propagation and Deterministic Channels-Capacity Upper Bound-Distance from Favorable Propagation-Favorable Propagation and Linear Processing-Singular Values and Favorable Propagation, Favorable Propagation and Random Channels-Independent Rayleigh Fading-Uniformly Random Line-of-Sight (UR-LoS)-Independent Rayleigh Fading versus UR-LoS - Finite-Dimensional Channels

UNIT III SINGLE-CELL SYSTEMS 9

Uplink Pilots and Channel Estimation - Orthogonal Pilots- De-Spreading of the Received Pilot

Signal-MMSE Channel Estimation, Uplink Data Transmission - Zero-Forcing -Maximum-Ratio, Downlink Data Transmission-Linear Precoding-Zero-Forcing-Maximum-Ratio, Discussion Interpretation of the Effective SINR Expressions-Implications for Power Control-Scaling Laws and Upper Bounds on the SINR - Near-Optimality of Linear Processing when M >> K - Net Spectral Efficiency - Limiting Factors: Number of Antennas and Mobility

UNIT IV **MULTI-CELL SYSTEMS** 9

Uplink Pilots and Channel Estimation, Uplink Data Transmission - Zero-Forcing -Maximum-Ratio, Downlink Data Transmission -Zero-Forcing - Maximum-Ratio, Discussion -Asymptotic Limits with Infinite Numbers of Base Station Antennas - The Effects of Pilot Contamination - Non-Synchronous Pilot Interference

UNIT V **CASE STUDIES** 9

Single-Cell Deployment Example: Fixed Broadband Access in Rural Area, Multi-Cell Deployment: Preliminaries and Algorithms, Multi-Cell Deployment Examples: Mobile Access - Dense Urban Scenario - Suburban Scenario - Minimum Per-Terminal Throughput Performance –Additional Observations -Comparison of Power Control Policies

TOTAL: 45 PERIODS

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Understand the fundamental concepts and characteristics of Massive MIMO networks.

CO2: Analyze the propagation channels and their impact on Massive MIMO systems.

CO3:Apply channel estimation techniques and data transmission methods in single-cell systems.

CO4: Evaluate the performance and challenges of multi-cell deployments in various scenarios.

CO5: Demonstrate the ability to apply theoretical knowledge to real-world case studies and deployment scenarios in Massive MIMO networks.

Text Books:

1. Thomas L. Marzetta, Erik G. Larsson, Hong Yang, Hien Quoc Ngo, “Fundamentals of Massive MIMO”, Cambridge University Press 2016. (UNITS II-V)

2. Emil Björnson, Jakob Hoydis and Luca Sanguinetti (2017), “Massive MIMO Networks: Spectral, Energy, and Hardware Efficiency”, Foundations and Trends, Now, 2017. (UNIT I)

References:

1. Long Zhao, Hui Zhao, Kan Zheng, “Wei Xiang Massive MIMO in 5G Networks: Selected Applications”, Springer 2018.

2. Leibo Liu, Guiqiang Peng, Shaojun Wei, “Massive MIMO Detection Algorithm and VLSI Architecture”, Springer 2019.

3. Shahid Mumtaz, Jonathan Rodriguez, Linglong Dai, “mmWave Massive MIMO A Paradigm for 5G”, Elsevier, 2017

Course Code	ADVANCED WIRELESS COMMUNICATION TECHNIQUES	L	T	P	C
VD4V56		3	0	0	3

COURSE OBJECTIVES

- Understand the evolving paradigm of cooperative communication in wireless networks.
- Gain insight into concepts related to green wireless communication and energy efficiency.

- Develop the ability to analyze and implement power-saving strategies and energy-efficient signal, system, and network designs.
- Familiarize with energy-saving techniques adopted in existing wireless components.
- Acquire knowledge of advanced access techniques and resource allocation strategies for green radio networks.

UNIT I COOPERATIVE COMMUNICATIONS AND GREEN CONCEPTS 9

Network architectures and research issues in cooperative cellular wireless networks ; Cooperative communications in OFDM and MIMO cellular relay networks: issues and approaches; Fundamental trade-offs on the design of green radio networks, Green modulation and coding schemes

UNIT II COOPERATIVE TECHNIQUES 9

Cooperative techniques for energy efficiency, Cooperative base station techniques for cellular wireless networks; Turbo base stations; Antenna architectures for cooperation; Cooperative communications in 3GPP LTE-Advanced, Partial information relaying and Coordinated multi-point transmission in LTE-Advanced.

UNIT III RELAY-BASED COOPERATIVE CELLULAR NETWORKS 9

Distributed space-time block codes ; Collaborative relaying in downlink cellular systems ; Radio resource optimization; Adaptive resource allocation ; Cross-layer scheduling design for cooperative wireless two-way relay networks ; Network coding in relay-based networks.

UNIT IV GREEN RADIO NETWORKS 9

Base Station Power-Management Techniques- Opportunistic spectrum and load management, Energy-saving techniques in cellular wireless base stations , Power-management for base stations in smart grid environment, Cooperative multi cell processing techniques for energy-efficient cellular wireless communications.

UNIT V ACCESS TECHNIQUES FOR GREEN RADIO NETWORKS 9

Cross-layer design of adaptive packet scheduling for green radio networks; Energy-efficient relaying for cooperative cellular wireless networks ; Energy performance in TDD-CDMA multihop cellular networks ; Resource allocation for green communication in relay-based cellular networks ; Green Radio Test-Beds and Standardization Activities

TOTAL: 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: Recognize the importance and design principles of cooperative communication in wireless networks.

CO2: Comprehend the significance and design principles of environmentally friendly wireless

communication.
CO3: Understand novel techniques in the field of wireless communication.
CO4: Validate feasibility through the utilization of mathematical models and simulation tools.
CO5: Evaluate the effects of green engineering solutions on a global scale, considering economic, environmental, and societal impacts.

Text Books:

1. Ekram Hossain, Dong In Kim, Vijay K. Bhargava , "Cooperative Cellular Wireless Networks",Cambridge University Press, 2011.
2. Ekram Hossain, Vijay K. Bhargava(Editor), Gerhard P. Fettweis (Editor), "Green Radio Communication Networks", Cambridge University Press, 2012.

References:

1. F. Richard Yu, Yu, Zhang and Victor C. M. Leung "Green Communications and Networking", CRC press, 2012.
2. Ramjee Prasad and Shingo Ohmori, Dina Simunic, "Towards Green ICT", River Publishers,2010.
3. Jinsong Wu, Sundeep Rangan and Honggang Zhang, "Green Communications: Theoretical Fundamentals, Algorithms and Applications", CRC Press, 2012.

Vertical 6: Deep Tech

Course Code	MACHINE LEARNING FOR ELECTRONIC DESIGN	L	T	P	C
VD4V61		3	0	0	3

COURSE OBJECTIVES:

- Understand core concepts and types of machine learning relevant to electronics applications.
- Use Python and machine learning libraries to implement classifiers and neural networks.
- Apply artificial neural networks for sizing and placement in analog IC design.
- Utilize machine learning for lithography process optimization and defect detection.
- Evaluate and improve machine learning models for efficiency and accuracy in electronics applications.

UNIT I Fundamentals of Machine Learning 9

Machine learning, Types of machine learning and its comparison. Basic types of data and data pre- processing, modelling and evaluation, supervised learning: classification and regression, unsupervised learning,Bayesian concept learning.

UNIT II Practice Algorithms 9

Platform for machine learning, Machine learning python libraries, machine learning classifiers using scikit- learn: k-nearest neighbours, decision tree using scikit -learn, introduction to NN, MLP, optimizers, early stop, regularization, Deep learning: improvement of Deep neural network, convolutional network

UNITIII ML for Electronics Design I 9

Using ANN to size analog IC: Design flow, Problem and Dataset Definition, Regression–Only Model, Using the ANN for Circuit Sizing, Classification and Regression Model, Test Case–Regression: Single-StageAmplifier with Voltage Combiners, Two-Stage Miller Amplifier, classification and regression model case studies

UNIT IV **ML for Electronics Design II** **9**

ANN for automatic analog IC placement: Layout Synthesis by Deep Learning, development of ANN model: Circuit Used for Tests, Dataset Architecture, Neural Network Architecture: Preprocessing the Data,Metrics to Evaluate the Models, Experimental Results, case studies: Machine Learning for Design Space Exploration in HLS

UNIT V **ML for Electronics Manufacturing** **9**

ML for Lithography and physical design: Machine Learning for Compact Lithographic Process Models: Importance of Lithographic Patterning Process to the Economics of Computing, Representation of the Lithographic Patterning Process, Machine Learning of Compact Process Models, Lithography Hotspot Detection, Machine Learning for Optical Proximity Correction, Machine Learning for SRAF Insertion, MachineLearning for Lithography Simulation.

TOTAL : 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES:

On completion of this course, the students will be able to:
CO1: Understand fundamental machine learning concepts as applied to electronics.
CO2: Implement machine learning algorithms using Python and libraries.
CO3: Use artificial neural networks for accurate analog IC design.
CO4: Optimize manufacturing processes like lithography using machine learning.
CO5: Evaluate and improve machine learning models for better performance in electronics applications.

TEXTBOOKS:

1. Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, Machine Learning, PearsonEducation India, 2018.
2. Elfadel, Ibrahim Abe M., Duane S. Boning, and Xin Li, eds. Machine learning in VLSI computer- aided design. Springer, 2019

REFERENCES

1. Gavin Hackeling, Machine Learning with scikit-learn, Packet publishing, O'Reily, 2018.
2. Tom M Mitchell, "Machine Learning", McGraw-Hill 1997.
3. Anuradha Srinivasaraghavan, Vincy Joseph, "Machine Learning", Wiley 2019.

Course Code	**BASEBAND SYSTEMS ON FPGA**	L	T	P	C
VD4V62		3	0	0	3

COURSE OBJECTIVES:

- To understand the basics of FPGA technology and how to design and program FPGAs.
- To study number representation, binary adders, dividers, and floating-point units.
- To design and implement FIR and IIR digital filters on FPGA platforms.

- To understand and apply various DFT and FFT algorithms in digital signal processing.
- To design and implement communication system components like error codes, modulation, and adaptive filters.

UNIT I FPGA TECHNOLOGY 9

Basics of FPGA, Gate array, Comparison of ASIC and FPGA, Introduction to FPGA Design flow, Programming languages, programming technology

UNIT II BASIC BUILDING BLOCKS 9

Number representation, Binary adders, Binary dividers, Floating point arithmetic, MAC & SOP unit

UNIT III DIGITAL FILTER IMPLEMENTATION 9

FIR filter, Theory and Structure, Filter design, Constant coefficient, FIR Design IIR filter, IIR theory, Coefficient computation and Implementation details, Fast IIR filter

UNIT IV FOURIER TRANSFORM 9

DFT algorithms, Goertzel algorithm, Hartley transform, Winograd DFT, blustein chirp-z transform, Rader algorithm, FFT algorithms, Cooley-tukey, Good Thomas, Winograd FFT

UNIT V COMMUNICATION BLOCKS 9

Computation of Special Functions Using CORDIC, Error codes, Linear block code, Convolution codes, Modulation and Demodulation, Adaptive filters, LMS, RLS, Decimator and Interpolator, High Decimation Rate Filters.

TOTAL: 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES:

On completion of this course, the students will be able to:

CO1: Ability to design and program FPGA-based systems.

CO2: Skill in designing and implementing binary adders, dividers, and floating-point units.

CO3: Capability to design and implement FIR and IIR digital filters on FPGA platforms.

CO4: Understanding and application of various DFT and FFT algorithms.

CO5: Skill in designing and implementing error codes, modulation techniques, and adaptive filters.

TEXTBOOKS:

1.Uwe.Meyer-Basese, ”Digital Signal processing with Field Programmable Gate Arrays”, Springer,Third Edition, May 2007

2.Keshab K. Parhi, ”VLSI Digital Signal Processing Systems, Design and implementation”, Wiley, Inter Science,1999

Reference(s)

1.John G. Proakis, ”Digital Communications”, Fourth Ed. McGraw Hill International Edition,2000

2.Michael John Sebastian Smith, "Applications Specific Integrated Circuits", Pearson Education,2000

Course Code	QUANTUM COMPUTING	L	T	P	C
VD4V63		2	0	2	3

COURSE OBJECTIVES:

- To gain understanding of the fundamentals of quantum mechanics.
- To become familiar with quantum circuits, postulates, and fundamental concepts.
- To explore basic quantum algorithms and their underlying principles.
- To learn about quantum cryptography and the potential advantages of quantum computing.
- To acquire programming skills tailored for quantum computers.

UNIT I Quantum Mechanics-Fundamentals 9

Linear algebra basics, Vector Spaces, Tensor products, inner and outer product, Hilbert space, N dimensional inner product, Infinite dimensional inner product, Schwarz's Inequality, Hilbert space examples,Probabilities and Measurements, Spectral decomposition, Quantum entanglement, Spectral decomposition, Bell's inequalities, Density operators

UNIT II Quantum Circuits and Postulates 9

Quantum Computing and its advantage, Postulates of Quantum mechanics, Qubits and Dirac notation, Bloch sphere, Quantum Gates-Single and Multi-qubit, Quantum circuits-basic

UNIT III Quantum Algorithms 9

No-Cloning Theorem, Deutsch-algorithm, Deutsch-Jozsa algorithm, Grover's Search algorithm, Quantum Fourier Transform, Shor's factoring algorithm, Variational quantum algorithms such as QAOA, VQE

UNIT IV Quantum Cryptography 9

Quantum cryptography-Introduction, Quantum Key Distribution, BB84 Protocol, B92 Protocol, EPR Protocol, Quantum Teleportation

UNIT V Programming Quantum Computer 9

The IBMQ, Bell test, GHZ state, W state, Quantum circuits for specific application-Design, graphically building quantum circuits, Dynamic circuit design using Qiskit

TOTAL: 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES:

Upon completion of the course, participants will:

CO1: Define the role and applications of linear algebra in quantum computing.

CO2: Interpret the fundamental postulates of quantum mechanics in relation to quantum circuits.
CO3: Examine various quantum algorithms and their computational advantages.
CO4: Investigate the principles and applications of cryptography in quantum computing.
CO5: Gain practical experience in designing, simulating, and testing quantum circuits using IBMQ.

TEXTBOOKS:

1. Michael A. Nielsen and Issac L. Chuang, "Quantum Computation and Information, Cambridge (2002).
2. Quantum Computing, A Gentle Introduction, Eleanor G. Rieffel, and Wolfgang H. Polak MITpress (2014)
3. David McMahon-Quantum Computing Explained-Wiley- Interscience, IEEE ComputerSociety (2008)

REFERENCES:

1. N. S. Yanofsky and M. A. Mannucci, Quantum Computing for Computer Scientists.Cambridge, England: Cambridge University Press, 2022.
2. A. Ozaeta, W. van Dam, and P. L. McMahon, "Expectation values from the single-layerQuantum Approximate Optimization Algorithm on Ising problems," Quantum Sci. Technol.,2022.
3. www.quantum-computing.ibm.com

Course Code	HIGH PERFORMANCE COMPUTING	L	T	P	C
VD4V64		3	0	0	3

COURSE OBJECTIVES:

- To learn the fundamental concepts of High Performance Computational programming
- To study the basics of the core of high end computers and parallelization.
- To learn the concept of shared and distributed parallel computers
- To apply the principle of heterogeneous parallel computing.
- To design GPU/FPGA programs for Deep Learning frameworks.

UNIT I HIGH-END COMPUTER SYSTEMS 9

High-End Computer Systems: Memory Hierarchies, Multi-core Processors: Homogeneous and Heterogeneous, Shared-memory Symmetric Multiprocessors, Vector Computers, Distributed Memory Computers, Supercomputers and Petascale Systems, Application Accelerators/ Reconfigurable Computing, Novel computers: Stream, multithreaded, and purpose

UNIT II MODERN PROCESSORS 9

Modern processors - pipelining-super scalarity-multicore processors- Multithreaded processors- vector processors- basic optimization techniques for serial code - taxonomy of parallel computing paradigms- shared memory computers- distributed-memory computers- Hierarchical Systems-networks- basics of parallelization - data parallelism - function parallelism- Parallel scalability-shared memory parallel programming with OpenMp - Distributed-memory parallel programming with MPI.

