SYLLABI

FOR

B.E. DEGREE PROGRAMME

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

FOR THE STUDENTS ADMITTED IN THE

ACADEMIC YEAR 2022-23 ONWARDS

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided Autonomous Institution Affiliated to Anna University)
MADURAI – 625 015, TAMILNADU
Phone : 0452 – 2482240, 41
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Vision and Mission of the Department

Vision:

To empower the Electronics and Communication Engineering students with technological excellence, professional commitment and social responsibility.

Mission:

ME1. Attaining academic excellence in Electronics and Communication Engineering through dedication to duty, innovation in learning and research, state of the art laboratories and industry driven skill development.

ME2. Establishing suitable environment for the students to develop professionalism and face life challenges with ethical integrity.

ME3. Nurturing the students to understand the societal needs and equip them with technical expertise to provide appropriate solutions.

ME4. Providing breeding ground to obtain entrepreneurial skills and leadership qualities for self and social growth.

Program Educational Objectives (PEOs):

PEO1. Graduates will be capable of developing specification and design procedures, prototyping and test methodologies for modern electronics and communication systems and gadgets that perform analog and digital processing functions.

PEO2. Graduates will be able to work and adapt to changes in allied areas of Electronics and Communication Engineering through personal success and life long learning.

PEO3. Graduates will be able to identify technological requirements for the society and provide cost effective solutions.

- These objectives will be evidenced by professional visibility (publications, presentations, inventions, patents and awards), entrepreneurial activities, international activities (participation in international conferences, collaborative research and employment abroad)

Program Outcomes:
Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes:
Engineering Graduates will be able to

PSO1. Design circuits and systems for complex engineering problems in Electronics and Communication and allied areas.
PSO2. Apply research methodologies to provide solutions for contemporary problems in the areas including RF, Signal Processing, Image Processing, VLSI, Optical Communication, Networks and Embedded Systems for given specifications.
PSO3. Actively contribute as a member or leader in diverse teams, and communicate effectively on complex engineering activities and involve in life-long learning, by applying reasoning and ethical principles.

PEO- Mission Mapping:

	ME1	ME2	ME3	ME4
PEO1	S	M	M	L
PEO2	L	S	M	M
PEO3	M	L	S	M

PEO-PO-PSO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
PEO 1	■	■	■	■	■			■	■	■			■	■	
PEO 2	■							■	■	■	■	■	■		■
PEO 3	■	■				■	■	■					■	■	

PO-GA Mapping:

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
PO1	■											
PO2		■										
PO3			■									
PO4				■								
PO5					■							
PO6						■						
PO7							■					
PO8								■				
PO9									■			
PO10										■		
PO11											■	
PO12												■

TCE PROFICIENCY SCALE (CDIO Curriculum Framework)

TCE Proficiency Scale (TPS)	Proficiency	Cognitive	Affective	Psychomotor
TPS1	To have been exposed to	Remember	Receive	Perception, Set
TPS2	To be able to interpret and imitate	Understand	Respond	Guided Response
TPS3	To be skilled in the practice or implement	Apply	Value	Mechanism
TPS4	To be able to participate in and contribute	Analyse	Organise	Complex Overt Responses
TPS5	To be able to judge and adapt	Evaluate	Organise	Adaptation
TPS6	To be able to lead and innovate	Create	Characterize	Origination

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015
B. E. DEGREE PROGRAMME
(Electronics and Communication Engineering)

CREDIT DISTRIBUTION
(For the students admitted in the Academic Year 2022-23 onwards)

Sl. No.	Category		Credits	
			Regular	Lateral Entry
A.	**Foundation Courses (FC)**		**54 - 66**	**23 – 35**
	a.	Humanities and Social Sciences including Management Courses (HSMC)	09 - 12	06 - 09
	b.	Basic Science Courses (BSC)	24 - 27	09 - 11
	c.	Engineering Science Courses (ESC)	21 - 27	08 - 15
B.	**Professional Core Courses (PCC)**		**55**	**44**
C.	**Professional Elective Courses (PEC)**		**24 - 39**	**24 – 39**
	a.	Programme Specific Elective (PSE)	15 - 24	15 – 24
	b.	Programme Elective for Expanded Scope (PEES)	09 - 15	09 – 15
D.	**Open Elective Courses (OEC)**		**06 - 12**	**06 – 12**
	a.	Interdisciplinary Elective (IE)	03 - 06	03 – 06
	b.	Basic Science Elective (BSE)	03 - 06	03 – 06
E.	**Project Work (PW)**		**12**	**12**
F.	**Internship and Mandatory Audit Courses as per Regulatory authorities**		Non-Credit and not included in CGPA	Non-Credit and not included in CGPA
Minimum Credits to be earned for the award of the Degree			**160**	**120**
			From A to E and the successful completion of F	From A to E and the successful completion of F

SCHEDULING OF COURSES FOR STUDENTS JOINED FROM *ACADEMIC YEAR 2022-23* ONWARDS (B.E. ECE Programme) *											
Sem	Theory / Theory cum Practical / Practical								CDIO courses	Audit Courses (Mandatory Non-credit}	Credit
	1	2	3	4	5	6	7	8			
I	22MA110 Calculus for Engineers (BSC-4)	22PH120 Physics (BSC-3)	22CH130 Chemistry (BSC-3)	22EG140 Technical English (HSMC-2)	22EC160 Computer Aided Engg. Graphics (TCP) (ESC-3)	22EG170 English Laboratory (HSMC-1)	22PH180 Physics Laboratory (BSC-1)	22CH190 Chemistry Laboratory (BSC-1)	22EC190 Engineering Exploration (TCP) (ESC-2)	22CHAA0 Environmental Science (AC-0)	20
II	22EC210 Matrices and Linear Algebra (BSC-3)	22EC220 Electronic Devices (ESC-3)	22EC230 Electric and Magnetic Circuits (PCC-4)	22EC240 Digital Circuit Design (TCP) (PCC-4)	22EC250 Field Theory and Transmission Lines (PCC-3)	22EC260 Problem Solving using Computers (TCP) (ESC-3)					20
III	22EC310 Probability and Statistics (BSC-3)	22EC320 Analog Circuit Design (TCP) (PCC-4)	22EC330 Network Analysis and Synthesis (BSC-3)	22EC340 Computer Organization and Microprocessor (TCP) (PCC-4)	22EC350 Signals and Systems (PCC-4)	22EC360 Object Oriented Programming (ESC-3)			22ES390 Design Thinking (ESC-3)		24
IV	22EC410 Optimization (BSC-3)	22EC420 Mixed Signal Circuit Design (PCC-3)	22EC430 RF Circuit Design (TCP) (PCC-4)	22EC440 Microcontrollers and Embedded Systems (TCP) (PCC-4)	22EC450 Discrete-Time Signal Processing (TCP) (PCC-4)	22EC460 Data Science (ESC-2)				22CHAB0 Constitution of India (AC-0)	20

V	*22EC510 Data Communication Networks (ESC-3*)	22EC520 VLSI Circuits and Systems (PCC-3)	22EC530 Antennas and Wave Propagation (TCP) (PCC-3)	22EC540 Sensors and Instrumentation (BSC-2)	*22EC550 Analog and Digital Communication (PCC-3)*	*22EC570 Data Communication Networking Laboratory (ESC-1)*	*22EC580 Analog and Digital Communication Laboratory (PCC-1)*	22YYGX0 Interdisciplinary Elective (IE-3)	22EC590 Project-I (PW-3)	22CHAC0 Essence of Indian Knowledge (AC-0)	22
VI	22EC610 Accounting and Finance (HSMC-4)	22EC620 Image Processing (TCP) (PCC-3)	22ECXY0 PEC-1 (3)		22EC630 Optical and Wireless Communication (TCP) (PCC-4)		22YYBX0 Basic Science Elective (BSE-3)	22EG660 Professional Communication (HSMC-2)	22EC690 Project-II (PW-3)		22
\VII	22ECXY0 PEC-2 (3)	22ECXY0 PEC-3 (3)	22ECXY0 PEC-4 (3)	22ECXY0 PEC-5 (3)	22ECXY0 PEC-6 (3)	*22EC640 Systems Software (ESC-2)*			22EC790 Project-III (PW-3)		20
VIII	22ECXY0 PEC-7 (3)	22ECXY0 PEC-8 (3)	22ECXY0 PEC-9 (3)						22EC890 Project-IV (PW-3)		12