UNIT III PARALLEL COMPUTERS 9

Taxonomy of parallel computing paradigms- Shared memory computers- Cache coherence- UMA - ccNUMA- Distributed-memory computers- Hierarchical systems- Networks- Basic

performance characteristics- Buses- Switched and fat- tree networks- Mesh networks- Hybrids - Basics of parallelization - Data Parallelism - Function Parallelism- Parallel Scalability- Factors that limit parallel execution- Scalability metrics- Simple scalability laws- parallel efficiency – serial performance Vs Strong scalability- Refined performance models

UNIT IV HETEROGENEOUS PARALLEL COMPUTING 9

Heterogeneous parallel computing; Accelerators, GPUs, CUDA, Overview of CUDA C; threads, blocks and grids, warps, different GPU memories, CUDA Kernels, Operations in Deep Learning and their implementation on CUDA. Designing High Performance Systems for Accelerated Machine Learning and Deep Learning Workloads. Deep Learning Software: Setting up Application Environment for Deep Learning and HPC workloads using Container Platform like Docker. Introduction to PyTorch, Tensor Flow

UNIT V DEEP LEARNING ON FPGA 9

Deep learning on FPGA: Introduction to FPGAs, Architecture of FPGAs, Implementation of complex digital computations with FPGAs, FPGAs for AI, the challenges of using GPUs for deep learning, FPGAs vs. GPUs for Deep Learning, Different deep learning architectures for FPGAs, Deep Learning Accelerator scaling on FPGA Creating ASICs for AI. Pros and cons of using FPGAs for AI workload acceleration.

TOTAL: 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES:

On completion of this course, the students will be able to:

CO1: Understanding the basic concepts of computational programming and its applications
CO2: Understanding the core of high end computers, components and their capacities
CO3: Understand the need for parallel algorithms and learn on various parallel programming Applications
CO4: To apply the need for the concepts of heterogeneous parallel computing programming
CO3: Analyzing the concept of GPU/FPGA programs for Deep Learning frameworks.

TEXT BOOKS:

1. Georg Hager and Gerhard Wellein, Introduction to High Performance Computing for Scientists and Engineers, 1 st ed. Chapman & Hall / CRC Computational Science series, 2011.
2. David Kirk Wen-mei Hwu, Programming Massively Parallel Processors, A Hands-on Approach, 2nd edition ,2012
3. Morgan Kaufmann ,Jason sanders and Edward Kandrot, CUDA by Example: An Introduction to General-Purpose GPU Programming, 1st ed. Addison-Wesley,2010
4. Michael J. Quinn, Parallel Programming in C with MPI and Open MP, 1st ed. McGraw-Hill,2003
5. Palnitkar S. Verilog HDL: a guide to digital design and synthesis. 1st ed. Prentice Hall Professional; 2003

REFERENCE BOOKS:

1.Y. Bengio, I. Goodfellow and A. Courville, "Deep Learning", MIT Press, 2016.
2. Wolf W. FPGA-based system design. 1st ed. Pearson Education India; 2004.
3. Kilts S. Advanced FPGA design: architecture, implementation, and optimization. 1st ed. John Wiley & Sons; 2007
4. Adrian Rosebrock, "Deep Learning for Computer Vision with Python", E-Book, 1st ed. September 2017

Course Code	**mm WAVE COMMUNICATION**	L	T	P	C
VD4V65		3	0	0	3

COURSE OBJECTIVES:

- To understand the characteristics and propagation effects of mm wave communications.
- To study mm wave generation, amplification devices, and analog components.
- To learn modulation techniques and transceiver architectures for mm wave systems.
- To explore massive MIMO communications and multiple antenna implementations.
- To design and optimize antennas for mm wave systems.

UNIT - I INTRODUCTION 9

Millimeter wave characteristics- millimeter wave wireless, implementation challenges, Radio wave propagation for mm wave: Large scale propagation channel effects, small scale channel effects, Outdoor and Indoor channel models, Emerging applications of millimeter wave communications.

UNIT - II mm WAVE DEVICES AND CIRCUITS 9

Millimeter wave generation and amplification: Peniotrons, Ubitrons, Gyrotrons and Free electron lasers. HEMT, models for mm wave Transistors, transistor configurations, Analog mm wave components: Amplifiers, Mixers, VCO, PLL. Metrics for analog mm wave devices, Consumption factor theory, Trends and architectures for mm wave wireless, ADC's and DAC's.

UNIT - III mm WAVE COMMUNICATION SYSTEMS 9

Modulations for millimeter wave communications: OOK, PSK, FSK, QAM, OFDM, Millimeter wave
link budget, Transceiver architecture, Transceiver without mixer, Receiver without Oscillator, Millimeter wave calibration, production and manufacture, Millimeter wave design considerations.

UNIT - IV mm WAVE MIMO SYSTEMS 9

Massive MIMO Communications, Spatial diversity of Antenna Arrays, Multiple Antennas, Multiple Transceivers, Noise coupling in MIMO system, Potential benefits for mm wave systems, Spatial, Temporal and Frequency diversity, Dynamic spatial, frequency and modulation allocation.

UNIT - V ANTENNAS FOR MM WAVE SYSTEMS 9

Antenna beamwidth, polarization, advanced beam steering and beam forming, mm wave design consideration, On-chip and In package mm wave antennas, Techniques to improve gain of on-chip antennas, Implementation for mm wave in adaptive antenna arrays, Device to Device communications over 5G systems, Design techniques of 5G mobile.

TOTAL: 45 PERIODS

Course Format
Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading
Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES:
On completion of this course, the students will be able to:
CO1: Describe and analyze mm wave characteristics and propagation effects.
CO2: Explain and model mm wave generation and analog components.
CO3: Apply modulation schemes and design transceiver architectures.
CO4: Design and evaluate massive MIMO systems with multiple antennas.
CO5: Implement and optimize antennas for mm wave systems.

TEXTBOOKS:
1. K.C. Huang, Z. Wang, "Millimeter Wave Communication Systems", Wiley-IEEE Press, March 2011.
2. Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.

REFERENCES:
1. Xiang, W; Zheng, K; Shen, X.S; "5G Mobile Communications: Springer, 2016.

Course Code	**HIGH SPEED SWITCHING AND NETWORKING**	L	T	P	C
VD4V66		3	0	0	3

Course Objectives
- To explore the various space division switches
- To enable the various network performance analysis
- To get the clear idea about the various multimedia application
- To get a clear idea about the traffic and Queuing systems.
- Interpret the basics of security management and the various attacks & its countermeasures

UNIT I SWITCHING ARCHITECTURES **9**
Shared medium switches – Shared memory switches – Space division switches – Cross bar based switching architecture – Input queued, Output queued and Combined input-output queued switches – Non blocking and blocking cross bar switches – Banyan networks – Batcher Banyan networks – Optical switches – Unbuffered and buffered switches – Buffering strategies – Optical packet switches and Optical burst switches – MEMS optical switches

UNIT II NETWORK PERFORMANCE ANALYSIS **9**
Objectives and requirements for Quality of Service (QoS) in high performance networks. Architecture of high performance networks (HPN), design issues, protocols for HPN, VHF backbone networks, virtual interface architectures, virtual interface for networking, High-speed switching and routing - internet and PSTN IP switching techniques, SRP protocols, SRP authentication, and key exchange, comparison of TCP/IP, FTP, TELNET, queuing systems, network modeling as a graph

UNIT III MULTIMEDIA NETWORKING APPLICATIONS **9**

Streaming stored Audio and Video, Best effort service, protocols for real time interactive applications, Beyond best effort, scheduling and policing mechanism, integrated services, RSVP-differentiated services.

UNIT IV PACKET QUEUES AND DELAY ANALYSIS **9**

Littles theorem, Birth and Death process, queueing discipline- Control & stability -, Markovian FIFO queueing system, Non-markovian - PollaczekKhinchin formula and M/G/1, M/D/1, self-similar models and Batch-arrival model, Networks of Queues – Burkes theorem and Jackson Theorem.

UNIT V NETWORK SECURITY AND MANAGEMENT **9**

Principles of cryptography – Elliptic-AES Authentication – integrity – key distribution and certification– Access control and: fire walls – DoS-attacks and countermeasures – security in many layers.Infrastructure for network management – The internet standard management framework – SMI, MIB,SNMP, Security and administration – ASN.1.

Total: 45 Periods

Course Outcomes:

Upon completion the students will be able to

CO1: Understand the fundamental concepts of the switching architecture involved in various switching types

CO2: Interpret the basics of various protocols and QOS in the network performance

CO3: Understand the various types of multimedia networking application

CO4: Recognize the concepts of various analysis method involved in the processing

CO5: Understand fundamental issues involved in providing the security as well as the management.

Text Books:

1. Achille Pattavina, “Switching Theory Architectures and performance in Broadband ATM networks”, John wiley & sons Ltd. New York, 2007.

2. Elhanany, Itamar, Hamdi and Mounir, “High Performance Packet Switching Architectures”, Springer 2007

References:

1. Walrand .J. Varatya, “High Performance Communication Network”, Morgan Kaufmann – Harcourt Asia Pvt. Ltd., 2nd Edition, 2000.

2. Fred Halsall and Lingana Gouda Kulkarni, “Computer Networking and the Internet”, Fifth Edition, Pearson Education, 2012.

3. Nader F.Mir, “Computer and Communication Networks”, Pearson Education, 2009.

APPENDIX B: OPEN ELECTIVES

Open Electives- I

S.No	Course Code	Course Title
1	BM46O1	Biomedical Instrumentation
2	ME46O5	Nanotechnology
3	EE46O3	Space Engineering
4	EE46O4	Industrial Management
5	EE46O6	Database Management Systems
6	MT46O1	Renewable Energy Technologies
7	CZ46O1	Introduction to Cyber Security
8	CZ46O2	Security Principles
9	CE46O2	Life Cycle Assessment
10	CY46O1	Engineering Chemistry

Open Electives- II

S.No	Course Code	Course Title
1	BM47O1	Biomaterials
2	BM47O4	Biomedical Optics and Photonics
3	ME47O2	Production and Operations Management for Entrepreneurs
4	ME47O4	Concepts in Mobile Robotics
5	CE47O1	Climate Change and Adaptation
6	CE47O5	Environmental Impact Assessment
7	EE47O6	Introduction to PLC Programming
8	CZ47O2	Cyber Crime
9	CZ47O3	Digital Forensics
10	CZ47O4	Operational Technology Security

Open Electives- I

Course Code	Biomedical Instrumentation	L	T	P	C
BM4601		3	0	0	3

COURSE OBJECTIVES:

- To understand the origin of various biological signals and electrode configurations specific to bio-potential measurements.
- To understand the characteristics of Bio signals.
- To understand the design of bio amplifiers
- To explain the different techniques used for measurement of non-electrical bio parameters
- To explain the biochemical measurement techniques as applicable for diagnosis and treatment.

UNIT I Electrode Configurations **9**

Bio signals characteristics – Origin of bio potential and its propagation. Frequency and amplitude ranges. Electrode configurations: Electrode-electrolyte interface, electrode–skin interface impedance, polarization effects of electrode – non-polarizable electrodes. Unipolar and bipolar configuration, classification of electrodes.

UNIT II Biosignal Characteristics **9**

Bio signals characteristics – ECG-frequency and amplitude ranges – Einthoven's triangle, standard 12 lead system. EEG - EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode. EMG - Electrode configuration -unipolar and bipolar mode. ECG, EEG, EMG, ERG, EOG, GSR, PCG.

UNIT III Bioamplifiers **9**

Need for bio-amplifier - Differential bio-amplifier – Single ended amplifier - Band pass filtering, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier. Chopper amplifier. Power line interference, Electrical Isolation (optical and electrical)

UNIT IV Measurement of Bio Signals **9**

Temperature, respiration rate and pulse rate measurements. Blood Pressure - indirect methods: Auscultatory methods, oscillometric method, direct methods: electronic manometer, Pressure amplifiers - systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurements

UNIT V Biochemical Measurements **9**

Biochemical sensors - pH, pO2 and pCO2, Ion selective Field effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors. Blood gas analyzers, Colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyzer. Safety of Biomedical Instruments

TOTAL: 45 PERIODS

Course Format
Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading
Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES:
On successful completion of this course, the student will be able to
CO1: Illustrate the origin and characteristics of various biological
CO2: Gain knowledge on characteristics of bio signals
CO3: Gain knowledge on various amplifiers involved in monitoring and transmission of biosignals.
CO4: Explain the different measurement techniques for non-electrical bio-parameters
CO5: Explain the biochemical measurement techniques as applicable for diagnosis and further treatment

TEXT BOOKS:
1. Leslie Cromwell, "Biomedical Instrumentation and measurement", 2nd edition, Prentice hall of India, New Delhi, 2015.
2. John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India Pvt Ltd, New Delhi, 2015.
3. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 2003.

REFERENCES:
1. John Enderle, Susan Blanchard, Joseph Bronzino, "Introduction to Biomedical Engineering", second edition, Academic Press, 2005.
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.

Course Code	**NANOTECHNOLOGY**	L	T	P	C
ME4605		3	0	0	3

COURSE OBJECTIVES:
- The course emphasis on the molecular safe assembly and materials for polymer electronics

UNIT I Introduction **9**
Historical Perspectives, Lessons from Nature, Engineering the Functions, Tuning the functions, Multiscale Modeling and Computation, Classification of Functional Materials, Functional Diversity of Materials, Hybrid Materials, Technological Relevance, Societal Impact.

UNIT II Synthesis Of Nanomaterials **9**
Bottom up and Top-down approach for obtaining nano materials - Precipitation methods – sol gel technique – high energy ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods – laser ablation, sputtering.

UNIT III Nano Composites **9**
Definition- importance of nanocomposites- nano composite materials-classification of composites metal/metal oxides, metal-polymer- thermoplastic based, thermoset based and

elastomer based influence of size, shape and role of interface in composites applications.

UNIT IV Nano Structures And Characterization Techniques **9**

Classifications of nanomaterials - Zero dimensional, one-dimensional and two-dimensional nanostructures- Kinetics in nanostructured materials- multilayer thin films and superlattice-clusters of metals, semiconductors and nanocomposites. Spectroscopic techniques, Diffraction methods, thermal analysis method, BET analysis method.

UNIT V Applications Of Nano Materials **9**

Overview of nanomaterials properties and their applications, nano painting, nano coating, nanomaterials for renewable energy, Molecular Electronics and Nanoelectronics – Nanobots Biological Applications. Emerging technologies for environmental applications- Practice of nanoparticles for environmental remediation and water treatment.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications

CO2: Able to acquire knowledge about the different types of nano material synthesis

CO3: Describes the shape, size,structure of composite nano materials and their interference.

CO4: Understand the different characterization techniques for nanomaterials

CO5: Develop a deeper knowledge in the application of nanomaterials in different fields.

TEXT BOOKS:

1. Mick Wilson, Kamali Kannangara,Geoff Smith, Michelle Simmom, Burkhard Raguse, " Nano Technology: Basic Science & Engineering Technology", 2005, Overseas Press

2. G. Cao, "Nanostructures & Nanomaterials: Synthesis, Properties & Applications" Imperial College Press, 2004

3. William A Goddard "Handbook of Nanoscience, Engineering and Technology", 3rd Edition, CRC Taylor and Francis group 2012.

REFERENCES:

1. R.H.J.Hannink & A.J.Hill, Nanostructure Control, Wood Head Publishing Ltd.,Cambridge, 2006.

2. C.N.R.Rao, A.Muller, A.K.Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications Vol. I & II, 2nd edition, 2005, Wiley VCH Verlag Gibtl & Co

3. Ivor Brodie and Julius J.Muray,'The physics of Micro/Nano – Fabrication',Springer International Edition,2010

Course Code	**Space Engineering**	L	T	P	C
EE4603		3	0	0	3

COURSE OBJECTIVES:

The main objectives of this course are to:

- Use the standard atmosphere tables and equations.
- Find lift and drag coefficient data from NACA plots.

- Apply the concept of static stability to flight vehicles.
- Describe the concepts of stress, strain, Young's modulus, Poisson's ratio, yield strength.
- Demonstrate a basic knowledge of dynamics relevant to orbital mechanics.

Course Description
This course provides an introduction to key concepts in aerospace engineering, covering the fundamental principles of aerodynamics, aircraft performance, propulsion, aircraft stability, structural theory, and space applications. Students will learn about the history of aviation, standard atmosphere, lift generation, aircraft types, drag calculations, aircraft stability, materials science, space research history, spacecraft trajectories, orbital mechanics, and laws governing motion in space.

Prerequisites
- Basic knowledge of physics, including mechanics and thermodynamics.
- Familiarity with calculus and differential equations.
- Understanding of fundamental concepts in engineering, such as forces, energy, and motion.

UNIT I Standard Atmosphere **8**
History of aviation – standard atmosphere - pressure, temperature and density altitude.