This schedule shows an optimal way of completing the B.E. Degree programme successfully in 4 Years ***Total Credits for Curricular Activities: 160***

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015
B. E. DEGREE PROGRAMME
(Electronics and Communication Engineering)

COURSES OF STUDY
(For the students admitted in the Academic Year 2022-23 onwards)

FIRST SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
22MA110	Calculus for Engineers	BSC	3	1	-	4
22PH120	Physics	BSC	3	-	-	3
22CH130	Chemistry	BSC	3	-	-	3
22EG140	Technical English	HSMC	2	-	-	2
THEORY CUM PRACTICAL						
22EC160	Computer Aided Engineering Graphics	ESC	2	-	2	3
22EC190	Engineering Exploration	ESC	1	-	2	2
PRACTICAL						
22EG170	English Laboratory	HSMC	-	-	2	1
22PH180	Physics Laboratory	BSC	-	-	2	1
22CH190	Chemistry Laboratory	BSC	-	-	2	1
Total			**14**	**1**	**10**	**20**

SECOND SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
22EC210	Matrices and Linear Algebra	BSC	2	1	-	3
22EC220	Electronic Devices	ESC	2	1	-	3
22EC230	Electric and Magnetic Circuits	PCC	3	1	-	4
22EC250	Field Theory and Transmission Lines	PCC	2	1	-	3
THEORY CUM PRACTICAL						
22EC240	Digital Circuit Design	PCC	3	-	2	4
22EC260	Problem Solving using Computers	ESC	2	-	2	3
AUDIT COURSE						
22CHAA0	Environmental Science	BSC	1	-	1	0
Total			**15**	**4**	**5**	**20**

THIRD SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
22EC310	Probability and Statistics	BSC	2	1	-	3
22EC330	Network Analysis and Synthesis	BSC	2	1	-	3
22EC350	Signals and Systems	PCC	3	1	-	4
22EC360	Object Oriented Programming	ESC	3	-	-	3
22ES490	Design Thinking	ESC	1	-	2	3

THEORY CUM PRACTICAL						
22EC320	Analog Circuit Design	PCC	3	-	2	4
22EC340	Computer Organization and Microprocessor	PCC	3	-	2	4
Total			**17**	**3**	**6**	**24**

FOURTH SEMESTER

Course Code	**Name of the Course**	**Category**	**No. of Hours / Week**			**Credits**
			L	**T**	**P**	
THEORY						
22EC410	Optimization	BSC	2	1	-	3
22EC420	Mixed Signal Circuit Design	PCC	3	-	-	3
22EC460	Data Science	ESC	2	-	-	2
THEORY CUM PRACTICAL						
22EC430	RF Circuit Design	PCC	3	-	2	4
22EC440	Microcontrollers and Embedded Systems	PCC	3	-	2	4
22EC450	Discrete-Time Signal Processing	PCC	3	-	2	4
Total			**16**	**1**	**6**	**20**

Third and Fourth Semester Mathematics course for Lateral Entry Students

Course Code	**Name of the Course**	**Category**	**No. of Hours / Week**			**Credits**
			L	**T**	**P**	
THEORY						
22MA310	Essentials of Matrices and Calculus	BSC	2	1	-	3
22ECL10	Vector Spaces, Probability and Optimization	BSC	2	1	-	3

FIFTH SEMESTER

Course Code	**Name of the Course**	**Category**	**No. of Hours / Week**			**Credits**
			L	**T**	**P**	
THEORY						
22EC510	Data Communication Networks	ESC	3	-	-	3
22EC520	VLSI Circuits and Systems	PCC	3	-	-	3
22EC540	Sensors and Instrumentation	BSC	2	-	-	2
22EC550	Analog and Digital Communication	PCC	2	1	-	3
22YYGX0	Interdisciplinary Elective	IE	3	-	-	3
THEORY CUM PRACTICAL						
22EC530	Antennas and Wave Propagation	PCC	2	-	2	3
PRACTICAL						
22EC570	Data Communication Networking Laboratory	ESC	-	-	2	1
22EC580	Analog and Digital Communication Laboratory	PCC	-	-	2	1
PROJECT						
22EC590	Project-I	PW	-	-	6	3
Total			**15**	**1**	**12**	**22**

SIXTH SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
22EC810	Accounting and Finance	HSMC	4	-	-	4
22ECXY0	PEC-1	PEC	3	-	-	3
22YYBX0	Basic Science Elective	BSE	3	-	-	3
THEORY CUM PRACTICAL						
22EC620	Image Processing	PCC	2	-	2	3
22EC630	Optical and Wireless Communication	PCC	3	-	2	4
22EG660	Professional Communication	HSMC	-	1	2	2
PROJECT						
22EC690	Project-II	PW	-	-	6	3
Total			**15**	**1**	**12**	**22**

BSC : Basic Science Courses
PCC : Professional Core Courses
ESC : Engineering Science Courses

L : Lecture
T : Tutorial
P : Practical

Note:
1 Hour Lecture is equivalent to 1 credit
1 Hour Tutorial is equivalent to 1 credit
2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B. E. DEGREE PROGRAMME

(Electronics and Communication Engineering)

SCHEME OF EXAMINATIONS

(For the Students admitted in the academic year 2022-23 onwards)

FIRST SEMESTER

. #	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	22MA110	Calculus for Engineers	3	40	60	100	27	50
2	22PH120	Physics	3	40	60	100	27	50
3	22CH130	Chemistry	3	40	60	100	27	50
4	22EG140	Technical English	3	40	60	100	27	50
THEORY CUM PRACTICAL								
5	22EC160	Computer Aided Engineering Graphics	3	50	50	100	25	50
6	22EC190	Engineering Exploration	3	50	50	100	25	50
PRACTICAL								
7	22EG170	English Laboratory	3	60	40	100	18	50
8	22PH180	Physics Laboratory	3	60	40	100	18	50
9	22CH190	Chemistry Laboratory	3	60	40	100	18	50

SECOND SEMESTER

Course Code	Name of the Course	Duration of TE in Hrs.	Marks			Min. Marks for Pass	
			CA*	TE	Max. Marks	TE	Total
THEORY							
22EC210	Matrices and Linear Algebra	3	40	60	100	27	50
22EC220	Electronic Devices	3	40	60	100	27	50
22EC230	Electric and Magnetic Circuits	3	40	60	100	27	50
22EC250	Field Theory and Transmission Lines	3	40	60	100	27	50
THEORY CUM PRACTICAL							

22EC240	Digital Circuit Design	3	50	50	100	25	50
22EC260	Problem Solving using Computers	3	50	50	100	25	50
AUDIT COURSE							
22CHAA0	Environmental Science	-	50	50	100	25	50

THIRD SEMESTER

Course Code	Name of the Course	Duration of TE in Hrs.	Marks			Min. Marks for Pass	
			CA*	TE	Max. Marks	TE	Total
THEORY							
22EC310	Probability and Statistics	3	40	60	100	27	50
22MA310 (for LE students)	Essentials of Matrices and Calculus	3	40	60	100	27	50
22EC330	Network Analysis and Synthesis	3	40	60	100	27	50
22EC350	Signals and Systems	3	40	60	100	27	50
22EC360	Object-Oriented Programming	3	40	60	100	27	50
THEORY CUM PRACTICAL							
22EC320	Analog Circuit Design	3	50	50	100	22.5	50
22EC340	Computer Organization and Microprocessor	3	50	50	100	22.5	50

FOURTH SEMESTER

Course Code	Name of the Course	Duration of TE in Hrs.	Marks			Min. Marks for Pass	
			CA*	TE	Max. Marks	TE	Total
THEORY							
22EC410	Optimization	3	40	60	100	27	50
22ECL10 (for LE students)	*Vector Spaces, Probability and Optimization*	*3*	*40*	*60*	*100*	*27*	*50*
22EC420	Mixed Signal Circuit Design	3	40	60	100	27	50
22EC460	Data Science	3	40	60	100	27	50
22ES490	Design Thinking	3	40	60	100	27	50
THEORY CUM PRACTICAL							
22EC430	RF Circuit Design	3	50	50	100	22.5	50
22EC440	Microcontrollers and Embedded Systems	3	50	50	100	22.5	50
22EC450	Discrete-Time Signal Processing	3	50	50	100	22.5	50

FIFTH SEMESTER

Course Code	Name of the Course	Duration of TE in Hrs.	Marks			Min. Marks for Pass	
			CA*	TE	Max. Marks	TE	Total
THEORY							
22EC510	Data Communication Networks	3	40	60	100	27	50
22EC520	VLSI Circuits and Systems	3	40	60	100	27	50
22EC540	Sensors and Instrumentation	3	40	60	100	27	50
22EC550	Analog and Digital Communication	3	40	60	100	27	50
22YYGX0	Interdisciplinary Elective	3	40	60	100	27	50
THEORY CUM PRACTICAL							
22EC530	Antennas and Wave Propagation	3	50	50	100	25	50
PRACTICAL							
22EC570	Data Communication Networking Laboratory	3	60	40	100	18	50
22EC580	Analog and Digital Communication Laboratory	3	60	40	100	18	50
PROJECT							
22EC590	Project-I	-	50	50	100	25	50

SIXTH SEMESTER

Course Code	Name of the Course	Duration of TE in Hrs.	Marks			Min. Marks for Pass	
			CA*	TE	Max. Marks	TE	Total
THEORY							
22EC810	Accounting and Finance	3	40	60	100	27	50
22ECXY0	PEC-1	3	40	60	100	27	50
22YYBX0	Basic Science Elective	3	40	60	100	27	50
THEORY CUM PRACTICAL							
22EC620	Image Processing	3	50	50	100	25	50
22EC630	Optical and Wireless Communication	3	50	50	100	25	50
22EG660	Professional Communication	3	50	50	100	25	50
PROJECT-II							
22EC690	Project-II	-	50	50	100	25	50

TE – Terminal Examination, CA – Continuous Assessment

*CA evaluation pattern will differ from course to course and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern

CURRICULUM AND DETAILED SYLLABI

FOR

B. E. DEGREE PROGRAMME
(Electronics and Communication Engineering)

FIRST SEMESTER

FOR THE STUDENTS ADMITTED IN THE

ACADEMIC YEAR 2022-23

THIAGARAJAR COLLEGE OF ENGINEERING
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22MA110	CALCULUS FOR ENGINEERS

Category	L	T	P	Credit
BSC	3	1	0	4

Preamble

This course aims to provide technical competence of modeling engineering problems using calculus. In this course, the calculus concepts are taught geometrically, numerically, algebraically and verbally. Students will apply the main tools for analyzing and describing the behavior of functions of single and multi-variables: limits, derivatives, integrals of single and multi-variables to model and solve complex engineering problems using analytical methods and MATLAB.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Cognize the concept of functions, limits and continuity	TPS2	75	70
CO2	Compute derivatives and apply them in solving engineering problems	TPS3	70	65
CO3	Employ partial derivatives to find maxima minima of functions of multi variables	TPS3	70	65
CO4	Demonstrate the techniques of integration to find the surface area of revolution of a curve.	TPS3	70	65
CO5	Utilize double integrals to evaluate area enclosed between two curves.	TPS3	70	65
CO6	Apply triple integrals to find volume enclosed between surfaces	TPS3	70	65

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L							L		L	
CO2	S	M	L						L		L	
CO3	S	M	L						L		L	
CO4	S	M	L						L		L	
CO5	S	M	L						L		L	
CO6	S	M	L						L		L	

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	Assessment 1						Assessment 2						Terminal (%)			
	Written Test 1 (%)			Assignment 1 (%)			Written Test 2 (%)			Assignment 2 (%)						
TPS	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**TOTAL (%)**
CO1	20%			50%			-			-			-	10%	-	10%
CO2	32%						-			-			-	-	16%	16%
CO3	36%						-			-			-	-	18%	18%
CO4	12%			-			39%			50%			-	-	25%	25%
CO5	-			-			35%						-	-	17%	17%
CO6	-			-			26%						-	-	14%	14%
MATLAB	-			50%			-			50%						
TOTAL	**100%**			**100%**			**100%**			**100%**			**-**	**10%**	**90%**	**100 %**

* Assignment 1: (i)Application Problems in CO1, CO2 and CO3 (50%).
(ii) MATLAB Onramp & Introduction to symbolic Math with MATLAB (50%).

**Assignment 2: (i) Application Problems in CO4, CO5 and CO6 (50%).
(ii) Application problems using MATLAB. (50%).

Syllabus

DIFFERENTIAL CALCULUS

Functions - New functions from old functions - Limit of a function - Continuity - Limits at infinity - Derivative as a function - Maxima and Minima of functions of one variable – Mean value theorem - Effect of derivatives on the shape of a graph- Application problems in engineering using MATLAB.

FUNCTIONS OF SEVERAL VARIABLES:

Function of several variables- Level curves and level surfaces - Partial derivatives – Chain rule - Maxima and minima of functions of two variables –Method of Lagrange's Multipliers - Application problems in engineering using MATLAB.

INTEGRAL CALCULUS:

The definite integral – Fundamental theorem of Calculus – Indefinite integrals and the Net Change Theorem – Improper integrals – Area of surface of revolution - Volume of solid of revolution -Application problems in engineering using MATLAB.

MULTIPLE INTEGRALS:

Iterated integrals-Double integrals over general regions-Double integrals in polar coordinates-Applications of double integrals (density, mass, moments & moments of inertia problems only)-triple integrals- triple integrals in cylindrical coordinates- triple integrals in spherical coordinates-change of variables in multiple integrals - Application problems in engineering using MATLAB.

Text Book

1) James Stewart, "Calculus Early Transcendentals", 9th Edition, Cengage Learning, New Delhi, 2019.
    a. **DIFFERENTIAL CALCULUS:** [Sections: 1.3, 2.2, 2.5, 2,6,2.8, 4.1, 4.2 and 4.3.]
    b. **FUNCTIONS OF SEVERAL VARIABLES:** [Sections: 14.1,14.3,14.5,14.7 and 14.8.]
    c. **INTEGRAL CALCULUS:** [Sections: 5.2, 5.3, 5.4, 7.8, 8.2 and 6.2.]
    d. **MULTIPLE INTEGRAL:** [Sections: 15.1-15.4, 15.6-15.9]
2) Lecture Notes on Calculus Through Engineering Application Problems and Solutions, Department of Mathematics, Thiagarajar College of Engineering, Madurai.

Reference Books& web resources

1) George B. Thomas, "Thomas Calculus: early Transcendentals", 14thedition, Pearson, New Delhi, 2018.