UNIT II Aerodynamics **10**
Aerodynamic forces – Lift generation Viscosity and its implications - Shear stress in a velocity profile - Lagrangian and Eulerian flow field - Concept of a streamline – Aircraft terminology and geometry - Aircraft types - Lift and drag coefficients using NACA data.

UNIT III Performance and Propulsion **9**
Viscous and pressure drag - flow separation - aerodynamic drag - thrust calculations - thrust/power available and thrust/power required

UNIT IV Aircraft Stability and Structural Theory **9**
Degrees of freedom of aircraft motions - stable, unstable and neutral stability - concept of static stability - Hooke's Law- brittle and ductile materials - moment of inertia – section modulus.

UNIT V Space Applications **9**
History of space research - spacecraft trajectories and basic orbital manoeuvres - six orbital elements - Kepler's laws of orbits - Newton's law of gravitation.

TOTAL: 45 PERIODS

Course Format
Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations and online resources.

Assessments & Grading
Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES:
Upon completion of the course, the students will be able to:
CO1: Illustrate the history of aviation & developments over the years
CO2: Ability to identify the types & classifications of components and control systems

CO3: Explain the basic concepts of flight & Physical properties of Atmosphere
CO4: Identify the types of fuselage and constructions.
CO5: Distinguish the types of Engines and explain the principles of Rocket

TEXT BOOKS:

1. John D. Anderson, Introduction to Flight, 8 th Ed., McGraw-Hill Education, New York, 2015.
2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021.
3. Stephen. A. Brandt, " Introduction to Aeronautics: A design perspective " American Institute of Aeronautics & Astronautics, 1997.

REFERENCES:

1. Kermode, A.C., "Mechanics of Flight", Himalayan Book, 1997.

YouTube Resources:

1. https://youtu.be/zKzCd1mbrb4?si=G9fGy7wbJjY4xHLY
2. https://youtu.be/tEWuP1NVdgE?si=4OCZYmkz0HNTmzrT
3. https://youtu.be/yIX8b0P3IQs?si=NRZ0Q3DiBHgTTUjY
4. https://youtu.be/ruBfXIVSYZ8?si=Iota97jb_kptOVZ3
5. https://youtu.be/uReN2Nd1yuo?si=XrmIcSMGqy_x79Rz

Course Code	**Industrial Management**	L	T	P	C
EE4604		3	0	0	3

COURSE OBJECTIVES:

The main objectives of this course are to:

- To introduce fundamental concepts of industrial management
- To understand the approaches to the study of Management
- To learn about Decision Making, Organizing and leadership
- To analyze the Managerial Role and functions
- To know about Supply Chain Management.

Course Description

This course provides a comprehensive overview of the principles and practices of management in organizations. It covers topics such as technology management, functions of management (planning, organizing, leading, controlling), organizational behaviour, group dynamics, and modern management concepts. Students will explore the evolution of management thought, different forms of organization, organizational culture, leadership styles, communication, decision-making, conflict resolution, and contemporary management approaches such as Management by Objectives (MBO), Strategic Management, and Information Technology in Management.

UNIT I Introduction **9**

Technology Management - Definition - Functions - Evolution of Modern Management- Scientific Management Development of Management Thought. Approaches to the study of Management, Forms of Organization -Individual Ownership - Partnership - Joint Stock Companies - Co-operative Enterprises - Public Sector Undertakings, Corporate Frame Work- Share Holders -

Board of Directors - Committees - Chief Executive Line and Functional Managers,-Financial-Legal-Trade Union.

UNIT II Functions of Management **9**

Planning - Nature and Purpose - Objectives - Strategies – Policies and Planning Premises - Decision Making - Organizing - Nature and Process - Premises - Departmentalization - Line and staff - Decentralization -Organizational culture, Staffing - selection and training .Placement - Performance appraisal - Career Strategy – Organizational Development. Leading - Managing human factor - Leadership.Communication, Controlling - Process of Controlling - Controlling techniques, productivity and operations management - Preventive control, Industrial Safety.

UNIT III Organizational Behaviour **9**

Definition - Organization - Managerial Role and functions -Organizational approaches, Individual behaviour - causes - Environmental Effect - Behaviour and Performance, Perception - Organizational Implications. Personality - Contributing factors - Dimension – Need Theories - Process Theories - Job Satisfaction, Learning and Behaviour-Learning Curves, Work Design and approaches.

UNIT IV Group Dynamics **9**

Group Behaviour - Groups - Contributing factors - Group Norms, Communication - Process - Barriers to communication - Effective communication, leadership - formal and informal characteristics – Managerial Grid - Leadership styles - Group Decision Making - Leadership Role in Group Decision, Group Conflicts - Types -Causes - Conflict Resolution -Inter group relations and conflict, Organization centralization and decentralization - Formal and informal - Organizational Structures Organizational Change and Development -Change Process – Resistance to Change - Culture and Ethics.

UNIT V Modern Concepts **9**

Management by Objectives (MBO) - Management by Exception (MBE),Strategic Management - Planning for Future direction - SWOT Analysis -Evolving development strategies, information technology in management Decisions support system-Management Games Business Process Reengineering(BPR) –Enterprises Resource Planning (ERP) - Supply Chain Management (SCM) - Activity Based Management (AM) – Global Perspective - Principles and Steps Advantages and disadvantage.

TOTAL: 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations and online resources.

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES:

Upon completion of the course, the students will be able to:

CO1: Understand the basic concepts of industrial management
CO2: Identify the group conflicts and its causes.
CO3: Perform swot analysis

CO4: Analyze the learning curves
CO5: Understand the placement and performance appraisal

TEXT BOOKS:

1. Ibrahim Garbie, "Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0", Springer International Publishing. United States, 2016, ISBN 13: 978-3319293042.
2. Davim J.P., "Sustainable Manufacturing", John Wiley & Sons., United States, 2010, ISBN: 978-1-848-21212-1.

REFERENCES:

1. Maynard H.B, "Industrial Engineering Hand book", McGraw-Hill, sixth 2008
2. Seliger G., "Sustainable Manufacturing: Shaping Global Value Creation", Springer, United States, 2012, ISBN 978-3-642-27289-9.

YouTube Resources:
1. **https://youtu.be/zHpi7mnGdg0?si=YuL4o4CAFCvf4Cf3**
2. https://youtu.be/jOLHwYi-waI?si=0sjcmd4D9DOjuxV5
3. https://youtu.be/pHg3ZfGk5j0?si=sfpHalDwksop1fdK
4. https://youtu.be/YctbIjIo5wI?si=iaMJcC_2Ofm29oCe
5. https://youtu.be/Nwo3D4tQ_AU?si=SqWasBUp7gwVDplh

Course Code	**Database Management Systems**	L	T	P	C
EE4606		3	0	0	3

COURSE OBJECTIVES:

The main objectives of this course are to:
- To learn the fundamentals of data models, relational algebra and SQL
- To represent a database system using ER diagrams and to learn normalization techniques
- To understand the fundamental concepts of transaction, concurrency and recovery Processing
- To understand the internal storage structures using different file and indexing techniques which will help in physical DB design
- To have an introductory knowledge about the Distributed databases, NOSQL and database security.

Course Description
This course provides a comprehensive overview of database management systems (DBMS), covering fundamental concepts, relational databases, database design, transactions, implementation techniques, and advanced topics. Students will gain a deep understanding of database systems architecture, relational model, SQL fundamentals, database design principles, transaction management, implementation techniques such as indexing and hashing, and advanced topics including distributed databases, NoSQL databases, and database security.

Prerequisites

- Basic understanding of computer science fundamentals
- Familiarity with data structures and algorithms
- Knowledge of programming concepts, preferably in a language like Python or Java

UNIT I Relational Databases **9**

Purpose of Database System – Views of data – Data Models – Database System Architecture – Introduction to relational databases – Relational Model – Keys – Relational Algebra – SQL fundamentals – Advanced SQL features – Embedded SQL– Dynamic SQL

UNIT II Database Design **9**

Entity-Relationship model – E-R Diagrams – Enhanced-ER Model – ER-to-Relational Mapping – Functional Dependencies – Non-loss Decomposition – First, Second, Third Normal Forms, Dependency Preservation – Boyce/Codd Normal Form – Multi-valued Dependencies and Fourth Normal Form – Join Dependencies and Fifth Normal Form.

UNIT III Transactions **9**

Transaction Concepts – ACID Properties – Schedules – Serializability – Transaction support in SQL – Need for Concurrency – Concurrency control –Two Phase Locking- Timestamp – Multiversion –Validation and Snapshot isolation– Multiple Granularity locking – Deadlock Handling – Recovery Concepts – Recovery based on deferred and immediate update – Shadow paging – ARIES Algorithm

UNIT IV Implementation Techniques **9**

RAID – File Organization – Organization of Records in Files – Data dictionary Storage – Column Oriented Storage– Indexing and Hashing –Ordered Indices – B+ tree Index Files – B tree Index Files – Static Hashing – Dynamic Hashing – Query Processing Overview – Algorithms for Selection, Sorting and join operations – Query optimization using Heuristics - Cost Estimation.

UNIT V Advanced Topics **9**

Distributed Databases: Architecture, Data Storage, Transaction Processing, Query processing and optimization – NOSQL Databases: Introduction – CAP Theorem – Document Based systems – Key value Stores – Column Based Systems – Graph Databases. Database Security: Security issues –Access control based on privileges – Role Based access control – SQL Injection – Statistical Database security – Flow control – Encryption and Public Key infrastructures – Challenges.

TOTAL: 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES:

Upon completion of the course, the students will be able to:

CO1: Construct SQL Queries using relational algebra

CO2: Design database using ER model and normalize the database

CO3: Construct queries to handle transaction processing and maintain consistency of the Database

CO4: Compare and contrast various indexing strategies and apply the knowledge to tune the performance of the database

CO5: Appraise how advanced databases differ from Relational Databases and find a suitable database for the given requirement..

TEXT BOOKS:

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts", Seventh Edition, McGraw Hill, 2020.
2. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", Seventh Edition, Pearson Education, 2017.

REFERENCES:

1. C.J.Date, A.Kannan, S.Swamynathan, "An Introduction to Database Systems", Eighth Edition, Pearson Education, 2006.

YouTube Resources:

1. https://youtu.be/OqjJjpjDRLc?si=3qJgPs5XUoKbqjCi
2. https://youtu.be/s57648-bbOs?si=AURtbrEgknFNHXKg
3. https://youtu.be/lJvkIgFT3dY?si=FicSqdSc6FZ9jaUn
4. https://youtu.be/_RbsFXWRZ10?si=RNu19XWxFonaeZbo
5. https://youtu.be/NNjUhvvwOrk?si=XixN-_fzPwU7t_j-

Course Code	RENEWABLE ENERGY TECHNOLOGIES	L	T	P	C
MT4603		3	0	0	3

COURSE OBJECTIVES:

- To know the Indian and global energy scenario
- To learn the various solar energy technologies and its applications.
- To educate the various wind energy technologies.
- To explore the various bio-energy technologies.
- To study the ocean and geothermal technologies.

UNIT I Energy Scenario **9**

ndian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status.Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans.

UNIT II Solar Energy **9**

Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications

UNIT III Wind Energy **9**

Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues – Applications.

UNIT IV Bio-Energy **9**

io resources – Biomass direct combustion – thermochemical conversion - biochemical conversionmechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration –- Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production – Applications

UNIT V Ocean and geothermal energy **9**

Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Discuss the Indian and global energy scenario.
CO2: Describe the various solar energy technologies and its applications.
CO3: Explain the various wind energy technologies.
CO4: Explore the various bio-energy technologies.
CO5: Discuss the ocean and geothermal technologies.

TEXT BOOKS:

1. Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636
2. Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 812034470

REFERENCES:

1. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 2012.
2. Rai.G.D., “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2014.
3. Sukhatme.S.P., “Solar Energy: Principles of Thermal Collection and Storage”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
4. Tiwari G.N., “Solar Energy – Fundamentals Design, Modelling and applications”, Alpha Science Intl Ltd, 2015.
5. Twidell, J.W. & Weir A., “Renewable Energy Resources”, EFNSpon Ltd., UK, 2015

Course Code	**INTRODUCTION TO CYBERSECURITY**	L	T	P	C
CZ4601		3	0	0	3

Course Objective:

- Develop a comprehensive understanding of fundamental cybersecurity concepts, including cyber threats, preventive measures, and the principles of cyber security.
- Explore the basics of networking, focusing on concepts, protocols, and architectures crucial to understanding cyber security measures.
- Acquire knowledge on core security principles, including risk management practices, to build a solid foundation for implementing effective security measures.
- Understand the principles of cryptography and encryption, exploring their role in securing data and communication channels in the realm of cybersecurity.

- Develop the skills to create, implement, and enforce security policies and procedures, fostering a security-aware culture and mitigating cyber threats through effective governance.

Course Description:

This course covers cybersecurity, networking basics, security principles, cryptography, and security policy development. Participants will understand cyber threats, network protocols, risk management, and practical security applications. The curriculum aims to equip students with essential skills for navigating the dynamic cybersecurity landscape and contributing to secure digital environments. Upon completion, students will be prepared for challenges in maintaining resilient and secure information systems.

Unit 1: INTRODUCTION TO CYBERSECURITY CONCEPTS 9

Introduction to Cybersecurity Fundamentals - Cyber Threat Landscape -Cybersecurity Frameworks and Standards - Security Architecture and Models - Incident Response and Cybersecurity Incident Handling - Security Awareness and Training - Legal and Ethical Aspects of Cybersecurity - Emerging Trends in Cybersecurity.

Unit 2: FUNDAMENTALS OF NETWORKING 9

Introduction to Networking Concepts - OSI Model Overview - TCP/IP Protocol Suite - Network Devices and Components - IP Addressing and Subnetting - Routing and Switching Basics - Wireless Networking Fundamentals - Network Security Principles.

Unit 3: SECURITY FUNDAMENTALS 9

Introduction to Security Principles - Access Control and Authentication - Security Risk Management - Security Policies and Procedures - Security Incident Response - Security Awareness Training - Vulnerability Assessment and Management - Physical Security Considerations

Unit 4: CRYPTOGRAPHY AND ENCRYPTION 9

Introduction to cryptography - symmetric encryption algorithms - asymmetric encryption and public key infrastructure (PKI) - hash functions and message digests - digital signatures - cryptographic key management - transport layer security (TLS) and secure sockets layer (SSL) - cryptography in blockchain technology.

Unit 5: SECURITY POLICIES AND PROCEDURES 9

introduction to security policies and procedures - policy development and implementation - access control policies - data classification and handling policies - incident response plans - security awareness training programs - compliance and regulatory policies - security auditing and monitoring procedures

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, online resources and tutorials

Assessments & Grading
Quizzes, Assignments/ Project, 2IAs, Model, Final Examination.

Course Outcomes:
At the end of this course, the students will be able to:
(CO1):Gain a clear understanding of fundamental cybersecurity principles, exploring the core concepts that form the basis of cyber defense.
(CO2):Understand the application of cybersecurity policies and risk management practices, emphasizing their importance in maintaining a secure digital environment.
(CO3):Learn about the basic tools and techniques used in investigating various types of cybercrimes, providing a foundational knowledge base for cybercrime detection and resolution.
(CO4):Apply security fundamentals to digital environments, incorporating knowledge of risk management, access control, and other core principles to enhance overall security.
(CO5):Demonstrate proficiency in cyber forensics techniques and methodologies, integrating knowledge gained from security policies and procedures to enhance investigative capabilities.

Assignments:
1) Analyze a real-world cybersecurity case study, identifying the threats, preventive measures, and the application of fundamental cybersecurity principles.
2) Develop a comprehensive proposal for a secure network design, considering protocols, architectures, and security measures to address potential threats.
3) Create a risk management plan for a fictional organization, outlining potential risks, mitigation strategies, and a framework for implementing security policies.
4) Evaluate the implementation of cryptographic techniques in a given system, assessing their effectiveness in securing data and communication.
5) Draft an incident response plan for a specific type of cybersecurity incident, detailing the steps to be taken during detection, analysis, and resolution.
6) Design and implement a comprehensive security awareness campaign for an organization. Include strategies for educating employees on cybersecurity best practices, phishing awareness, and the importance of maintaining a security-conscious culture.
7) Conduct a simulated penetration test on a network or system, identifying vulnerabilities and providing a detailed report with recommendations for remediation.
8) Evaluate an organization's compliance with relevant cybersecurity regulations (e.g., GDPR, HIPAA). Develop a report outlining areas of compliance and suggesting improvements if necessary.
9) Perform a threat hunting exercise using security tools and techniques to proactively identify potential threats within a network. Provide a report detailing the findings and proposed actions.
10) Analyze and review the cybersecurity policies of a chosen organization. Identify strengths, weaknesses, and areas for improvement. Develop a report with recommendations for enhancing policy effectiveness.

Text Book Links:
Unit 1: Introduction to Cybersecurity by Jeetendra pande
https://uou.ac.in/sites/default/files/slm/Introduction-cyber-security.pdf
Unit 2: Fundamentals of Networking:
https://www.cisco.com/c/dam/global/fi_fi/assets/docs/SMB_University_120307_Networking_Fundamentals.pdf
Unit 3: Security Fundamentals:
https://training.apnic.net/wp-content/uploads/sites/2/2016/11/eSEC01_NetSec.pdf

Unit 4: **Cryptography and Encryption:**
https://www.cs.umd.edu/~waa/414-F11/IntroToCrypto.pdf
Unit 5: **Security Policies and Procedures:**
https://oklahoma.gov/content/dam/ok/en/omes/documents/InfoSecPPG.pdf

Reference Book:

1. Cybersecurity – Attack and Defense Strategies by Yuri Diogenes and Eradal Ozkaya.
2. Applied Cryptography :Protocols, Algorithms and Source code in C by Bruce Schneier.
3. Hacking: The Art of Exploitation by Jon Erickson

Course Code	SECURITY PRINCIPLES	L	T	P	C
CZ46O2		3	0	0	3

COURSE OBJECTIVES:

- To understand the basic principles and concepts of cybersecurity.
- To identify and assess security threats and vulnerabilities.
- To implement security controls and measures to protect information assets.
- To develop strategies for risk management and incident response.
- To understand the legal and ethical aspects of cybersecurity.

UNIT I : INTRODUCTION TO CYBERSECURITY 9

Overview of cybersecurity concepts and terminology -Threat landscape and common types of cyber threats -Principles of risk management and risk assessment .

UNIT II : CRYPTOGRAPHY AND ACCESS CONTROL 9

Basics of cryptography: encryption, hashing, digital signatures -Access control models and mechanisms: discretionary, mandatory, role-based access control

UNIT 3: NETWORK SECURITY 9

Principles of network security: firewalls, intrusion detection systems, VPNs-Secure network protocols: HTTPS, SSH, IPsec

UNIT 4: SECURITY OPERATIONS AND INCIDENT RESPONSE 9

Security monitoring and incident detection-Incident response procedures: detection, analysis, containment, eradication, recovery.

UNIT 5: LEGAL AND ETHICAL ASPECTS OF CYBERSECURITY 9

Legal frameworks and regulations: GDPR, HIPAA, PCI DSS-Ethical considerations in cybersecurity: privacy, intellectual property, professional ethics.

TOTAL : 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, online resources and tutorials

Assessments & Grading
Quizzes, Assignments/ Project, 2IAs, Model, Final Examination.

ASSIGNMENTS:

1. Threat Assessment Report: Analyze potential security threats to a given organization and propose countermeasures.
2. Risk Management Plan: Develop a risk management plan outlining strategies for mitigating identified risks.
3. Security Policy Review: Evaluate an organization's security policies and procedures and make recommendations for improvement.
4. Incident Response Simulation: Participate in a simulated security incident response exercise, including detection, analysis, and containment.
5. Ethical Dilemma Case Study: Analyze real-world ethical dilemmas in cybersecurity and propose solutions based on ethical principles.

COURSE OUTCOMES:
Students will be able to
CO1: Describe the various types of cybersecurity threats and their impact on organizations.
CO2: Demonstrate proficiency in implementing security controls such as encryption, firewalls, and intrusion detection systems.
CO3: Develop the skills necessary to conduct risk assessments and formulate risk mitigation strategies.
CO4: Analyze security incidents and respond effectively to security breaches.
CO5: Understand the ethical and legal issues surrounding cybersecurity, including privacy and compliance requirements.

TEXTBOOKS:
1. "Principles of Computer Security: CompTIA Security+ and Beyond" by Wm. Arthur Conklin, Greg White, Chuck Cothren, Roger L. Davis, and Dwayne Williams - This book provides a comprehensive introduction to computer security principles, covering topics such as network security, cryptography, access control, and risk management. It aligns with the CompTIA Security+ certification exam objectives.
2. "Computer Security: Principles and Practice" by William Stallings and Lawrie Brown - This textbook offers a thorough examination of computer security principles and practices, including cryptographic techniques, network security protocols, access control mechanisms, and security management. It covers both theoretical concepts and practical applications.
3. "Security in Computing" by Charles P. Pfleeger, Shari Lawrence Pfleeger, and Jonathan Margulies - This book provides a solid foundation in computer security principles, emphasizing risk management, security policies, cryptography, and secure software development. It offers practical insights and real-world examples to illustrate key concepts.

REFERENCE BOOKS:
1. "Cryptography and Network Security: Principles and Practice" by William Stallings - This reference book focuses on cryptographic techniques and network security protocols, providing detailed explanations of encryption algorithms, digital signatures, authentication protocols, and secure communication protocols.
2. "Introduction to Computer Security" by Matt Bishop - This book offers an introduction to the fundamental principles of computer security, covering topics such as access control, security

models, security policies, and intrusion detection systems. It provides a solid theoretical foundation for understanding security concepts.
3. "Information Security: Principles and Practices" by Mark S. Merkow and James Breithaupt - This reference book explores the principles and practices of information security, including risk management, security governance, compliance frameworks, and incident response. It covers a wide range of security topics relevant to both beginners and experienced professionals.
4. "Network Security Essentials: Applications and Standards" by William Stallings - This book focuses on network security principles and practices, including secure communication protocols, intrusion detection systems, firewalls, and virtual private networks (VPNs). It offers comprehensive coverage of network security technologies and their applications.
5. "Computer Security Handbook" by Seymour Bosworth, M. E. Kabay, and Eric Whyne - This handbook provides a comprehensive overview of computer security principles, practices, and technologies. It covers a wide range of topics, including risk assessment, security policies, cryptography, access control, and security management.

YOUTUBE REFERENCES:

1. "Cybersecurity Fundamentals" by Cybersecurity Training and Certification
2. "Introduction to Cryptography" by Khan Academy
3. "Network Security Basics" by Cisco Networking Academy
4. "Incident Response Process" by SANS Institute
5. "Ethical Hacking and Penetration Testing" by The Cyber Mentor

Course Code	**LIFE CYCLE ASSESSMENT**	L	T	P	C
CE46O2		3	0	0	3

COURSE OBJECTIVES:

The main objectives of this course are to:

- To impart knowledge and skills on the concept and methodology of Life Cycle Assessment as per international standards and its potential applications
- To develop sustainable products and promote sustainable consumption.
- Understanding of the principles, methodologies, and techniques involved in Life Cycle Assessment (LCA).
- Develop the ability to identify, quantify, and assess the environmental impacts associated with various stages of a product or system's life cycle.
- Learn how to interpret LCA results and communicate findings effectively, including understanding the significance of different impact categories.

Course Description

This course provides an in-depth exploration of the principles, methodologies, and applications of LCA, equipping students with the knowledge and skills necessary to conduct comprehensive environmental assessments and make informed decisions to promote sustainability.

Prerequisites

· Familiarity with the concept of life cycle thinking and systems theory.
· Understanding of fundamental environmental science concepts such as ecology, environmental impacts, and sustainability principles provides a foundational knowledge base for studying LCA.

UNIT I Life Cycle Thinking and Life Cycle Management **9**

Introduction to Life Cycle Thinking – Industrial ecology – Life cycle management (LCM) and Stakeholder Expectations - LCM drivers and issues - materials flow analysis - Life cycle of Products and services- International organizations and networks - History and definition of LCA - analytical tools for product and service systems ––-Value creation along the life cycle– technical characteristics – applications – limitations

UNIT II LCA Goal, Scope and Inventory **9**

ISO 14040 framework for LCA - Life cycle goal and scope definition - function, functional unit and reference flow System boundaries, data categories, inputs and outputs, data quality, critical review and other procedural aspects - Inventory Analysis: Raw Material Extraction and Processing , Manufacturing and Production , Product Use and Consumption , End-of-life Management, Transportation and Distribution - Dealing with Allocation Issues - Solutions to the multi functionality problem - Flow diagram - Format and data categories - Attributional versus consequential LCI – LCA software and database - Data quality - Data collection and relating data to unit processes – Data validation - Cut-off and data estimation .

UNIT III Life Cycle Impact Analysis and Interpretation **9**

Characterization factors and principle of characterization - Selection of impact categories, category indicators and characterization models – Classification -Characterization - Optional elements - normalization , grouping, weighting ,data quality analysis - Characterization models – Impact assessment Case studies -Simplified/streamlined Life Cycle Assessments – procedural approaches, numerical approaches - Examples of numerical approaches - contribution analysis, perturbation analysis, uncertainty - analysis, comparative analysis, key issue analysis – Treatment of uncertainties - Elements in uncertainty handling - Sensitivity of LCA results – Sustainability analysis - Extending LCA - economic dimension, social dimension - Life cycle costing – Eco efficiency - Combining LCA and LCC – Case studies

UNIT IV Design for Environment and Ecolabelling **9**

Sustainable consumption – Eco-efficiency - green consumerism - product stewardship and green engineering - Extended producer responsibility – Design For Environment Strategies, Practices, Guidelines, Methods, And Tools .Eco design strategies –Design for Disassembly - Dematerialization, re materialization, trans materialization – Green procurement and green distribution - Analysis framework for reuse and recycling – Typical constraints on reuse and recycling - Communication of Life Cycle Information - Indian eco mark scheme – Environmental product declarations – Environmental marketing

UNIT V LCA Softwares and Case Studies **9**

LCA Softwares - LCA Software Demo: SimaPro, GREET, BEES, CMU EIO,GABI - Advances in LCA: Hybrid LCA, Thermodynamic LCA - LCA case studies on Product Design, Product Improvement, Product Comparison and Policy development.

COURSE OUTCOMES:

OUTCOMES: Upon completion of the course, the students will be able to:

CO1: Explain the various functional elements of Life Cycle Analysis and Design for Environment

CO2: Apply the knowledge of science and engineering fundamentals to characterize the environmental interactions of products and services

CO3: Design of engineering systems taking into account the material flow and pollutant interactions between engineering decisions and the environment

CO4: Select appropriate LCA tools to support product/process design and decision making,

taking into account the impact of the solutions in a sustainability context
CO5: Evaluate generative models using appropriate metrics and critically analyse the ethical implications, privacy concerns, and societal impact of generative AI technologies.

TEXT BOOKS:

1. Ralph Horne, Tim Grant, Karli Verghese, Life Cycle Assessment: Principles, Practice and Prospects, Csiro Publishing, 2009.

REFERENCES:

1. ISO 14040-2016-Environmental management - Life cycle assessment - Principles and framework, International Organization for Standardization, 2016.
2. ISO/TR 14047:2003, Environmental management - Life cycle impact assessment - Examples of application of ISO 14042, International Organization for Standardization, 2007.
3. International Organization for Standardization: ISO TR 14062 Environmental management Integrating environmental aspects into product design and development, 2002.
4. European Commission - Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook – General guide for Life Cycle Assessment - Detailed guidance. Luxembourg. European Union; 2010.
5. Catherine Benoit, UQAM/CIRAIG, and Bernard Mazijn, Guidelines for Social Life Cycle Assessment of Products, United Nations Environment Programme,2009

TOTAL: 45 PERIODS

YouTube Resources:

1. **Sustainable Minds -** Sustainable Minds is a provider of cloud-based software and services for sustainable product development.
2. **Life Cycle Assessment – SimaPro**- SimaPro is one of the leading software tools for conducting Life Cycle Assessments.
3. **European Commission – JRC**- The Joint Research Centre (JRC) of the European Commission produces research and technical reports on a wide range of topics, including environmental sustainability and Life Cycle Assessment.
4. **Life Cycle Initiative** - The Life Cycle Initiative, hosted by the United Nations Environment Programme (UNEP), promotes the use of life cycle approaches for sustainable development.
5. **LCA Learning** - This channel offers various educational videos on Life Cycle Assessment, including tutorials, case studies, and discussions on LCA methodology and applications.

Course Code	**Engineering Chemistry**	L	T	P	C
CY46O1		3	0	0	3

COURSE OBJECTIVES

- To inculcate sound understanding of water quality and water treatment techniques.
- To impart knowledge on the preparatory methods of nanomaterial's.
- To introduce the properties and applications of composites
- To facilitate the understanding of fuel classification, preparation, combustion, and environmental impact.
- To be conversant with the principle electrochemistry, cell reactions, and corrosion protection techniques.
- To acquire a deep understanding of renewable energy sources along with energy storage technologies and innovation in sustainable energy systems.

UNIT I WATER AND ITS TREATMENT 9

Water: Sources and impurities, Requisites of portable water- hardness (Calculation of hardness in terms of calcium carbonate equivalents) and alkalinity. - Municipal water treatment (screening, sedimentation, coagulation, filtration and disinfection - ozonolysis, UV treatment, chlorination), Desalination of brackish water: Reverse Osmosis.

Boiler troubles: Scale and sludge, Priming & foaming. Treatment of boiler feed water: Internal treatment (phosphate, colloidal, sodium aluminate, and calgon conditioning) and External treatment - Ion exchange demineralization and zeolite process.

UNIT II NANO MATERIALS & COMPOSITES 9

Basics: Distinction between molecules, Nanomaterials, and bulk materials; Types of nanomaterials: Definition, properties, and uses of nanoparticles and nanotubes. Preparation of nano materials: laser ablation, and electro spinning. Application of nano materials in medicine, agriculture, energy, electronics, and catalysis.

Composites: Properties and applications of Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. FRP-Hybrid composites- definition and examples. Basic concept of biomaterials.

UNIT III FUELS AND COMBUSTION 9

Fuels: Introduction: Classification of fuels; Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; Power alcohol and biodiesel.

Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value (Dulong's Formula only); Flue gas analysis - ORSAT Method. CO_2 emission and carbon footprint.

UNIT IV ELECTRO CHEMISTRY AND CORROSION CONTROL 9

Electrochemistry - Introduction, Electrochemical cell - electrolytic cell - reversible and irreversible cells. Electrode potential-Oxidation and reduction Potentials-emf, Nernst equation and applications. Reference electrodes-Calomel electrode-Electrochemical series and its applications.

Corrosion protection - cathodic protection - sacrificial anodic and impressed current protection methods; advanced protective coatings: electroplating and electroless plating.

UNIT V ENERGY SOURCES AND STORAGE DEVICES 9

Solar energy conversion: Principle, working and applications of solar cells; recent developments in solar cell (DSSC) materials - Wind energy; Geothermal energy. Hydrogen as fuel: Sources of hydrogen - Hydrogen production methods - electrolysis, limitations and applications.

Storage Devices: Batteries - Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion battery; Electric vehicles-working principles; Fuel cells: H_2-O_2 fuel cell.

THEORY: 45 PERIODS

COURSE OUTCOMES .

At the end of the course, the students will be able to:

CO1: Infer the quality of water and propose suitable treatment methodologies for hard water.

CO2: Identify and apply basic concepts of nanomaterial's preparation for engineering applications.
CO3: Gain knowledge of fuel properties, manufacturing processes, combustion characteristics, and environmental considerations.
CO4: Attain expertise in electrochemical principles, cell reactions and corrosion protection techniques.
CO5: Attain proficiency in different forms of energy resources and fuel cell utilization, fostering the lead advancements in renewable energy and energy storage solutions.

TEXT BOOKS:

1. Dara S.S, Umare S.S, "Engineering Chemistry", First revised Edition by S. Chand & Company Ltd., New Delhi 2015.
2. Jain P. C. & Monica Jain., "Engineering Chemistry", 16th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.
3. K. Klabunde, G. Sergeev, Nanochemistry, 2nd Edition, Springer Publisher, 2013.
4. S.A. Sherif, D. Yogi Goswami, E.K. (Lee) Stefanakos, Aldo Steinfeld "Handbook of Hydrogen Energy", 1st Edition, CRC Press, 2014.