2) Howard Anton, Irl Bivens and Stephen Davis, “Calculus: Early Transcendentals”, 12th e, John Wiley & Sons, 2021.
3) Kuldeep Singh, "Engineering Mathematics Through Applications", 2nd edition, Blooms berry publishing, 2019.
4) Kuldip S. Rattan, Nathan W. Klingbeil, Introductory Mathematics for Engineering Applications, 2nd e John Wiley& Sons , 2021.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**DIFFERENTIAL CALCULUS**	
1.1	Functions and New functions from old functions	2
1.2	Limit of a function &Continuity of a function	1
	Tutorial	**1**
1.3	Limits at infinity	1
1.4	Derivative as a function	2
	Tutorial	**1**
1.5	Maxima and Minima of functions of single variable	2
1.6	The Mean value theorem and effect of derivatives on the shape of a graph of a function	1
	Tutorial	**1**
1.7	Application problems in engineering using MATLAB	1
2	**FUNCTIONS OF SEVERAL VARIABLES**	
2.1	Level curves and level surfaces	2
2.2	Partial derivatives – Chain rule	1
	Tutorial	**1**
2.3	Maxima and minima of functions of two variables	2
2.4	Method of Lagrange’s Multipliers	1
	Tutorial	**1**
2.5	Application problems in engineering using MATLAB	1
3	**INTEGRAL CALCULUS**	
3.1	The definite integral	1
3.2	Fundamental theorem of Calculus	2
	Tutorial	**1**
3.3	Indefinite integrals and the Net Change Theorem	1
3.4	Improper integrals	2
	Tutorial	**1**
3.5	Area of surface of revolution	1
3.6	Volume of solid of revolution.	2
3.7	Application problems in engineering using MATLAB	1
4	**MULTIPLE INTEGRALS**	
4.1	Iterated integrals	1
4.2	Double integrals over general regions	2
	Tutorial	**1**
4.3	Double integrals in polar coordinates	1
4.4	Applications of double integrals (density, mass, moments & moments of inertia problems only)	2

Module No.	Topic	No. of Periods
	Tutorial	**1**
4.5	Triple integrals	1
4.6	Triple integrals in cylindrical coordinates	1
4.7	Triple integrals in spherical coordinates	1
	Tutorial	**1**
4.8	Change of variables in multiple integrals	1
4.9	Application problems in engineering using MATLAB	1
	Total	**48**

Course Designer(s):

1. Dr.B.Vellaikannan, bvkmat@tce.edu
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4. Dr.S.Saravanakumar, sskmat@tce.edu
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22PH120	PHYSICS

Category	L	T	P	Credit
BSC	3	0	0	3

Preamble

The course work aims in imparting fundamental knowledge of mechanics, oscillations and waves and optics, electromagnetism and quantum mechanics which are essential in understanding and explaining engineering devices.

Prerequisite

None

Course Outcomes

On the successful completion of the course, students will be able to

	Course Outcome	TCE Proficiency Scale	Expected Proficiency (%)	Expected Attainment Level (%)
CO1	Apply the vector calculus approach and Newton's law in polar coordinates to solve problems in mechanics	TPS3	85	80
CO2	Solve for the solutions and describe the behaviour of a damped harmonic oscillator and waves.	TPS3	85	80
CO3	Introduce Schrodinger equation to arrive at the energy values of particle in a box and linear harmonic oscillator	TPS3	85	80
CO4	Use the principle of quantum mechanics for quantum mechanical tunnelling, quantum confinement and quantum computation	TPS2	85	80
CO5	Use the laws of electrostatics and magnetostatics to explain electromagnetic wave propagation	TPS3	85	80
CO6	Explain the fundamentals of optical phenomena and its applications	TPS2	85	80

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	L	-	-	-	-	-	L	L	-	-
CO2	S	M	L	-	-	-	-	-	L	L	-	-
CO3	S	M	L	-	-	-	-	-	L	L	-	-
CO4	M	L		-	-	-	-	-	L	L	-	-
CO5	S	M	L	-	-	-	-	-	L	L	-	-
CO6	M	L										

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II * (%)					
TPS Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	8	15	22	100									6	6	10
CO2	8	10	15										4	3	10
CO3	4	5	13				-	-	15	100			-	2	15
CO4							4	15	-				4	6	-
CO5							-	-	35				-	3	15
CO6							16	15	-				6	10	-
Total	**20**	**30**	**50**	**100**			**20**	**30**	**50**	**100**			**20**	**30**	**50**

*Assignment I, II –Quiz/ Puzzle/ Case analysis/ Problem-solving/ Presentation/ Writing tasks

Syllabus

Mechanics of Particles:

Scalars and vectors under rotation transformation - Coordinate system - Cartesian, Polar, Spherical, Cylindrical - Newton's second law of motion - Forces in nature - Central forces - Conservative and non-conservative forces - Work - Energy theorem - Conservation of angular momentum - Satellite manoeuvres

Oscillations and Waves:

Simple harmonic oscillators - Energy decay in a Damped harmonic oscillator - Q factor- Impedance matching- Wave groups and group velocity - Non dispersive Transverse and Longitudinal waves - Waves with dispersion - Water waves - Acoustic waves - Earthquake and Tsunami waves

Quantum Mechanics:

Wave nature of particles - wave function - probability current density and expectation values - Schrodinger wave equation - Uncertainty principle - Particle in a box in 1D - Linear harmonic oscillator - Quantum tunnelling – Quantum confinement in 0D, 1D, 2D systems - Scanning tunnelling microscope - Quantum Cascade lasers - Quantum computation (qubit) - Entanglement - Teleportation

Electromagnetic Fields and Waves:

Electric potential and Electric field of a charged disc - Magnetic Vector potential - Maxwell's equation - Equation of continuity – Poynting Vector - Energy and momentum of EM waves - CT/MRI scan

Optics:

Ray paths in inhomogeneous medium and its solutions – Applications - Fibre optics - Numerical Aperture& Acceptance angle - Fibre optic sensors - Liquid Level & Medical Applications - Interference in non-reflecting films - Fabry-Perot interferometer - Diffraction - Fraunhofer diffraction due to double slit.

Text Books

1. Principles of Physics, Halliday, Resnick and Jearl Walker, 9th Edition, Wiley, 2011.
2. Paul A. Tipler and G. Mosca, Physics for Scientists and Engineers, 6th Edition, Freeman, 2008.

Reference Books & web resources

MECHANICS OF PARTICLES

Paul A. Tipler and Gene Mosca, Physics for Scientists and Engineers, 6th Edition, Freeman, 2008 (Chapters – 4, 9 & 10).

Manoj K. Harbola, Engineering Mechanics, 2nd Edition, Cengage, 2018.

OSCILLATIONS AND WAVES

1. Paul A. Tipler and Gene Mosca, Physics for Scientists and Engineers, 6th Edition, Freeman, 2008 (Chapters – 14 & 15).
2. H. J. Pain, The Physics of Vibrations and Waves, 6th Edition, John Wiley, 2005

(Chapters 2, 5 & 6).

ELECTROMAGNETIC FIELDS AND WAVES

1. Principles of Physics, Halliday, Resnick and Jearl Walker, 9th Edition, Wiley, 2011 (Chapters - 23, 24, 32 & 33)
2. Paul M. Fishbane, Stephen G. Gasiorowicz and Stephen T. Thornton, Physics for Scientists and Engineers with Modern Physics, 3rd Edition, Pearson, 2005 (Chapters - 26, 28, 31 & 34).

OPTICS

1. Paul A. Tipler and Gene Mosca, Physics for Scientists and Engineers, 6th Edition, Freeman, 2008 (Chapters – 31 & 33).
2. Ajoy Ghatak, Optics, 5th Edition, Tata McGraw Hill, 2012 (Chapters – 3, 18, 20)

QUANTUM MECHANICS

1. Paul A. Tipler and Gene Mosca, Physics for Scientists and Engineers, 6th Edition, Freeman, 2008 (Chapters – 34 & 35).
2. Stephen T. Thornton and Andrew Rex, Modern Physics for Scientists and Engineers, 4th Edition, Cengage, 2013. (Chapters - 5 & 6).
3. R. Shankar, Fundamentals of Physics – I, II, Yale University Press, 2014, 2016.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Mechanics of Particles**	**8**
1.1	Scalars and vectors under rotation transformation	2
1.2	Coordinate system - Cartesian, Polar, Spherical, Cylindrical	2
1.3	Newton's second law of motion - Forces in nature - Central forces	2
1.4	Conservative and non-conservative forces - Work - Energy theorem - Conservation of angular momentum - Satellite manoeuvres	2
2	**Oscillations and Waves**	**6**
2.1	Simple harmonic oscillators - Energy decay in a Damped harmonic oscillator	2
2.2	Q factor- Impedance matching – Wave groups and group velocity	2
	CAT-I after 12 contact hours	
2.3	Non-dispersive transverse and Longitudinal waves	1
2.4	Waves with dispersion- Water waves -Acoustic waves – Earthquake and Tsunami waves	1
3	**Quantum Mechanics**	**10**
3.1	Wave nature of particles - wave function -probability current density and expectation values - Schrodinger wave equation	3
3.2	Uncertainty principle - Particle in a box in 1D – Linear harmonic oscillator	3
3.3	Quantum tunnelling – Quantum confinement in 0D, 1D, 2D systems - Scanning tunnelling microscope – Quantum Cascade lasers – Quantum computation (qubit) – Entanglement - Teleportation	4
	CAT-II after 12 contact hours	
4	**Electromagnetic Fields and Waves**	**6**
4.1	Electric potential and Electric field of a charged disc	1
4.2	Magnetic Vector potential – Maxwell's Equations	2
4.3	Equation of continuity-Poynting Vector-Energy and momentum of EM waves	2
4.4	CT/MRI scan	1
5	**Optics**	**6**
5.1	Ray paths in inhomogeneous medium & its solutions–Applications – Fiber optics	2

5.2	Numerical Aperture& Acceptance angle - Fiber optic sensors - Liquid Level & Medical Applications	2
5.3	Interference in non-reflecting films - Fabry- Perot interferometer - Diffraction - Two slit Fraunhofer diffraction	2
	CAT-III after 12 contact hours	
	Total	**36**

Course Designer(s):

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22CH130	CHEMISTRY

Category	L	T	P	Credit
BSC	3	0	0	3

Preamble

The objective of this course is to bestow basic concepts of chemistry and its applications in engineering domain. It imparts knowledge on properties and treatment methods of water, spectroscopic techniques and their applications. This course provides exposure on electrochemical techniques for corrosion control, surface coatings and energy storage devices and also emphasis the properties and applications of engineering materials.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Explain the essential water quality parameters of water	TPS2	70	70
CO2	Determine hardness of water and identify suitable water treatment method	TPS3	70	70
CO3	Explain the electrochemical process involved in energy storage devices and corrosion of metals	TPS2	70	70
CO4	Interpret the electrochemical principles in modern energy storage devices and corrosion control methods	TPS3	70	70
CO5	Identify the appropriate spectroscopic technique for various applications	TPS3	70	70
CO6	Select the materials based on the properties for Engineering applications	TPS3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	M	L	-	-	-	-	-	-	-	-	-	-
CO2.	S	M	L	-	-	-	L	-	-	-	-	-
CO3.	M	L	-	-	-	-	-	-	-	-	-	-
CO4.	S	M	L	-	-	-	-	-	L	-	-	-
CO5.	S	M	L	-	-	-	L	-	L	-	-	-
CO6.	S	M	L	-	-	-	-	-	-	-	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	4	20	0										2	8				
CO2	4	0	20										2	4	10			
CO3	4	20	0										2	8				
CO4	8	0	20										2	4	10			
CO5							12	20	20				6	8	10			
CO6							8	20	20				6	8	10			

*****Terminal examination should cover all Course Outcomes in the appropriate TPS Scale level.

CO	Assignment 1*						Assignment 2*					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6
CO1												
CO2			20									
CO3												
CO4			20									
CO5									20			
CO6									20			

*Assessment type: Quiz / Test /Presentation

Syllabus

Water: Water-sources- physical - characteristics - alkalinity - hardness of water – types - determination of hardness by EDTA method. Boiler trouble-Softening of water: Internal and External treatment methods. Waste water treatment process. **Electrochemical technologies for energy storage and surface engineering:** Electrochemistry and Energy storage: Basics of electrochemistry. Batteries **-** Primary and Secondary batteries. Fuel cells. Hydrogen generation and storage. Corrosion and Surface Engineering–Basics –Corrosion - causes-factors- types - corrosion of metal and computer components- Corrosion control. Electroplating - Electroless process. **Spectroscopic technique and applications:** Principle, instrumentation, and applications: X-ray-diffraction - UV–Visible spectroscopy- Atomic Absorption Spectroscopy - Fluorescence spectroscopy - Inductively Coupled Plasma - Optical Emission Spectroscopy- Infra-red spectroscopy - Nuclear magnetic resonance spectroscopy**. Engineering materials:** Bonding and their influences on the property of materials - melting point - brittleness, ductility – thermal, electrical, and ionic conductivity - optical – magnetic properties, hydrophobic, hydrophilic. **Polymer composites** - structure and properties- applications. **Ceramics and advanced ceramics** - types-properties-applications-**Nano-materials** – Synthesis, structure, and properties –applications.

Text Book

1. P.C. Jain and Monica Jain, A Textbook of Engineering Chemistry, Dhanpat Rai publications, New Delhi, 16th edition, 2015.

Reference Books& web resources

- S.S. Dara and S.S. Umare, “A Textbook of Engineering Chemistry”, S.Chand & Company, 12th Edition, Reprint, 2013.
- Shashi Chawla, “ A text book of Engineering Chemistry”, Dhanpat Rai & Co.(pvt) ltd, 3rd edition, reprint 2011.
- C. N. Banwell and E.M. McCash, “Fundamentals of Molecular Spectroscopy”, Tata McGraw-Hill (India), 5th Edition, 2013.

- W.F. Smith, Principles of Materials Science and Engineering: An Introduction; Tata Mc-Graw Hill, 2008.
- V. Raghavan, Introduction to Materials Science and Engineering; PHI, Delhi, 2005.
- M. Akay, 2015, An introduction to polymer matrix composites," from: https://www.academia.edu/37778336/An_introduction_to_polymer_matrix_composites

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Water**	
1.1	Importance of water, sources, standards for drinking water, (WHO, BIS & ICMR standards) physical, chemical & biological characteristics, Alkalinity (principle only)	1
1.2	Hardness of water - types, units. Determination of hardness by EDTA method and numerical problems	2
1.3	**boiler trouble:** Scale and sludge formation, boiler corrosion, priming and foaming, caustic embrittlement	1
1.4	**Internal treatment methods:** Carbonate, Phosphate, Colloidal, Calgon conditioning	1
1.5	**softening of water:** External treatment methods: Lime-soda process (concept only), zeolite process, ion exchange process	2
1.6	Desalination- reverse osmosis, electro dialysis, solar and multistage flash distillation, nano-filtration	1
1.7	Waste water treatment – primary, secondary, and tertiary treatment	1
2	**Electrochemical technologies for energy storage and surface engineering**	
2.1	**Electrochemistry and Energy storage**: Introduction**–** Basics of electrochemistry – Redox process, EMF	1
2.2	**Energy storage** – Batteries, Battery quality parameters	1
2.3	Primary battery – Dry cell and Alkaline cell	1
2.4	Secondary battery – Lead-acid battery, Lithium-ion battery	1
2.5	Fuel cells – Fundamentals, types and applications. Hydrogen generation and storage	1
2.6	**Corrosion and Surface Engineering**- Basics –Corrosion - causes- factors- types	1
2.7	chemical, electrochemical corrosion (galvanic, differential aeration), corrosion of metal and computer components-	1
2.8	Corrosion control - material selection and design aspects - electrochemical protection – sacrificial anode method and impressed current cathodic method	1
2.9	Electroplating –Introduction, Process, Applications (Gold and nickel plating). Electroless plating – Principle, process, Applications (PCB manufacturing)	1
3	**Spectroscopic technique and applications**	
3.1	Introduction to Electromagnetic Radiation, Types of atomic and molecular spectra	1
	Principle, Instrumentation and Applications:	1

Module No.	Topic	No. of Periods
3.2	X-ray-diffraction	
3.3	UV–Visible spectroscopy, Atomic Absorption Spectroscopy	2
3.4	Fluorescence spectroscopy, Inductively Coupled Plasma - Optical Emission Spectroscopy	2
3.5	Infra-red spectroscopy	2
3.6	Nuclear magnetic resonance spectroscopy – Magnetic resonance imaging	1
4	**Engineering materials**	
4.1	Bonding and its influence on the property of materials	1
4.2	Properties of materials- melting point - brittleness, ductility - thermal, electrical and ionic conductivity	1
4.3	optical – magnetic properties, hydrophobic, hydrophilic	1
4.4	**Polymer composites** - structure and properties	1
4.5	applications -automotive, aerospace, marine, biomedical, and defense	1
4.6	**Ceramics and advanced ceramics** - types-properties	1
4.7	applications- medicine, electrical, electronics, space	1
4.8	**Nano-materials** – Synthesis, structure and properties	1
4.9	applications - sensors, drug delivery, photo and electro-catalysis, and pollution control	1
	Total	36