REFERENCE BOOKS:

1. Shikha Agarwal., "Engineering Chemistry and Applications", Cambridge University press, 2016.
2. Lefrou.,Christine., Fabry., Pierre., Poignet., Jean-claude., "Electrochemistry - The Basics, with examples" Springer. 2012.
3. Zaki Ahmad, Digby Macdonald, "Principles of Corrosion Engineering and Corrosion Control", Elsevier Science, 2nd Edition, 2012.
4. Introduction to Nano: basics to Nanoscience and Nanotechnology, by Sengupta, Amretashis, Sarkar, Chandan Kumar, Springer Publisher, 2015.
5. Kazunari Sasaki, Hai-Wen Li, Akari Hayashi, Junichiro Yamabe, Teppei Ogura, Stephen M. Lyth, Hydrogen Energy Engineering A Japanese Perspective, Springer, 2016

WEB REFERENCES:

1. https://www.who.int/
2. www.corrosionsource.com/
3. https://ocw.mit.edu/courses/chemistry
4. https://nptel.ac.in/courses/113108051
5. https://onlinecourses.nptel.ac.in/noc20_me29/preview

Course Code	**Biomaterials**	L	T	P	C
BM 4703		3	0	0	3

COURSE OBJECTIVES:

The students should be made:

- To have an overview of biomaterial science.
- To describe the principles of compatibility design with a case study.
- To explain the interaction and design parameters

- To study about various tests.
- To study about ethical issues and regulation aspects

UNIT I Introduction to Biomaterial Science 9

Basic properties of biomaterials - Metallic, Ceramic, Polymeric and Composite -Medical fibres and biotextiles – Smart polymers – bioresorbable and bio erodible materials – natural materials, metals and ceramics – physicochemical surface modification. Chemical and biochemical degradation of polymers – degradation of metals and ceramics – calcification of biomaterials.

UNIT II Compatibility 9

Biocompatibility concepts: Introduction to biocompatibility – cell material interaction – types of materials – toxic, inert, bioactive – long term effects of materials within the body – cell response. Biomaterial characterization techniques Fundamental characteristics of implants - biocompatibility, bioactivity, biodegradability. Basics of drug delivery Basics of tissue engineering Rheology.

UNIT III Interactions 9

Host reactions and their evaluation: Inflammation and foreign body response – adaptive immunity – systemic toxicity and hypersensitivity – blood coagulation and blood materials interactions – device related infections.

UNIT IV Evaluation 9

Biological testing of biomaterials: Invitro and invivo assessment of tissue compatibility – evaluation of blood materials interaction – microscopy in biomaterials.

UNIT V Regulation 9

Practical aspects of biomaterials: Bioelectrodes, biomedical sensors and biosensors – sterilization of implants – implant failure – implant retrieval and evaluation – legal aspects, ethical issues and regulation aspects.

45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Gain adequate knowledge about biomaterial science.
CO2: Get clear idea of compatibility parameters and solutions.
CO3: Have in-depth knowledge about interaction.
CO4: Explain different types testing techniques.
CO5: Access practical issues

TEXT BOOKS & REFERENCES:

1. Buddy D Ratner, Allan S Hoffman, “Biomaterials Science – An introduction to materials in Medicine”, Elsevier academic press, (2004).
2. John Enderle, Joseph D.Bronzino, Susan M.Blanchard, “Introduction to biomedical Engineering”, Elsevier, 2005.

Course Code	BIOMEDICAL OPTICS AND PHOTONICS	L	T	P	C
BM4704		3	0	0	3

COURSE OBJECTIVES:

The students should be made:

- To acquire knowledge about the physical properties of light and optical properties of tissue.
- To learn the design and working principle of various optical components.
- To understand the principles and applications of optical biosensors.
- To understand the engineering and practical applications of optical related to diagnostic and surgical applications.
- To understand the phenomenon of laser tissue interaction and practical application of optical related to therapeutic equipment.

UNIT I Optical Properties **9**

Basic principles of light - Reflection - Refraction - Absorption - Polarization - Interference - Coherence, Basic laws of light - Beer Lambert law - Snell's law, Optical properties of tissues - Absorption - Scattering - Anisotropy.

UNIT II Optical Instrumentation **9**

Working principle of light sources - Lasers - LEDs, Working principle of optical detectors - Photodiode - Spectrometer- CMOS and CCD cameras - Lens - Optical filters - Optical fibers.

UNIT III Optical Biosensors **9**

Principles of Optical biosensing - Immobilization of bio-recognition elements, Types of optical biosensor - Fiber optic - Planar waveguide - Evanescent - Interferometric - Surface plasmon resonance - Advantages and disadvantages - Applications.

UNIT IV Applications of Lasers **9**

Diagnostic - Optical coherence tomography, Fluorescence, Raman, Photo acoustic tomography, Laser induced breakdown spectroscopy (LIBS), Hyper spectral imaging. Surgical - Lasers in dentistry, Dermatology, Ophthalmology.

UNIT V Laser Tissue Interaction **9**

Laser tissue interactions via photochemical, Photo thermal, Photomechanical techniques, Photodynamic therapy (PDT) - Oncological and non-ontological applications, Low level laser therapy (LLLT) – bio stimulation applications.

45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES: Upon completion of the course, the student will be able to

CO1: Explain the various physical properties of light and optical properties of tissues.

CO2: Design analysis-by-synthesis model for speech perception..

CO3: Discuss the various applications of biosensors in medicine

CO4: Summarize the diagnostic and surgical applications of lasers in medicine
CO5: Explain the laser tissue interaction and various therapeutic applications of lasers.

TEXT BOOKS:

1. Taun vo dinh, 'biomedical photonics'-handbook, CRC press, Bacaraton,2014
2. Jurgen Popp, Valery V. Tuchin, Arthur Chiou and Stefen Heinemann, handbook of biophotonics, Vol 2: Photonics for Healthcare, John Wiley and Sons, 1st Edition, 2011.

REFERENCES:

1. Markolf H. Niemz, "Laser-Tissue Interaction Fundamentals and Applications" Springer, 2007.
2. Splinter R and Hooper B. A., "An Introduction to Biomedical Optics", Taylor and Francis, 2006.
3. Mark E. Brezinski, "Optical Coherence Tomography: Principles and Applications", Academic Press, 2006.
4. Paras N. Prasad, "Introduction to Biophotonics", A. John Wiley and sons, Inc. Publications, 2003.

Course Code	PRODUCTION AND OPERATIONS MANAGEMENT FOR ENTREPRENEURS		T	P	C
ME4702		3	0	0	3

COURSE OBJECTIVES:

The students should be made:

- To know the basic concept and function of Production and Operation Management for entrepreneurship.
- To understand the Production process and planning.
- To understand the Production and Operations Management Control for business owners

UNIT I Introduction to Production and Operations Management 9

Functions of Production Management - Relationship between production and other functions – Production management and operations management, Characteristics of modern production and operation management, organisation of production function, recent trends in production /operations management - production as an organisational function, decision making in production Operations research

UNIT II Production & operation systems 9

Production Systems- principles – Models - CAD and CAM- Automation in Production - Functions and significance- Capacity and Facility Planning: Importance of capacity planning- Capacity measurement – Capacity Requirement Planning (CRP) process for manufacturing and service industry

UNIT III Production & Operations planning 9

Facility Planning – Location of facilities – Location flexibility – Facility design process and techniques – Location break even analysis-Production Process Planning: Characteristic of production process systems – Steps for production process- Production Planning Control

Functions – Planning phase- Action phase- Control phase - Aggregate production planning

UNIT IV Production & operations management process 9

Process selection with PLC phases- Process simulation tools- Work Study – Significance – Methods, evolution of normal/ standard time – Job design and rating - Value Analysis - Plant Layout: meaning – characters –- Plant location techniques - Types- MRP and Layout Design - Optimisation and Theory of Constraints (TOC)– Critical Chain Project Management (CCPM)- REL (Relationship) Chart – Assembly line balancing- – Plant design optimisation -Forecasting methods.

UNIT V Controlling production & operations management 9

Material requirement planning (MRP)- Concept- Process and control - Inventory control systems and techniques – JIT and Lean manufacturing - Network techniques - Quality Management: Preventive Vs Breakdown maintenance for Quality – Techniques for measuring quality - Control Chart (X , R , p , np and C chart) - Cost of Quality, Continuous improvement (Kaizen) - Quality awards - Supply Chain Management - Total Quality Management - 6 Sigma approach and Zero Defect Manufacturing.

45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES:

CO1: To understand the basics and functions of Production and Operation Management for business owners.
CO2: To learn about the Production & Operation Systems.
CO3:To acquaint on the Production & Operations Planning Techniques followed by entrepreneurs in Industries.
CO4: To known about the Production & Operations Management Processes in organisations.
CO5: To comprehend the techniques of controlling, Production and Operations in industries.

REFERENCES:

1. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson, 2007.
2. Amitabh Raturi, Production and Inventory Management, , 2008.
3. Adam Jr. Ebert, Production and Operations Management, PHI Publication, 1992.
4. Muhlemann, Okland and Lockyer, Production and Operation Management, Macmillan India,1992.
5. Chary S.N, Production and Operations Management, TMH Publications, 2010.

Course Code	CONCEPTS IN MOBILE ROBOTICS	L	T	P	C
ME4704		3	0	0	3

COURSE OBJECTIVES

The objective of this course is to enable the student to:

- To introduce mobile robotic technology and its types in detail.
- To learn the kinematics of wheeled and legged robot.
- To familiarize the intelligence into the mobile robots using various sensors.
- To acquaint the localization strategies and mapping technique for mobile robot.
- To aware the collaborative mobile robotics in task planning, navigation and intelligence.

UNIT I Introduction to mobile robots 9

Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Roots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles

UNIT II Kinematics 9

Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints – Degree of Mobility and Steerability – Manoeuvrability – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots

UNIT III Perception 9

S ensor for Mobile Robots – Classification and Performance Characterization – Wheel/Motor Sensors – Heading Sensors - Ground-Based Beacons - Active Ranging - Motion/Speed Sensors – Camera - Visual Appearance based Feature Extraction

UNIT IV Localization 9

Localization Based Navigation Versus Programmed Solutions - Map Representation - Continuous Representations - Decomposition Strategies - Probabilistic Map-Based Localization - Landmark-Based Navigation - Globally Unique Localization - Positioning Beacon Systems - Route-Based Localization - Autonomous Map Building - Simultaneous Localization and Mapping (SLAM).

UNIT V Planning, Navigation and Collaborative Robots 9

Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures - Control Localization - Techniques for Decomposition - Case Studies – Collaborative Robots – Swarm Robots.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to

CO1: Evaluate the appropriate mobile robots for the desired application.
CO2: Create the kinematics for given wheeled and legged robot.
CO3: Analyse the sensors for the intelligence of mobile robotics.
CO4: Create the localization strategies and mapping technique for mobile robot.
CO5: Create the collaborative mobile robotics for planning, navigation and intelligence.

TEXT BOOKS

1. Roland Siegwart and IllahNourbakish, "Introduction to Autonomous Mobile Robots" MIT Press, Cambridge, 2004.

REFERENCES

1. Dragomir N. Nenchev, Atsushi Konno, TeppeiTsujita, "Humanoid Robots: Modelling and Control", Butterworth-Heinemann, 2018
2. Mohanta Jagadish Chandra, "Introduction to Mobile Robots Navigation", LAP Lambert Academic Publishing, 2015.
3. Peter Corke, "Robotics, Vision and Control", Springer, 2017.
4. Ulrich Nehmzow, "Mobile Robotics: A Practical Introduction", Springer, 2003.
5. Xiao Qi Chen, Y.Q. Chen and J.G. Chase, "Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions", Intec Press, 2009.
6. Alonzo Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, 2013, ISBN: 978-1107031159.

Course Code	CLIMATE CHANGE AND ADAPTATION	L	T	P	C
CE47O1		3	0	0	3

COURSE OBJECTIVES:

- To know the basics, importance of global warming
- To know the concept of mitigation measures against global warming
- To learn about the global warming and climate change

Course Description

This course provides an introduction to the theory and practical applications of Climate change and adaptation. Students will learn the fundamental concepts and techniques related to Climate change and adaptation and gain hands-on experience with creating and using Climate change and adaptation.

Prerequisites

- Basic knowledge of Climate change and adaptation..
- Familiarity with Climate change.

UNIT I Earth's Climate System **9**

Role of ozone in environment ozone layer ozone depleting gases Green House Effect, Radiative effects of Greenhouses Gases Hydrological Cycle Green House Gases and Global Warming Carbon Cycle

UNIT II Atmosphere And Its Components **9**

Importance of Atmosphere - Physical Chemical Characteristics of Atmosphere - Vertical structure of the atmosphere- Composition of the atmosphere Atmospheric stability- Temperature profile of the atmosphere - Lapse rates - Temperature inversion - effects of inversion on pollution dispersion

UNIT III Impacts Of Climate Change **9**

Causes of Climate change : Change of Temperature in the environment Melting of ice Pole-sea level rise-Impacts of Climate Change on various sectors Agriculture, Forestry and Ecosystem

Water Resources Human Health Industry, Settlement and Society Methods and Scenarios Projected Impacts for Different Regions Uncertainties in the Projected Impacts of Climate Change Risk of Irreversible Changes

UNIT IV Climate Changes And Its Causes 9

Climate change and Carbon credits - CDM - Initiatives in India-Kyoto Protocol Intergovernmental Panel on Climate change - Climate Sensitivity and Feedbacks - The Montreal Protocol - UNFCCCIPCC - Evidences of Changes in Climate and Environment - on a Global Scale and in India.

UNIT V Climate Change And Mitigation Measures 9

Clean Development Mechanism -Carbon Trading -examples of future Clean Technology - Biodiesel - Natural Compost - Eco-Friendly Plastic - Alternate Energy -Hydrogen - Bio-fuels - Solar Energy - Wind - Hydroelectric Power -Mitigation Efforts in India and Adaptation funding Key Mitigation Technologies and Practices-Energy Supply - Transport - Buildings- Industry- Agriculture - Forestry - Carbon sequestration- Carbon capture and storage (CCS) - Municipal solid Waste (MSW) & Bio waste, Biomedical, Industrial waste International and Regional cooperation.

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES:

Upon completion of the course, the students will be able to:

CO1: Demonstrate an understanding of how the threats and opportunities of predicted climate changes will influence specific sectors at global and regional scale.

CO2: Identify the relationship between atmosphere and its components

CO3: Analyze the impacts of climate change on environment parameters

CO4: Evaluate the scientific insights underlying the assessment reports of the IPCC, with a focus on impacts, adaptation and mitigation.

CO5: Critically evaluate the relative opportunities and needs for mitigation and adaptation (including vulnerability assessments) in a variety of sectoral contexts.

TEXT BOOKS:

1. Sangam Shrestha, Mukand S. Babel and Vishnu Prasad Pandey,2014, Climate Change and Water Resources, CRC Press an imprint of the Taylor & Francis Group.
2. Intergovernmental Panel on Climate Change: https://www.ipcc.ch/

REFERENCES:

1. Adaptation and mitigation of climate Scientific Technical Analysis, Cambridge University Press, Cambridge, 2006
2. Atmospheric Science, J.M. Wallace and P.V. Hobbs, Elsevier / Academic Press 2006
3. Jan C. van Dam, Impacts of Climate Change and Climate Variability on Hydrological Regimes?, Cambridge University Press, 2003

TOTAL: 45 PERIODS

YouTube Resources:

1. Climate Reality: Founded by former US Vice President Al Gore, this channel provides informative videos on climate change science, impacts, and solutions, as well as stories of communities adapting to a changing climate.

2. **NASA Climate Change:** NASA's YouTube channel features videos on climate change research, satellite observations, and educational content explaining the science behind climate change.

3. **Our Changing Climate:** This channel offers well-researched videos on various aspects of climate change, including its causes, impacts, and adaptation strategies, presented in an engaging and accessible format.

4. **Climate Central:** Climate Central's YouTube channel provides videos on climate science, extreme weather events, and adaptation efforts, with a focus on communicating climate change impacts to the public.

5. **UNFCCC:** The United Nations Framework Convention on Climate Change (UNFCCC) shares videos on its YouTube channel related to international climate negotiations, climate action initiatives, and adaptation efforts around the world.

6. **Yale Climate Connections:** This channel features videos on climate change news, solutions, and innovations, as well as stories of communities and individuals taking action to address climate change and adapt to its impacts.

7. **Climate Adaptation Knowledge Exchange (CAKE):** CAKE's YouTube channel offers resources and discussions on climate change adaptation strategies, case studies, and best practices, aimed at professionals, policymakers, and community leaders.

Course Code	**Environmental Impact Assessment**	L	T	P	C
CE47O5		3	0	0	3

COURSE OBJECTIVES:

The main objectives of this course are to:

●To expose the students to the need, methodology, documentation and usefulness of environmental impact assessment and to develop the skill to prepare an environmental management plan.

●To participate in the performance of an environmental assessment process (EIA or SEA), given the disciplinary knowledge and skills in natural sciences and engineering the student have achieved in other courses.

Course Description

This course provides an introduction to the theory and practical applications of environmental impact. Students will learn the fundamental concepts and techniques related to environmental impact and gain hands-on experience with creating and using environmental impact assessment.