Course Designer(s):

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22CH140	TECHNICAL ENGLISH

Category	L	T	P	Credit
HSMC	2	0	0	2

Preamble

The course aims at fostering the students' ability to communicate effectively in various academic, professional, and social settings through oral and written forms. Besides imparting the basic skills namely Listening, Speaking, Reading and Writing (LSRW), significant emphasis is placed on enriching their analytical, descriptive, and creative skills, enabling them to develop and demonstrate a holistic English language proficiency.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	**Relate** the fundamentals of language in terms of vocabulary, grammar and pronunciation in technical communication.	Understand	70%	80%
CO2	**Infer** ideas from technical and general contexts by identifying main ideas, specific details, predicting and note making	Understand	70%	80%
CO3	**Make use of** language in professional and social contexts with clarity and conciseness.	Apply	60%	70%
CO4	**Identify** specific contexts in technical writing, where appropriate lexical and grammatical functions are applied	Apply	60%	70%
CO5	**Develop** the skills such as understanding, evaluating, analysing and summarising the text and graphical representations.	Apply	60%	70%
CO6	**Organise** ideas with coherence, cohesion and precision in formal written communication	Apply	70%	80%

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									M	S		S
CO2									M	S		S
CO3								L	M	S		S
CO4									M	S		S
CO5									M	S		S
CO6								L	M	S		S

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	Assessment 1						Assessment 2						Terminal (%)		
	Written Test 1 (%)			Assignment 1 (%)			Written Test 2 (%)			Assignment 2 (%)					
TPS	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1		24%		100%						-			-	10%	-
CO2		34%								-			-	20%	
CO3			14%						24%	-			-	-	20%
CO4			14%	-					34%	100%			-	-	10%
CO5			14%	-									-	-	20%
CO6				-					42%				-	-	20%
TOTAL	**100%**			**100%**			**100%**			**100%**			**100%**		

* Assignment 1: Speaking activities in CO1, CO2, and CO3 (100%).
**Assignment 2: Writing activities in CO4, CO5, and CO6 (100%).
***Terminal examination should cover all Course Outcomes in the appropriate TPS Scale level.

Syllabus:

MODULE- I - Basics of Language (CO1)
Vocabulary - Word Building, Prefix, Suffix and Root Words, Basics of Grammar – Parts of Speech, Tenses, Phonetics - Phonemes, Syllables and Stress.

MODULE- II– Reading (CO2)
Reading- Skimming and Scanning of Short Comprehension Passages and Answering Questions or Cloze exercises based on the text prescribed for extensive reading, Note-Making.

MODULE- III–Functional English (CO3)
Framing Questions (WH and Yes/No), Modals, Manual Writing, Recommendations Writing, Agenda and Minutes of Meeting.

MODULE-IV – Technical Notions (CO4)
Technical Notions - Subject-Verb Agreement, Relative Clause, Phrasal Verbs, Impersonal Passive Voice, Noun Compounds, Classifications and Definitions, Cause and Effect, Purpose and Function, Numerical Adjectives.

MODULE-V – Analytical Writing and Business Correspondence (CO5 & CO6)
Summary Writing, Interpretation of Graphics, Jumbled Sentences, Paragraph Writing, Formal Letters (Seeking Permission for Industrial Visit / internship / Bonafide), E-mail Writing (BEC Vantage Writing Task I)

Suggested Reading:

Books:

1. Murphy, Raymond, English Grammar in Use with Answers; Reference and Practice for Intermediate Students, Cambridge: CUP, 2004
2. Jones, Daniel. An English Pronouncing Dictionary, Cambridge: CUP, 2006
3. Brook-Hart, Guy. Cambridge English- Business Benchmark-Upper Intermediate, CUP,2013.
4. Dhanavel, S.P. English and Communication Skills for Students of Science & Engineering, Orient BlackSwan, Chennai: 2016.
5. Swan, Michael. Practical English Usage.4thEdn. OUP. 2017.
6. Elbow, Peter. Writing with Power: Techniques for Mastering the Writing Process. New York, Oxford University Press, 1998.

Extensive Reading:

1. Anthology of Select Five Short Stories
2. Tagore, Rabindranath. *Chitra, a Play in One Act.* London, Macmillan and Co., 1914.

Websites:

1. www.englishclub.com
2. owl.english.purdue.edu
3. www.oxfordonlineenglish.com
4. www.bbclearningenglish.com
5. tcesrenglish.blogspot.com

Course Contents and Lecture Schedule

S.No	Topic	No. of Hours
1.	Word Building, Prefix, Suffix and Root Words	1
2.	Parts of Speech	1
3.	Tenses	1
4.	Skimming and Scanning of Short Comprehension Passages	1
5.	Manual Writing	1
6.	Recommendations	1
7.	Note-Making	1
8.	Subject-Verb Agreement	1
9.	Phonemes	1
10.	Syllables and Stress	1
11.	Answering Questions or Cloze exercises based on the text prescribed for extensive reading	1
12.	Noun Compounds, Classifications and Definitions	1
13.	Cause and Effect, Purpose and Function	1
14.	Summary Writing	1
15.	Interpretation of Graphics	1
16.	Jumbled Sentences	1
17.	Formal Letters (Seeking Permission for Industrial Visit/internship/ Bonafide)	1
18.	Phrasal Verbs and Impersonal Passive Voice	1
19.	Numerical Adjectives	1
20.	Framing Questions (WH and Yes/No) and Modals	1
21.	Agenda and Minutes of Meeting	1
22.	Relative Clause	1
23.	E-mail Writing (BEC Vantage Writing Task I)	1
24.	Paragraph Writing	1
Total		**24**

Course Designers:

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3. Dr.G. JeyaJeevakani gjjeng@tce.edu
4. Dr. R. TamilSelvi rtseng@tce.edu

22EC160	COMPUTER AIDED ENGINEERING GRAPHICS

Category	L	T	P	Credit
ESC	2	0	2	3

Preamble

Engineering Graphics is referred as language of engineers. An engineer needs to understand the geometry of any object through its orthographic or pictorial projections. The knowledge on engineering graphics is essential in proposing new product designs through drawings and in reading or understanding the existing drawings. This course covers manual drawing of points, straight lines and Computer aided Drawing of orthographic projection of planes & solids and isometric projection of simple and combined solids.

Prerequisite

Basic knowledge about geometry of objects.

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Draw Geometric constructions and projections of points (in all quadrants) and projection of Straight lines (in first quadrant) inclined to one reference plane. (Manual Drawing).	TPS 3	70	70
CO2	Draw the orthographic views (Front view, Top view and side view) of objects from the given isometric view. (Manual Drawing).	TPS 3	70	70
CO3	Draw the orthographic projections (Elevation and Plan) of plane surfaces inclined to any one reference plane using CAD software.	TPS 3	70	70
CO4	Draw the orthographic projections (Elevation and Plan) of regular solids (Prisms, Pyramids, Cylinder and Cone) with axis inclined to any one reference plane using CAD software.	TPS 3	70	70
CO5	Draw the isometric views of regular solids and combined solids (Prisms, Pyramids, Cylinder, Cone, frustum of pyramid, frustum of cone) using CAD software, by 3-D modelling.	TPS 3	70	70
CO6	Draw the isometric views of irregular solids from orthographic views using CAD software, by 3-D modelling.	TPS 3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	S	M	S	M	M	-	-	-	M	M	-	-
CO2	S	M	S	M	M	-	-	-	M	M	-	-
CO3	S	M	S	M	M	-	-	-	M	M	-	-
CO4	S	M	S	M	M	-	-	-	M	M	-	-
CO5	S	M	S	M	M	-	-	-	M	M	-	-
CO6	S	M	S	M	M	-	-	-	M	M	-	-
Overall	3	2	3	2	2	0	0	0	2	2	0	0
	S	M	S	M	M	-	-	-	M	M	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category /TPS Scale	Continuous Assessment Test	Terminal Examination
Remember / 1		
Understand / 2		
Apply / 3	100	100
Analyse / 4		
Evaluate / 5		
Create / 6		

Marks Allocation for Internal Assessment:

Sl. No	Description	Marks
1	Submission of Drawing sheets	60
2	Test	40
	Total	**100***

* The total marks secured out of 100 will be converted to 50 marks.

Syllabus

Introduction - Significance of engineering graphics, Use of drawing instruments, Standards, Lettering and dimensioning, Scales. Orthographic Projection- Principles of orthographic projections, First angle projection, Orthographic projection of objects from pictorial views.

Geometric constructions and projections of points (in all quadrants) and projections of straight lines (in first quadrant) inclined to one reference plane. (Manual Drawing).

Drawing orthographic views (Front view, Top view and side view) of objects from the given isometric view (Manual Drawing).

Projections (Elevation and Plan) of plane surfaces in first quadrant, inclined to any one reference plane by rotating object method using Computer Aided Drafting software.

Projection (Elevation and Plan) of regular solids (Prisms, Pyramids, Cylinder and Cone) in first quadrant, by rotating object method when the axis is inclined to one of the reference planes using Computer Aided Drafting software.

Isometric views of regular solids and combined solids (Prisms, Pyramids, Cylinder, Cone, frustum of pyramid, frustum of cone in vertical positions only) using CAD software, by 3-D modelling.

Isometric views of irregular solids from orthographic views by 3-D modelling using Computer Aided Drafting software.

Text Book

- Bhatt N.D., Panchal V.M. and Ingle P.R., (2014) "Engineering Drawing", Charotar Publishing House.
- CAD Software Theory and User Manuals (Technical Drawing with AutoCAD).

Reference Books

1. Shah M.B, and Rana B.C (2009) "Engineering Drawing and Computer Graphics", Pearson Education.
2. B.V.R. Gupta and M. Raja Roy, Engineering Drawing with AutoCAD, 3rd Edition, I.K.International Publications, 2009.

3. Natarajan K.V., “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2012.
4. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2019.
5. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 2011.
6. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Publications, Bangalore, 2017.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours	Practice Hours
1	**Introduction**- Significance of engineering graphics, Use of drawing instruments –Standards, Lettering and dimensioning, Scales, Orthographic Projection-Principles of orthographic projections,	1	1
2	Geometric constructions, Projection (Elevation and Plan) of points located in all quadrants, Projection (Elevation and Plan) of straight lines (in first quadrant) inclined to one reference plane (HP / VP). (Manual Drawing).	3	3
3	Drawing orthographic views (Front view, Top view and side view) of objects from the given isometric view (Manual Drawing).	2	2
4	Projection (Elevation and Plan) of plane surfaces in first quadrant, inclined to HP by rotating object method using Computer Aided Drafting software.	3	3
5	Projection (Elevation and Plan) of plane surfaces in first quadrant, inclined to VP by rotating object method using Computer Aided Drafting software.	3	3
6	Projection (Elevation and Plan) of regular solids (Prisms, Pyramids, Cylinder and cone) in first quadrant, by rotating object method when the axis is inclined to HP using CAD software.	3	3
7	Projection (Elevation and Plan) of regular solids (Prisms, Pyramids, Cylinder and cone) in first quadrant, by rotating object method when the axis is inclined to VP using CAD software.	3	3
8	Isometric projection – Principle, isometric scale, Isometric views and Isometric views of single simple solids and combined solids (Prisms, Pyramids, Cylinder, Cone, frustum of pyramid, frustum of cone in vertical positions only) using CAD software.	3	3
9	Isometric views of irregular solids from orthographic views by 3-D modelling using Computer Aided Drafting software.	3	3
	TOTAL	**24**	**24**

Marks Allocation for Continuous Assessment:

Sl. No	Description	Marks
1	Manual Drawing sheets (A4) submission	15
2	Computer Aided Drafting (CAD) Exercises	20
3	Continuous Assessment Test (CAT) using CAD software	15
Total		**50**

Question Pattern for Terminal Examination (Using CAD software only):

Question Number	Description	Type	Marks
1	Projection (Elevation and Plan) of points in all quadrants and straight lines (in first quadrant) inclined to any one reference plane.	Either or type	10
2	Orthographic views (Front view, Top view and side view) of objects from the given isometric view.	Either or type	10
3	Projection (Elevation and Plan) of plane surfaces (in first quadrant) inclined to any one reference plane.	Either or type	20
4	Projection (Elevation and Plan) of solids (in first quadrant) inclined to any one reference plane.	Either or type	20
5	3-D modelling of combined solids (Prisms, Pyramids, Cylinder, Cone, frustum of pyramid, frustum of cone in vertical positions only) and their isometric view.	Either or type	20
6	3-D modelling of irregular solids from orthographic views and their isometric view.	Either or type	20
Total			**100**

Note:

1. **One test or two tests will be conducted locally by respective Faculty In - charges during regular class hours to account for continuous assessment test (CAT) marks.**
2. **Terminal Practical examination (3 hrs) will be conducted centrally by the office of Controller of Examinations.**

Course Designers:

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- Dr. A.Samuel Raja, samuel1973@tce.edu
- Dr. B.Yogameena, ymece@tce.edu
- Dr. B.Sathyabama, sbece@tce.edu

22EC190	ENGINEERING EXPLORATION

Category	L	T	P	Credit
ESC	1	0	2	2

Preamble

The Course Electronics and Communication Engineering Exploration provide an introduction to Engineering and specifically to Electronics and Communication Engineering fields. It is designed to help the student to learn about engineering and how it affects our everyday lives. The students develop their fundamental understanding of critical concepts of Electronic controls in Consumer products and about Telecommunication through practical sessions.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Explain technological & engineering development, change and impacts of engineering	TPS2	70	70
CO2	Demonstrate the basic concepts of Electronics and functional blocks of communication system	TPS3	70	70
CO3	Interpret the role of Electronic controls in Domestic appliances	TPS3	70	70
CO4	Apply the concept of Electronics and Communication Engineering Design Process for building an electronic hardware	TPS3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	M	L	-	-	-	-	-	-	-	-	-	-
CO2.	S	M	L	-	L	L	L	-	L	L	-	-
CO3.	M	L	-	-	-	-	-	-	-	-	-	-
CO4.	M	L	-	-	-	-	-	-	-	-	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assesment-1						Assesment-2			Terminal Examination		
	THEORY						PRACTICAL			PRACTICAL		
CO	Case study			CAT-1								
TPS Scale	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1		50			50							
CO2			50			50						
CO3									40			40
CO4									60			60

Syllabus

What is Engineering: Engineering Requirement, Engineering disciplines, Engineering advancements. **Electronics and Communication Engineering**: Evolution, Theme areas, Concepts in Electronics**-** Active and Passive Components, Signals and EM spectrum– Functional blocks of Wired and Wireless Communication, Communication systems/devices – PSTN, Mobile phone. **Consumer Electronics-** Electrical and Electronic aspects, Electronic controls in Domestic appliances, Audio and Video systems; **Engineering Design:** Problem definition, idea generation through brainstorming and researching, solution creation through evaluating and communicating, test/analysis, final solution and design improvement.

List of Experiments:

1. Identification of components, sources and measuring instruments - experimenting with active and passive components: resistor (voltage division/current division), capacitors and inductors
2. Domestic electrical wiring
3. Practicing soldering and de-soldering
4. Schematic and Layout preparation using CAD tool
5. Practicing PCB fabrication
6. Mini project based on Engineering Design Process demonstrating electronic controls in Domestic appliances

Reference Books

- Ryan A.Brown, Joshua W.Brown and Michael Berkihiser: “Engineering Fundamentals: Design, Principles, and Careers”, Goodheart-Willcox Publisher, Second Edition, 2014.
- Saeed Moaveni, “Engineering Fundamentals: An Introduction to Engineering”, Cengage learning, Fourth Edition, 2011.
- Lynford L. Goddard, Young Mo Kang, Steven J. McKeown, Alexandra Haser, Cori C. Johnson, Madison N. Wilson, “A Project-Based Exploration of Electrical and Computer Engineering” Goddard Independent Publishing, Second Edition, 2020.
- Bali S.P, “Consumer Electronics”, Pearson Education, 2017.
- William D.Stanley amd John.M. Jeffords, “ Electronic Communications Principles and Systems”, Cengage Learning, 2009 (India Edition).