UNIT I **Introduction** **9**

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance-EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

UNIT II **Impact Identification and Prediction** **9**

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. Prediction tools for EIA – mathematical modelling for impact prediction – assessment of impacts – air – water – soil – noise – biological –– cumulative impact assessment

UNIT III Socio-Economic Impact Assessment 9

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

UNIT IV EIA Documentation And Environmental Management Plan 9

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

UNIT V Case Studies 9

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects.

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES:

Upon completion of the course, the students are expected to be able to:

CO1: Carry out scoping and screening of developmental projects for environmental and social Assessments

CO2: Explain different methodologies for environmental impact prediction and assessment.

CO3: Assessing socio-economic investigation of the environment as a project.

CO4: Plan environmental impact assessments and environmental management plans.

CO5: Knowledge to prepare environmental impact assessment reports for various projects.

TEXT BOOKS:

1. Canter, L.W., "Environmental Impact Assessment", McGraw Hill, New York. 1996.
2. Lawrence, D.P., "Environmental Impact Assessment – Practical solutions to recurrent problems",Wiley-Interscience, New Jersey. 2003 .

REFERENCES:

1. World Bank –Source book on EIA
2. Cutter, S.L., "Environmental Risk and Hazards", Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
3. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff "Risk Assessment and Management Handbook", McGraw Hill Inc., New York,1996.

TOTAL: 45 PERIODS

YouTube Resources:

1. **IIT Roorkee**- EIA is basically a tool used to assess the positive and negative environmental, economic and social impacts of a project.
2. **Science Sauce** - Explaining tricky Science concepts in as little time as possible. All content created by Alex Nixon..
3. **Border Archaeology** - They are mandated by The Town and Planning Regulations 2011 for projects falling under Schedule 1 and may also be sought by a local planning authority for Schedule 2-type projects following project screening and scoping..
4. **Sustainable Technology Solutions** - The relevance of EIA lies in its ability to ensure that projects are designed and implemented in a way that minimizes environmental harm and promotes sustainable development.
5. **Sigma Earth** - Climate change refers to long-term shifts in temperatures and weather patterns. Human activities have been the main driver of climate change, primarily due to the burning of fossil fuels like coal, oil and gas.

Course Code	**Introduction To PLC Programming**	L	T	P	C
EE4706		3	0	0	3

COURSE OBJECTIVES:

The main objectives of this course are to:

- Understand basic PLC terminologies, digital principles, PLC architecture and operation.
- Familiarize different programming languages of PLC.
- Develop PLC logic for simple applications using ladder logic.
- Understand the hardware and software behind PLC and SCADA.
- Exposures about communication architecture of PLC/SCADA.

Course Description

This course provides students with a comprehensive understanding of Programmable Logic Controllers (PLC) and Supervisory Control and Data Acquisition (SCADA) systems used in industrial automation. Students will learn about the fundamentals of PLCs, programming techniques, communication protocols, and their integration with SCADA systems. Case studies will be utilized to illustrate real-world applications of PLC and SCADA technology.

Prerequisites

- Basic understanding of electrical circuits and industrial automation systems.
- Familiarity with programming concepts and logic.

UNIT I Introduction to PLC 9

Introduction to PLC: Microprocessor, I/O Ports, Isolation, Filters, Drivers, Microcontrollers/DSP, PLC/DDC- PLC Construction: What is a PLC, PLC Memories, PLC I/O, , PLC Special I/O, PLC Types.

UNIT II PLC INSTRUCTIONS 9

PLC Basic Instructions: PLC Ladder Language- Function block Programming- Ladder/Function Block functions- PLC Basic Instructions, Basic Examples (Start Stop Rung, Entry/Reset Rung)- Configuration of Sensors, Switches, Solid State Relays- Interlock examples- Timers, Counters, Examples.

UNIT III PLC Programming 9

Different types of PLC program, Basic Ladder logic, logic functions, PLC module addressing, registers basics, basic relay instructions, Latching Relays, arithmetic functions, comparison functions, data handling, data move functions, timer-counter instructions, input-output instructions, sequencer instructions

UNIT IV Communication of PLC and SCADA 9

Communication Protocol – Modbus, HART, Profibus- Communication facilities SCADA: - Hardware and software, Remote terminal units, Master Station and Communication architectures

UNIT V Case Studies 9

Stepper Motor Control – Elevator Control – CNC Machine Control – conveyor control-Inter locking Problems.

TOTAL: 45 PERIODS

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, and online resources

Assessments & Grading

Quizzes / Assignments, Project, 3 Internal Assessments, Final Examination

COURSE OUTCOMES:

OUTCOMES: Upon completion of the course, the students will be able to:

CO1: Know the basic requirements of a PLC input/output devices and architecture.
CO2: Ability to apply Basics Instruction Sets used for ladder Logic and Function Block Programming.
CO3: Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function BIock.
CO4: Able to develop a PLC logic for a specific application on real world problems.
CO5: Ability to Understand the Concepts of Communication used for PLC/SCADA.

TEXT BOOKS:

1. FrankPetruzzula,ProgrammableLogicControllers,TataMc-GrawHillEdition
2. JohnW.Webb,RonaldA.Reis,ProgrammableLogicControllersPrinciplesand Applications, PHI publication

REFERENCES:

1. Madhuchannd Mitra and Samerjit Sengupta, Programmable Logic Controllers Industrial Automation an Introduction, Penram International Publishing Pvt. Ltd.
2. J.R.Hackworth and F.D.Hackworth, Programmable Logic Controllers Principles and Applications, Pearson publication.

YouTube Resources:

1. https://youtu.be/Y5NgUc_dxlA?si=ftn2jWz0DghyfEW5
2. https://youtu.be/qaI48NCUvkA?si=ZM5nHTKw6kTzeuVg
3. https://youtu.be/y2eWdLk0-Ho?si=qcmk_85ns4ixqhNA
4. https://youtu.be/dbSkqDw_UlQ?si=qiYQcX-C2DTnuBKG
5. https://youtu.be/jQGxJOZDfZI?si=0Vfl2hhLGog_EY3B

Course Code	CYBER CRIME	L	T	P	C
CZ47O2		3	0	0	3

Course Objectives:

The main objectives of this course are to

- To Understand cybercrime, preventing measures and range of cyber threats and the fundamental principles of cyber security.
- To focus on developing policies, implementing risk management practices, and fostering a security-aware culture to mitigate cyber threats.
- To understand the methodologies, tools, and techniques employed in investigating various types of cybercrimes.
- To provide participants with a foundational understanding of digital forensics, covering essential concepts, methodologies, and tools.
- To advance participants' proficiency in cyber forensics by delving into advanced techniques and methodologies.

Course Description:

This course provides a comprehensive examination of cybercrime, exploring the various forms of criminal activities in cyberspace, the techniques used by cybercriminals, and the strategies employed to prevent and investigate these crimes. Students will gain a solid foundation in the technical, legal, and ethical aspects of cybercrime, enabling them to understand, analyze, and respond to digital threats.

UNIT 1 ESSENTIALS OF CYBERSECURITY 9

Introduction to Cybersecurity - Authentication and Access Control - Common Cyber Threats - Protective Measures - Data Protection - Security Best Practices - Emerging Trends and Technologies - Regulatory Compliance

UNIT 2 CYBERCRIME TYPES AND PREVENTION 9

Introduction to Cybercrime - Types of Cybercrimes - Cybersecurity Fundamentals - Prevention and Mitigation - Incident Response and Cyber Forensics - Legal and Ethical Considerations in Cybersecurity - Emerging Trends in Cyber Threats - Social Engineering and Insider Threats.

UNIT 3 CYBERSECURITY POLICIES AND RISK MANAGEMENT 9

Role-Based Access Control (RBAC) - Incident Response Plans (IRP) - Risk Assessment and Management - Security Awareness Training - Security Governance - Regulatory Compliance and Legal Considerations - Security Training and Awareness Programs - Cybersecurity Risk Communication.

UNIT 4 CYBERCRIME INVESTIGATION TECHNIQUES 9

Digital Evidence Collection and Preservation - Network Forensics and Traffic Analysis - Malware Analysis and Reverse Engineering - Incident Response and Cyber Threat Hunting - Mobile Forensics - Cloud Forensics - Forensic Data Analysis and Visualization - Legal Aspects of Cybercrime Investigations.

UNIT 5 CYBER DECEPTION AND SOCIAL ENGINEERING TACTICS 9

Deepfake Technology and Social Engineering - Psychological Manipulation Techniques - Social Engineering in the Context of Business Email Compromise (BEC) - Cognitive Biases Exploited in Social Engineering - Hacking the Human OS: Exploiting Human Vulnerabilities in Cybersecurity

- Insights from Famous Social Engineering Attacks - Reverse Social Engineering: Turning the Tables on Attackers - Ethical Hacking and Social Engineering Awareness Programs.

Course Format
Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, online resources and tutorials

Assessments & Grading
Quizzes, Assignments/ Project, 2IAs, Model, Final Examination.

Assignments / Projects (sample): **45 PERIODS**

1. Designing a Cybersecurity Awareness Campaign
2. Cybercrime Case Analysis
3. Building a Cybercrime Prevention Handbook
4. Cybersecurity Policy Review
5. Risk Management Simulation
6. Digital Forensics Case Study
7. Building a Cybercrime Investigation Toolkit
8. Social Engineering Awareness Training
9. Cyber Deception Exercise

COURSE OUTCOMES :
At the end of this course, the students will be able to:
CO1. Demystify the fundamental principles of cyber security.
CO2. Delineate the use of Cyber security Policies and Risk Management
CO3. Elucidate the basic tools, and techniques employed in investigating various types of cybercrimes
CO4.Apply the digital forensics, covering essential concepts, methodologies, and tools
CO5. Demonstrate the cyber forensics techniques and methodologies.

TEXT BOOKS:
1. Cyber crime investigation manual published in 2011 https://jhpolice.gov.in/sites/default/files/documents-reports/jhpolice_cyber_crime_investigation_manual.pdf
2. Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley
3. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335, 2018

REFERENCES:
1. Cyber SecurityEssentials, James Graham, Richard Howard and Ryan Otson, CRC Press. 2. Introduction to Cyber Security , Chwan-Hwa(john) Wu,J.David Irwin.CRC PressT&FGroup
2. Cybercrime and Digital Forensics: An Introduction by Thomas J. Holt and Adam M. Bossler.
3. Cybercrime: Investigating High-Technology Computer Crime by Robert Moore.

YouTube Resources:
https://www.youtube.com/watch?v=38RZdFK7Prg
https://www.youtube.com/watch?v=1Luh3tBH-8I
https://www.youtube.com/watch?v=Ls8jyO46bmI

Course Code	DIGITAL FORENSICS	L	T	P	C
CZ4703		3	0	0	3

Course Objective:

The main objectives of this course are to:
●Learn preventive measures to safeguard digital systems and information against cyber threats.
●Develop policies specific to digital crime and focusing on digital investigation.
●Gain a comprehensive understanding of the methodologies, tools, and techniques used in investigating various types of cybercrimes.
●Acquire a foundational understanding of mobile device forensics, covering essential concepts, principles and tools.
●Explore cutting-edge tools and practices in digital forensics, applying them to complex and evolving cybercrime scenarios.

Course Description:

Digital forensics, often referred to as computer forensics, is a branch of forensic science that involves the investigation and analysis of digital devices, systems, and networks to gather and preserve electronic evidence. The primary goal of digital forensics is to uncover, analyze, and document information that can be used in legal proceedings or to investigate and prevent cybercrime.

Unit I **Digital Forensic Techniques and Traces** **9**

File System Analysis - Network Packet Analysis - Memory Forensics - Digital Evidence Collection - Mobile Device Forensics Techniques - Cloud Forensics - Big Data Analytics in Forensics - Incident Response and Timeline Analysis.

Unit II **Introduction to Digital Crime and Investigation** **9**

Digital Crime Overview - Legal and Ethical Frameworks - Digital Forensic Tools and Techniques - Incident Response Fundamentals - Digital Evidence Collection and Preservation - Cybersecurity Basics - Digital Investigation Methodologies - Cybercrime Trends and Emerging Threats.

Unit 3 **Internet Based Investigations** **9**

Social Media Investigations - Open-Source Intelligence (OSINT) - Email and Communication Tracing - Dark Web Investigations - Online Fraud Investigations - Cyber Threat Intelligence - Digital Copyright and Intellectual Property Investigations - Online Extremism and Radicalization Investigations.

Unit 4 **Mobile Device Forensics** **9**

Mobile Device Acquisition Techniques - Operating System Forensics - App Forensics - Cloud Integration and Data Synchronization - Mobile Device Security Measures - Location-Based Services and GPS Analysis - Mobile Device Network Analysis - Messaging and Social Media Forensics.

Unit 5 **Investigation and Evidence Collection** **9**

Digital Crime Scene Management - Legal Frameworks and Digital Forensic Regulations - Chain of Custody and Documentation - Evidence Collection from Digital Devices - Network Forensic Investigations - Incident Response Procedures - Forensic Imaging and Data Extraction - Forensic Analysis Tools and Techniques.

Course Format

Lectures and discussions, Hands-on coding exercises and projects, Guest lectures by industry Experts, Group discussions and presentations, Online resources and tutorials.

Assessments & Grading

Quizzes, Assignments/ Project, 2IAs ,Model, Final Examination

Assignments / Projects (sample): **TOTAL: 45 PERIODS**

1. Digital Forensic Tool Review
2. Digital Forensic Case Analysis
3. Digital Crime Trends Report
4. Digital Crime Awareness Campaign
5. Dark Web Exploration
6. Online Fraud Investigation
7. Mobile Device Security Analysis
8. Mobile Device Forensic Case Study
9. Legal and Ethical Considerations in Digital Investigations.
10. Mock Crime Scene Investigation

COURSE OUTCOMES:
At the end of this course, the students will be able to:
CO1 : Clarify the foundational principles of digital forensics, unravelling the core concepts essential to the field.
CO2 : Evaluate and delineate strategies for managing risks associated with digital forensic investigations.
CO3 : Elaborate on the basic tools and techniques utilized in the investigation of various types of cybercrimes.
CO4 : Apply digital forensics principles, methodologies, and tools in practical scenarios.
CO5 : Demonstrate advanced cyber forensics techniques and methodologies in real-world situations

TEXT BOOKS:
1. C. Altheide & H. Carvey Digital Forensics with Open Source Tools, Syngress, 2011. ISBN : 978159495868.
2. Warren G. Kruse II and Jay G. Heiser, "Computer Forensics: Incident Response Essentials", Addison Wesley, 2002.
3. Nelson, B, Phillips, A, Enfinger, F, Stuart, C., "Guide to Computer Forensics and Investigations, 2nd ed., Thomson Course Technology, 2006, ISBN:0-619-21706-5.

REFERENCES:
1. Vacca, J, *Computer Forensics, Computer Crime Scene Investigation*, 2nd Ed, Charles River Media, 2005, ISBN: 1-58450-389.
2. Digital Evidence and Computer Crime: Forensic Science, Computers, and the Internet, 3rd Edition Author: Eoghan Casey Publisher: Academic Press ISBN: 9780123742681.
3. The Art of Memory Forensics Authors: Michael Hale Ligh, Andrew Case, Jamie Levy, AAron Walters Publisher: Wiley ISBN: 1118825098

Online Reference:

1. https://www.coursera.org/specializations/computerforensics
2. https://www.youtube.com/watch?v=u2zgEFm5RHQ
3. https://www.youtube.com/playlist?list=PLJu2iQtpGvv-2LtysuTTka7dHt9GKUbxD

Course Code	OPERATIONAL TECHNOLOGY SECURITY	L	T	P	C
CZ4704		3	0	0	3

COURSE DESCRIPTION:

Operational Technology (OT) Security is a specialized course that focuses on securing industrial control systems, SCADA (Supervisory Control and Data Acquisition) systems, and other critical infrastructure from cyber threats. The course covers essential concepts, techniques, and best practices for protecting OT environments, including risk assessment, asset inventory, network segmentation, intrusion detection, and incident response.

COURSE OBJECTIVES:

Students can able to

- Understand the unique challenges and vulnerabilities of operational technology (OT) systems.
- Learn the principles and best practices for securing industrial control systems and SCADA systems.
- Develop skills in conducting risk assessments and implementing security controls in OT environments.
- Familiarize students with industry standards and regulations relevant to OT security.
- Prepare students to respond effectively to security incidents in OT environments.

UNIT I: INTRODUCTION TO OPERATIONAL TECHNOLOGY (OT) SECURITY 9

Overview of OT systems and their significance -Unique challenges and vulnerabilities of OT environments- Principles of OT security and risk management.

UNIT II: SECURING INDUSTRIAL CONTROL SYSTEMS (ICS) 9

Overview of industrial control systems (ICS) and SCADA systems - Security architecture and best practices for ICS security - Asset inventory and vulnerability assessment in ICS environments

UNIT III: NETWORK SEGMENTATION AND ACCESS CONTROL 9

Network segmentation strategies for OT environments - Access control mechanisms and authentication protocols in OT systems - Implementing access controls and network segmentation in OT networks

UNIT IV: INTRUSION DETECTION AND INCIDENT RESPONSE 9

Intrusion detection systems (IDS) for OT environments - Incident response procedures and best practices for OT security incidents- Incident detection, analysis, containment, and recovery in OT environments.

UNIT V: REGULATORY COMPLIANCE AND STANDARDS 9

Regulatory and compliance requirements for OT security - Industry standards and frameworks for OT security (e.g., NIST, IEC) -Ensuring compliance with relevant standards and regulations in OT environments.

TOTAL : 45 PERIODS

ASSIGNMENTS:

1. Risk Assessment Report: Conduct a risk assessment of a simulated OT environment and develop a risk mitigation plan.
2. Security Control Implementation: Implement security controls such as access controls, network segmentation, and IDS in a virtual OT environment.
3. Incident Response Simulation: Participate in a simulated security incident response exercise in an OT environment, including detection, analysis, and containment of security incidents.
4. Compliance Audit: Conduct a compliance audit of an OT environment, ensuring adherence to relevant standards and regulations.
5. Case Study Analysis: Analyze real-world case studies of OT security breaches and develop recommendations for improving security posture.

COURSE OUTCOMES:

At the end of this course, the students will be able to

CO1: Identify and assess security risks in operational technology (OT) systems.
CO2: Demonstrate proficiency in implementing security controls such as access controls, network segmentation, and intrusion detection systems (IDS) in OT environments.
CO3: Develop the ability to analyze and respond to security incidents in OT environments, including incident detection, containment, and recovery.
CO4: Understand the regulatory and compliance requirements applicable to OT security and be able to ensure compliance with relevant standards.
CO5: Gain practical experience through hands-on labs, case studies, and real-world simulations in securing OT systems.

TEXTBOOKS:

1. "Industrial Network Security: Securing Critical Infrastructure Networks for Smart Grid, SCADA, and Other Industrial Control Systems" by Eric D. Knapp and Joel Langill - This book provides comprehensive coverage of industrial network security, including SCADA systems, smart grids, and other critical infrastructure networks.
2. "Hacking Exposed Industrial Control Systems: ICS and SCADA Security Secrets & Solutions" by Clint Bodungen, Bryan L. Singer, and Aaron Shbeeb - This book offers practical insights and solutions for securing industrial control systems and SCADA environments, with a focus on real-world threats and vulnerabilities.
3. "Practical SCADA for Industry" by David Bailey and Edwin Wright - This book covers the fundamentals of SCADA systems and their practical applications in industrial environments, including security considerations and best practices.

REFERENCE BOOKS:

1. "SCADA and Me: A Book for Children and Management" by Robert M. Lee - This book provides an accessible introduction to SCADA systems and their importance in industrial operations, suitable for both children and management professionals.
2. "SCADA Security: What's Broken and How to Fix It" by Andrew Ginter - This book offers insights into the vulnerabilities and security challenges faced by SCADA systems, along with practical strategies for improving SCADA security.
3. "Introduction to Industrial Control Networks" by Perry Marshall - This book covers the basics of industrial control networks, including communication protocols, network architectures, and security considerations.

4. "Industrial Cybersecurity: Efficiently secure critical infrastructure systems" by Pascal Ackerman - This book provides guidance on designing and implementing cybersecurity solutions for industrial control systems and critical infrastructure networks.
5. "Security for SCADA Systems" by Dale Peterson - This book offers in-depth coverage of security principles, techniques, and best practices specific to SCADA systems, with practical examples and case studies.

YouTube References:

1. SANS Institute: Offers a variety of videos and webinars on OT security topics, including ICS/SCADA security, threat intelligence, and incident response.
2. Dragos: Provides insights and analysis on OT security threats and vulnerabilities, with a focus on industrial control systems and critical infrastructure.
3. Nozomi Networks: Offers educational content and tutorials on OT security best practices, including network monitoring, anomaly detection, and threat hunting in OT environments.

APPENDIX C: MANDATORY COURSES

Code	Course Title	Semester	L-T-P-C
MC4301	Introduction to Women and Gender Studies	III	2-0-0-0
MC4302	Elements for Literature	III	2-0-0-0
MC4303	Film Appreciation	III	2-0-0-0
MC4304	Disaster Management	III	2-0-0-0
MC4305	Design Thinking	III	2-0-0-0
MC4401	Environmental Science and Sustainability	IV	2-0-0-0
MC4402	Well Being with Traditional practices (Yogam Ayurveda and Siddha)	IV	2-0-0-0
MC4403	History of Science and Technology in India	IV	2-0-0-0
MC4404	Political and Economic Thought for a Humane Society	IV	2-0-0-0
MC4405	State, Nation building and Politics in India	IV	2-0-0-0
MC4406	Industrial Safety	IV	2-0-0-0

Course Code	INTRODUCTION TO WOMEN AND GENDER STUDIES	L	T	P	C
MC4301		2	0	0	0

COURSE OBJECTIVES:

- Understand the difference between sex and gender, including masculinity and femininity, shaped by societal norms.
- Critique patriarchal systems and hierarchies, advocating for the deconstruction of binary views and recognition of gender diversity.
- Engage with various feminist frameworks to analyze and address gender inequality.
- Trace the development and impact of feminist movements globally, nationally, and locally.
- Analyze language, media, and narratives to understand and challenge gender norms and stereotypes.

UNIT I **CONCEPTS** 2

Sex vs. Gender, masculinity, femininity, socialization, patriarchy, public/ private, essentialism, binaryism, power, hegemony, hierarchy, stereotype, gender roles, gender relation, deconstruction, resistance, sexual division of labour.

UNIT II **FEMINIST THEORY** 2

Liberal, Marxist, Socialist, Radical, Psychoanalytic, postmodernist, ecofeminist.

UNIT III **WOMEN'S MOVEMENTS: GLOBAL, NATIONAL AND LOCAL** 2

Rise of Feminism in Europe and America, Women's Movement in India.

UNIT IV **GENDER AND LANGUAGE** 2

Linguistic Forms and Gender, Gender and narratives.

UNIT V **GENDER AND REPRESENTATION** 2

Advertising and popular visual media, Gender and Representation in Alternative Media, Gender and social media.

TOTAL: 10 PERIODS

Course Outcomes:

Upon Successful Completion of the course the students will be able to

CO1: Mastery of key gender studies concepts, including sex vs. gender, patriarchy, and power dynamics.

CO2: Ability to critically evaluate societal norms and gender roles, recognizing and deconstructing stereotypes.

CO3: Application of diverse feminist theories to address gender inequality on local, national, and global scales.

CO4: Understanding of the historical progression and impact of feminist movements on social attitudes and policies.

CO5: Development of effective communication skills to advocate for gender equality, challenging norms in language, media, and society architecture and how different ARM processors work.

Text Books & References:

1. To be decided by the teacher and student, on the basis of individual student so as to enable him or her to write the term paper

Course Code	ELEMENTS OF LITERATURE	L	T	P	C
MC4302		2	0	0	0

COURSE OBJECTIVES:

●To make the students aware about the finer sensibilities of human existence through an art form. The students will learn to appreciate different forms of literature as suitable modes of expressing human experience

UNIT I RELEVANCE OF LITERATURE 2

Enhances Reading, thinking, discussing and writing skills, Develops finer sensibility for better human relationship, Increases understanding of the problem of humanity without bias, Providing space to reconcile and get a cathartic effect.

UNIT II ELEMENTS OF FICTION 2

Fiction, fact and literary truth, Fictional modes and patterns, Plot character and perspective.

UNIT III ELEMENTS OF POETRY 2

Emotions and imaginations, Figurative language, Simile, metaphor, conceit, symbol, pun and irony, Personification and animation, Rhetoric and trend.

UNIT IV ELEMENTS OF DRAMA 2

Drama as representational art, Content mode and elements, Theatrical performance, Drama as narration, mediation and persuasion, Features of tragedy, comedy and satire.

UNIT V TUTORIALS 2

The students will write a term paper to show their understanding of a particular piece of literature

TOTAL:10 PERIODS

Course Outcomes:

Upon Successful Completion of the course the students will be able to

Students will be able to understand the relevance of literature in human life and appreciate its aspects in developing finer sensibilities

Text Books:

1. An Introduction to the Study of English Literature, W.H. Hudson, Atlantic, 2007.
2. An Introduction to Literary Studies, Mario Klarer, Routledge, 2013.

References:

1. The Experience of Poetry, Graham Mode, Open college of Arts with Open Unv Press,1991.
2. The Elements of Fiction: A Survey, Ulf Wolf (ed), Wolfstuff, 2114.

Course Code	FILM APPRECIATION	L	T	P	C
MC4303		2	0	0	0

COURSE OBJECTIVES:

- Understand filmmaking components, including equipment and storytelling.
- Trace film language evolution, focusing on significant milestones.
- Explore film theories (realist, auteurist, psychoanalytic, feminist).

- Analyze representative films from diverse cultural contexts.
- Examine Indian cinema's development, from early era to regional diversity..

UNIT I THE COMPONENT OF FILMS 2

The material and equipment, The story, screenplay and script, The actors, crew members, and the director, The process of film making, Structure of a film

UNIT II EVOLUTION OF FILM LANGUAGE 2

Film language, form, movement etc, Early cinema, Silent film (Particularly French), The emergence of feature films: Birth of a Nation, Talkies

UNIT III FILM THEORIES AND CRITICISM/APPRECIATION 2

Realist theory: Auteurists, Psychoanalytic, Ideological, Feminists, How to read films? Film Criticism / Appreciation

UNIT IV DEVELOPMENT OF FILMS 2

Representative Soviet films, Representative Japanese films, Representative Italian films, Representative Hollywood film and the studio system.

UNIT V INDIAN FILMS 2

The early era, The important films made by the directors, The regional films, The documentaries in India

TOTAL:10 PERIODS

Course Outcomes:

Upon Successful Completion of the course the students will be able to

CO1: Gain a comprehensive understanding of filmmaking components and techniques

CO2: Explore the historical evolution of film language and major milestones.

CO3: Develop critical analysis skills through the study of various film theories.

CO4: Broaden cultural awareness by analyzing representative films from diverse contexts.

CO5: Appreciate the development and diversity of Indian cinema

Text Books:

A Reader containing important articles on films will be prepared and given to the students. The students must read them and present in the class and have discussion on these

Course Code	DISASTER RISK REDUCTION AND MANAGEMENT	L	T	P	C
MC4304		2	0	0	0

COURSE OBJECTIVES:

- To impart knowledge on concepts related to disaster, disaster risk reduction, disaster
- management
- To acquaint with the skills for planning and organizing disaster response

UNIT I HAZRADS, VULNERABILITY AND DISASTER RISKS 2

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Types of Disasters: Natural, Human induced, Climate change induced –Earthquake, Landslide, Flood, Drought, Fire etc – Technological disasters- Structural collapse, Industrial accidents, oil spills -Causes, Impacts including social, Economic, political, environmental, health, psychosocial, etc.- Disaster

vulnerability profile of India and Tamil Nadu - Global trends in disasters: urban disasters, pandemics, Complex emergencies, Inter relations between Disasters and Sustainable development Goals

UNIT II DISASTER RISK REDUCTION (DRR) 2

Sendai Framework for Disaster Risk Reduction, Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community Based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Early Warning System – Advisories from Appropriate Agencies.- Relevance of indigenous Knowledge, appropriate technology and Local resources

UNIT III DISASTER MANAGEMENT 2

Components of Disaster Management – Preparedness of rescue and relief, mitigation, rehabilitation and reconstruction- Disaster Risk Management and post disaster management – Compensation and Insurance- Disaster Management Act (2005) and Policy - Other related policies, plans, programmers and legislation - Institutional Processes and Framework at State and Central Level- (NDMA –SDMA-DDMA-NRDF- Civic Volunteers)

UNIT IV TOOLS AND TECHNOLOGY FOR DISASTER MANAGEMENT 2

Early warning systems -Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment. - Elements of Climate Resilient Development –Standard operation Procedure for disaster response – Financial planning for disaster Management.

UNIT V DISASTER MANAGEMENT: CASE STUDIES 2

Discussion on selected case studies to analyze the potential impacts and actions in the contest of disasters-Landslide Hazard Zonation: Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.- Field work-Mock drill -

TOTAL:10 PERIODS

Course Outcomes:

Upon Successful Completion of the course the students will be able to

CO1: To impart knowledge on the concepts of Disaster, Vulnerability and Disaster Risk reduction (DRR)

CO2: To enhance understanding on Hazards, Vulnerability and Disaster Risk Assessment prevention and risk reduction

CO3: To develop disaster response skills by adopting relevant tools and technology

CO4: Enhance awareness of institutional processes for Disaster response in the country

CO5: Develop rudimentary ability to respond to their surroundings with potential Disaster response in areas where they live, with due sensitivity

Text Books:

1.Taimpo (2016), Disaster Management and Preparedness, CRC Publications
2. Singh R (2017), Disaster Management Guidelines for earthquakes, Landslides, Avalanches and tsunami, Horizon Press Publications

References:

1. Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005.
2. Government of India, National Disaster Management Policy, 2009.

Course Code	**Design Thinking**	L	T	P	C
MC4305		2	0	0	0

COURSE OBJECTIVES:

The main objectives of this course are to:

- Introduce students to the fundamental concepts and principles of design thinking.
- Develop students' ability to empathize with users and identify their needs.
- Equip students with skills for problem-solving and generating innovative solutions.
- Foster collaboration and interdisciplinary teamwork among students.
- Apply design thinking methodologies to real-world engineering challenges.

Course Description

This course offers an exploration of the principles and methodologies behind design thinking, emphasizing on a human-centered approach to innovation and problem-solving. Through a blend of lectures, hands-on exercises, and interactive workshops, participants learn to empathize with users, define problems, generate creative solutions, and iterate on prototypes.

UNIT I Introduction to Design Thinking **2**

Definition and principles of design thinking – Importance and applications in engineering – Case studies of successful design thinking projects

UNIT II Empathize and Define **2**

Understanding user needs and motivations – Techniques for empathetic research (interviews, observations, etc.) – Defining problem statements based on user insights

UNIT III Ideate and Prototype **2**

Techniques for generating ideas (brainstorming, mind mapping, etc.) – Prototyping methods and tools – Iterative design process and feedback loops

UNIT IV Test and Iterate **2**

User testing and feedback collection – Analyzing and interpreting feedback – Iterating on prototypes based on feedback

UNIT V Application and Workshop **2**

Applying design thinking to engineering challenges – Workshop sessions for hands-on practice – Presentation (Posters / PPT / Demonstration) of final projects and reflection on the design process

Workshop Ideas:

1. Design Sprints: Conduct short, intensive workshops where students work collaboratively to solve a specific problem within a constrained timeframe.
2. Design Challenges: Pose open-ended design challenges to students and facilitate group work sessions where they brainstorm and prototype solutions.
3. User Persona Creation: Have students create user personas based on research findings and use them to guide the design process.
4. Prototyping Sessions: Provide materials and tools for students to create rapid prototypes of their ideas, encouraging experimentation and creativity.
5. Design Critiques: Organize sessions where students present their prototypes to peers for feedback and constructive criticism, fostering a culture of iteration and improvement.

TOTAL: 10 PERIODS

Course Format

Lectures and discussions, Workshops, Group discussions and presentations,

COURSE OUTCOMES:

OUTCOMES: Upon completion of the course, the students will be able to:

CO1: Understand the principles and process of design thinking.
CO2: Identify user needs through empathetic research.
CO3: Generate creative ideas and solutions through brainstorming and prototyping.
CO4: Apply design thinking methodologies to solve engineering problems effectively.
CO5: Work collaboratively in multidisciplinary teams to address complex challenges.

TEXT BOOKS:

1. Tim Brown, "Change by Design", Revised and Updated, Harper, 2019.
2. Christian Müller-Roterberg, “Handbook of Design Thinking: Tips & Tools for How to Design Thinking”, Independently Published, 2018.
3. Jeanne Liedtka, and Tim Ogilvie, “Designing for Growth: A Design Thinking Tool Kit for Managers”, Columbia University Press, 2011.

REFERENCES:

1. Don Norman, “The Design of Everyday Things”, Basic Books, 2015.
2. Hasso Plattner, Christoph Meinel, and Larry Leife (editors), “Design Thinking: Understand – Improve – Apply”, Springer-Verlag, 2013.
3. Richard Banfield, C. Todd Lombardo and Trace Wax, “Design Sprint: A Practical Guidebook for Building Great Digital Products”, O'Reilly Media, 2015.

Course Code	**ENVIRONMENTAL SCIENCE AND SUSTAINABILITY**	L	T	P	C
MC4401		2	0	0	0

COURSE OBJECTIVES:

●To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.

●To impart knowledge on the causes, effects and control or prevention measures of

environmental pollution and natural disasters.
●To facilitate the understanding of the global and Indian scenario of renewable and nonrenewable resources, causes of their degradation and measures to preserve them.
●To familiarize the concept of sustainable development goals and appreciate the interdependence of economic and social aspects of sustainability, recognize and analyze climate changes, concept of carbon credit and the challenges of environmental management.
●To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles and analyze the role of sustainable urbanization.

UNIT I ENVIRONMENT AND BIODIVERSITY 2

Definition, scope and importance of environment – need for public awareness. Ecosystem and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

UNIT II ENVIRONMENTAL POLLUTION 2

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollution. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts.

UNIT III RENEWABLE SOURCES OF ENERGY 2

Energy management and conservation, New Energy Sources: Need of new sources. Different types of new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

UNIT IV SUSTAINABILITY AND MANAGEMENT 2

Development, GDP, Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

UNIT V SUSTAINABILITY PRACTICES 2

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economical and technological change.

TOTAL : 10 PERIODS

Course Outcomes:

Upon Completion of the course the students will be able to

CO1: To recognize and understand the functions of the environment, ecosystems and biodiversity and their conservation.
CO2: To identify the causes, effects of environmental pollution and natural disasters and contribute to the preventive measures in the society.
CO3: To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.

CO4: To recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.
CO5: To demonstrate the knowledge of sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.

Text Books:
1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

References:
1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 . edition 2010
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai,2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, Third Edition,2015.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

Course Code	**WELL-BEING WITH TRADITIONAL PRACTICES-YOGA, AYURVEDA AND SIDDHA**	L	T	P	C
MC4402		2	0	0	0

COURSE OBJECTIVES:
- To enjoy life happily with fun filled new style activities that help to maintain health also
- To adapt a few lifestyle changes that will prevent many health disorders
- To be cool and handbill every emotion very smoothly in every walk of life
- To learn to eat cost effective but healthy foods that are rich in essential nutrients
- To develop immunity naturally that will improve resistance against many health disorders

UNIT I HEALTH AND ITS IMPORTANCE 2

Health: Definition - Importance of maintaining health - More importance on prevention than treatment Ten types of health one has to maintain - Physical health - Mental health - Social health – Financial health - Emotional health - Spiritual health - Intellectual health - Relationship health – Environmental health - Occupational/Professional heath.
Present health status - The life expectancy-present status - mortality rate - dreadful diseases - Non-communicable diseases (NCDs) the leading cause of death - 60% - heart disease – cancer –

diabetes - chronic pulmonary diseases - risk factors – tobacco – alcohol - unhealthy diet - lack of physical activities.
Types of diseases and disorders - Lifestyle disorders – Obesity – Diabetes – Cardiovascular diseases – Cancer – Strokes – COPD - Arthritis - Mental health issues. Causes of the above diseases / disorders - Importance of prevention of illness - Takes care of health - Improves quality of life - Reduces absenteeism - Increase satisfaction - Saves time Simple lifestyle modifications to maintain health - Healthy Eating habits (Balanced diet according to age) Physical Activities (Stretching exercise, aerobics, resisting exercise) – Maintaining BMI-Importance and actions to be taken

UNIT II DISASTER RISK REDUCTION (DRR) 2

Role of diet in maintaining health - energy one needs to keep active throughout the day - nutrients one needs for growth and repair - helps one to stay strong and healthy - helps to prevent diet-related illness, such as some cancers - keeps active and - helps one to maintain a healthy weight - helps to reduce risk of developing lifestyle disorders like diabetes – arthritis – hypertension – PCOD – infertility – ADHD – sleeplessness -helps to reduce the risk of heart diseases - keeps the teeth and bones strong.
Balanced Diet and its 7 Components - Carbohydrates – Proteins – Fats – Vitamins – Minerals - Fibre and Water. Food additives and their merits & demerits - Effects of food additives - Types of food additives - Food additives and processed foods - Food additives and their reactions

UNIT III ROLE OF AYURVEDA & SIDDHA SYSTEMS IN MAINTAINING HEALTH 2

AYUSH systems and their role in maintaining health - preventive aspect of AYUSH - AYUSH as a soft therapy. Secrets of traditional healthy living - Traditional Diet and Nutrition - Regimen of Personal and Social Hygiene - Daily routine (Dinacharya) - Seasonal regimens (Ritucharya) - basic sanitation and healthy living environment - Sadvritta (good conduct) - for conducive social life.
Principles of Siddha & Ayurveda systems - Macrocosm and Microcosm theory – Pancheekarana Theory / (Five Element Theory) 96 fundamental Principles - Uyir Thathukkal (Tri-Dosha Theory) - Udal Thathukkal Prevention of illness with our traditional system of medicine
Primary Prevention - To decrease the number of new cases of a disorder or illness – Health promotion/education, and - Specific protective measures - Secondary Prevention - To lower the rate of established cases of a disorder or illness in the population (prevalence) - Tertiary Prevention – To decrease the amount of disability associated with an existing disorder

UNIT IV MENTAL WELLNESS 2

Emotional health - Definition and types - Three key elements: the subjective experience - the physiological response - the behavioral response - Importance of maintaining emotional health - Role of emotions in daily life -Short term and long term effects of emotional disturbances - Leading a healthy life with emotions - Practices for emotional health - Recognize how thoughts influence emotions - Cultivate positive thoughts - Practice self-compassion - Expressing a full range of emotions. Stress management - Stress definition - Stress in daily life - How stress affects one's life - Identifying the cause of stress - Symptoms of stress - Managing stress (habits, tools, training, professional help) - Complications of stress mismanagement. Sleep - Sleep and its importance for mental wellness - Sleep and digestion. Immunity - Types and importance - Ways to develop immunity

UNIT V YOGA 2

Definition and importance of yoga - Types of yoga - How to Choose the Right Kind for individuals according to their age - The Eight Limbs of Yoga - Simple yogasanas for cure and prevention of health disorders - What yoga can bring to our life.

TOTAL:10 PERIODS

Course Outcomes:

Upon Successful Completion of the course the students will be able to

CO1:Embrace enjoyable, health-promoting activities to foster happiness and well-being.

CO2: Adopt lifestyle changes aimed at preventing various health issues.

CO3: Cultivate emotional resilience to navigate life's challenges with ease.

CO4: Learn to incorporate cost-effective, nutrient-rich foods into daily dietary habits.

CO5: Enhance natural immunity to bolster resistance against a range of health disorders

Text Books:

1. Nutrition and Dietetics - Ashley Martin, Published by White Word Publications, New York, NY 10001, USA

2. Yoga for Beginners_ 35 Simple Yoga Poses to Calm Your Mind and Strengthen Your Body, by Cory Martin, Copyright © 2015 by Althea Press, Berkeley, California

References:

1. WHAT WE KNOW ABOUT EMOTIONAL INTELLIGENCE How It Affects Learning, Work, Relationships, and Our Mental Health, by Moshe Zeidner, Gerald Matthews, and Richard D. Roberts

2. A Bradford Book, The MIT Press, Cambridge, Massachusetts, London, England The Mindful Self-Compassion Workbook, Kristin Neff, Ph.D Christopher Germer, Ph.D, Published by The Guilford Press A Division of Guilford Publications, Inc.370 Seventh Avenue, Suite 1200, NW

Course Code	HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA	L	T	P	C
MC4403		2	0	0	0

COURSE OBJECTIVES:

- Understand key historical concepts and perspectives relevant to the study of science and technology in India.
- Explore the historiography of Indian science and technology through the works of influential historians.
- Trace the development of science and technology in ancient and medieval India, including interactions with other civilizations.
- Analyze the impact of colonialism on Indian science and technology, including responses to Western influence.
- Examine the growth of techno-scientific institutions in colonial India

UNIT I CONCEPTS AND PERSPECTIVES 2

Meaning of History Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation verses evidence, concept of historical inevitability, Historical Positivism. Science and Technology-Meaning, Scope and Importance, Interaction of science, technology & society, Sources of history on science and technology in India.

UNIT II HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA 2

Introduction to the works of D.D. Kosambi, Dharmpal, Debiprasad Chattopadhyay, Rehman, S. Irfan Habib, Deepak Kumar, Dhruv Raina, and others.

UNIT III SCIENCE AND TECHNOLOGY IN ANCIENT INDIA 2

Technology in pre-historic period Beginning of agriculture and its impact on technology Science and Technology during Vedic and Later Vedic times Science and technology from 1st century AD to C-1200.

UNIT IV SCIENCE AND TECHNOLOGY IN MEDIEVAL INDIA **2**

Legacy of technology in Medieval India, Interactions with Arabs Development in medical knowledge, interaction between Unani and Ayurveda and alchemy Astronomy and Mathematics: interaction with Arabic Sciences Science and Technology on the eve of British conquest

UNIT V SCIENCE AND TECHNOLOGY IN COLONIAL INDIA 2

Science and the Empire Indian response to Western Science Growth of techno-scientific institutions

TOTAL:10 PERIODS

Course Outcomes:

Upon Successful Completion of the course the students will be able to

CO1: Understand historical concepts in the context of Indian science and technology.

CO2: Explore diverse historiography of Indian science and technology.

CO3: Trace the development of science and technology in ancient and medieval India

CO4: Analyze the impact of colonialism on Indian science and technology

CO5: Develop critical thinking skills to assess the relationship between science, technology, and society in India's history

Text Books:

1.A Social History of Indian Science" by Dhruv Raina

2. Science and Society in Early India" by D.P. Chattopadhyaya

References:

1. History of Science and Technology in India: Vol 1-5" by Debiprasad Chattopadhyaya

2. Science, Technology, Imperialism, and War" by Debiprasad Chattopadhyaya

Course Code	**POLITICAL AND ECONOMIC THOUGHT FOR A HUMANE SOCIETY**	L	T	P	C
MC4404		2	0	0	0

COURSE OBJECTIVES:

This course will begin with a short overview of human needs and desires and how different political-economic systems try to fulfill them. In the process, we will end with a critique of different systems and their implementations in the past, with possible future directions

UNIT I CAPITALISM 2

Capitalism – Free markets, demand-supply, perfect competition, laissez-faire, monopolies imperialism. Liberal democracy

UNIT II COMMUNISM 2

Fascism and totalitarianism. World war I and II. Cold war. Communism – Mode of production, theory of labour, surplus value, class struggle, dialectical materialism, historical materialism, Russian and Chinese models.

UNIT III **WELFARE STATE** 2

Welfare state. Relation with human desires. Empowered human beings, satisfaction. (3 lectures) Gandhian thought. Swaraj, Decentralized economy & polity, Community. Control over one's lives. Relationship with nature

UNIT IV **ESSENTIAL ELEMENTS OF INDIAN CIVILIZATION** **2**

Technology as driver of society, Role of education in shaping of society. Future directions. (Refs: Nandkishore Acharya, David Dixon, Levis Mumford)

UNIT V **SCIENCE AND TECHNOLOGY IN COLONIAL INDIA** 2

Science and the Empire Indian response to Western Science Growth of techno-scientific institutions

TOTAL:10 PERIODS

Course Outcomes:
Upon Successful Completion of the course the students will be able to:
The students will get an understanding of how societies are shaped by philosophy, political and economic system, how they relate to fulfilling human goals & desires with some case studies of how different attempts have been made in the past and how they have fared.

Text Books:
1. Adam Smith, J.S.MILL

References:
1. A Nagaraj, M K Gandhi, JC Kumarappa

Course Code	**STATE, NATION BUILDING AND POLITICS IN INDIA**	L	T	P	C
MC4405		2	0	0	0

COURSE OBJECTIVES:
The objective of the course is to provide an understanding of the state, how it works through its main organs, primacy of politics and political process, the concept of sovereignty and its changing contours in a globalized world. In the light of this, an attempt will be made to acquaint the students with the main development and legacies of national movement and constitutional development in India, reasons for adopting a Parliamentary-federal system, the broad philosophy of the Constitution of India and the changing nature of Indian Political System. Challenges/ problems and issues concerning national integration and nation-building will also be discussed in the contemporary context with the aim of developing a future vision for a better India.

UNIT I **CONCEPTS AND PERSPECTIVES** 2
Understanding the need and role of State and politics. Development of Nation-State, sovereignty, sovereignty in a globalized world.

UNIT II **ORGANS OF STATE** 2
Organs of State – Executive, Legislature, Judiciary. Separation of powers, forms of government unitary-federal, Presidential-Parliamentary, The idea of India.

UNIT III NATIONAL AWAKENING 2

1857 and the national awakening. 1885 Indian National Congress and development of national movement – its legacies.

UNIT IV CONSTITUTION 2

Constitution making and the Constitution of India. Goals, objective and philosophy. Need for a Federal system

UNIT V NATIONAL INTEGRATION AND NATION-BUILDING 2

Challenges of nation-building – State against democracy (Kothari) New social movements. The changing nature of the Indian Political System, the future scenario.

TOTAL:10 PERIODS

Course Outcomes:

Upon Successful Completion of the course the students will be able to:

It is expected that this course will make students aware of the theoretical aspect of the state, its organs, its operationalization aspect, the background and philosophy behind the founding of the present political system, broad streams and challenges of national integration and nation-building in India. It will equip the students with the real understanding of our political system/ process in correct perspective and make them sit up and think for devising ways for better participation in the system with a view to making the governance and delivery system better for the common man who is often left unheard and unattended in our democratic setup besides generating a lot of dissatisfaction and difficulties for the system.

Text Books:

1.Sunil Khilnani, The Idea of India. Penguin India Ltd., New Delhi.
2.Madhav Khosla, The Indian Constitution, Oxford University Press. New Delhi, 2012.

References:

1.Brij Kishore Sharma, Introduction to the Indian Constitution, PHI, New Delhi, latest edition.
2.Sumantra Bose, Transforming India: Challenges to the World's Largest Democracy, Picador India, 2013

Course Code	**INDUSTRIAL SAFETY**	L	T	P	C
MC4406		2	0	0	0

COURSE OBJECTIVES:

- To Understand the Introduction and basic Terminologies safety.
- To enable the students to learn about the Important Statutory Regulations and standards.
- To enable students to Conduct and participate in the various Safety activities in the Industry.
- To have knowledge about Workplace Exposures and Hazards.
- To assess the various Hazards and consequences through various Risk Assessment Techniques.

UNIT I SAFETY TERMINOLOGIES 2

Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators-Flammability- Toxicity Time-weighted Average (TWA) - Threshold Limit Value (TLV) - Short Term Exposure Limit (STEL)- Immediately dangerous to life or health (IDLH)- acute and

chronic Effects- Routes of Chemical Entry-Personnel Protective Equipment- Health and Safety Policy-Material Safety Data Sheet MSDS

UNIT II STANDARDS AND REGULATIONS 2

Indian Factories Act-1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Hazard Identification and Risk Analysis- code of practice IS 15656:2006

UNIT III SAFETY ACTIVITIES 2

Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment

UNIT IV WORKPLACE HEALTH AND SAFETY 2

Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety- Toxic gas Release

UNIT V HAZARD IDENTIFICATION TECHNIQUES 2

Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment- Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment

TOTAL:10 PERIODS

Course Outcomes:

Upon Successful Completion of the course the students will be able to
CO1:Understand the basic concept of safety.
CO2:Obtain knowledge of Statutory Regulations and standards.
CO3:Know about the safety Activities of the Working Place.
CO4:Analyze on the impact of Occupational Exposures and their Remedies
CO5:Obtain knowledge of Risk Assessment Techniques

Text Books:

1. R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems KHANNA PUBLISHER
2. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education

References:

1. Frank Lees (2012) 'Lees' Loss Prevention in Process Industries. Butterworth-Heinemann publications, UK, 4th Edition.
2. John Ridley & John Channing (2008)Safety at Work: Routledge, 7th Edition.
3. Dan Petersen (2003) Techniques of Safety Management: A System Approach
4. Alan Waring.(1996).Safety management system: Chapman &Hall, England
5. Society of Safety Engineers, USA