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Engineering**	
1.1	Engineering Requirement, Engineering disciplines, Engineering advancements	1
1.2	**Electronics and Communication –** Evolution, Theme areas	1
1.3	Active and Passive Components	1
2	**Tele Communication System**	
2.1	Functional blocks of Wired and Wireless Communication	1
2.2	Communication System/devices – PSTN, Mobile phone	2
3	**Consumer Electronics**	
3.1	Electrical and Electronic aspects in Domestic appliances	1
3.2	Electronic controls in Domestic appliances	1
3.3	Audio and Video systems	1
4	**Engineering Design Process**	
4.1	Problem definition	1
4.2	Idea generation through brainstorming and researching	
4.3	Solution creation through evaluating and communicating	1

Module No.	Topic	No. of Periods
4.4	Test/Analysis	1
4.5	Final solution and design improvement	
	Theory	12
	Practical	24
	Total	**36**

Course Designers:

- Dr M N Suresh, mns@tce.edu
- Dr V Vinoth Thyagarajan, vvkece@tce.edu
- Dr N Ayyanar, naece@tce.edu
- Dr M Senthilarasi, msiece@tce.edu

22EG170	ENGLISH LABORATORY	Category	L	T	P	Credit
		HSMC	0	0	2	1

Preamble

This practical course enables the students to develop and evaluate their basic English language skills through individualized learning process at the Language Lab, using English Software and online resources. In addition, it facilitates students with the need-based student-centric presentation sessions in a multi-media driven classroom environment.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

COs	Course Outcomes	TCE Proficiency Scale
CO1	Interpret words correctly through listening and watching general and technical online contents	TPS1
CO2	Develop appropriate pronunciation skills through listening and speaking practices	TPS3
CO3	Build and apply a wide range of lexicons in general and technical presentations	TPS3
CO4	Identify and apply the key ideas and spoken English features learnt through auditory and visual listening tools	TPS3
CO5	Experiment with inventiveness by creating a blog, vlog, or YouTube channel.	TPS3
CO6	Prepare and deliver oral and written presentations using digital tools.	TPS3

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									**M**	**S**		**S**
CO2									**M**	**S**		**M**
CO3								**L**	**M**	**S**		**S**
CO4								**L**	**M**	**S**		**M**
CO5								**L**	**M**	**S**		**S**
CO6								**L**	**S**	**S**		**S**

Assessment Pattern

Students' performance will be assessed in the language lab/ classroom as given below:

- Spoken Task - General / Technical Presentation / Picture Description :20 Marks
- Listening Task –(MCQs, Gap Filling Exercises) :10 Marks
- Written Test - Phonetics, Grammar, Vocabulary, Reading :20 Marks

External: Online Exam- Phonetics, Grammar, Vocabulary, Reading (45 Minutes): 50 Marks
Listening Test : 20 Marks
Submission of Students' Record on Practical Tasks in the Class and Lab :10 Marks
BEC Vantage Speaking Tasks I and II : 20 Marks

List of Experiments

S.No	Topic	Hours
	LAB ACTIVITIES (12 Hours)	
1	Listening to TED Talks/ Podcasts/ Product Advertisements/ News Bulletins.	2
2	Phonetics – Tutorials through Online Repositories, English Movie Clips and Software in the Lab(S-net)	2
3	Vocabulary Development through Movies / Short Films/ Documentaries	2
4	Language Development through English software S-net and Online Content (T Voices, SV Agreement, Prepositions, Coherence Markers, Relative Clauses, M Punctuation)	2
5	Reading Comprehension – I (General / Technical, BEC Vantage Reading Task	2
6	Creating a Blog/Vlog/YouTube Channel –Uploading MP3/MP4 – Practice (Movie/Book/ Gadget Review, General/Tech Talks, Interview with Celebrities)	1
7	Revision – Model Online Aptitude Test	1
	CLASSROOM ACTIVITIES (12 Hours)	
8	Introduction of Spoken English Features	1
9	Self-introduction and Introducing others	1
10	Video Comprehension – Brainstorming and Note-Taking	2
11	Role-Play, Picture/Movie Description	1
12	Reporting the events from Media / Newspapers – Discussion	1
13	Interactive Games for Language Development	1
14	Reading / Note Making (Extensive Reading – News Paper Reports)	1
15	Presentation – I (Book /Movie Review, Story Telling, General Presentations)	2
16	Presentation – II (Technical Presentations)	2
	Total	24

Software Used:

1. English Software S Net
2. Business English Certificate-Vantage- Practice Software

Teaching Resources and Websites:

1. Open Online Repositories from Oxford / Cambridge / British Council/ Voice of America
2. Free Video Downloads from YouTube
3. www.ted.com
4. tcesrenglish.blogspot.com

Course Designers:

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22PH180	PHYSICS LABORATORY

Category	L	T	P	Credit
BSC	0	0	2	1

Preamble

This course ensures that students are able to apply the basic physics concepts and carry out the experiments to determine the various physical parameters related to the material

- Learn the necessary theory to understand the concept involved in the experiment.
- Acquire the skills to carry out the experiment.
- Tabulate the observed data and use the formula to evaluate the required quantities.
- Plot the data in a graph and use it for calculation.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

	Course Outcome	TCE Proficiency Scale	Expected Proficiency (%)	Expected Attainment Level (%)
CO1	Analyze the mechanical & electrical oscillations and determine their resonance frequency	TPS3	85	90
CO2	Analyse the interference and diffraction patterns for micron sized objects	TPS3	85	90
CO3	Investigate the V-I characteristics of photodiode, phototransistor under dark and bright illumination conditions	TPS3	85	90
CO4	Determine the Planck's constant using LEDs	TPS3	85	90
CO5	Plot the VI characteristics of solar cell and find the fill factor	TPS3	85	90
CO6	Determine the reversibility of classical and quantum logic gates	TPS3	85	90
CO7	Identify the variation of magnetic field with distance for circular coils	TPS3	85	90

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	S	M	L	-	M	-	-	-	S	-	-	L
CO2.	S	M	L	-	M	-	-	-	S	-	-	L
CO3	S	M	L	-	M	-	-	-	S	-	-	L
CO4	S	M	L	-	M	-	-	-	S	-	-	L
CO5	S	M	L	-	M	-	-	-	S	-	-	L
CO6	S	M	L	-	M	-	-	-	S	-	-	L
CO7	S	M	L	-	M	-	-	-	S	-	-	L

S- Strong; M-Medium; L-Low

List of Experiments

1. Quantum Logic Gate-Toffoli gate
2. Study of Optoelectronic Devices- Photodiode, Phototransistor.
3. Solar cell VI characteristics, fill factor & Optical Fibre - Determination of numerical aperture.

4. Torsional pendulum – Determination of rigidity modulus of wire and moment of inertia of regular objects.
5. Laser Diffraction - Determination of wave length of the laser using grating and determination of micro particle size. (Observing diffraction pattern due to single and double slit)
6. Air wedge – Determination of thickness of a thin sheet/wire.
7. Determination of Planck's constant through V-I characteristics of LED.
8. Determination of magnetic field-Stewart and Gees.
9. LCR Circuit – Determination of resonant frequency

Course Designer(s):

1. Dr N. Sankarasubramanian, Professor, nssphy@tce.edu
2. Dr A. L . Subramaniyan, Assistant Professor, alsphy@tce.edu
3. Dr P.K. Kannan, Assistant Professor, akphy@ce.edu

22CH190	CHEMISTRY LABORATORY

Category	L	T	P	Credit
BSC	0	0	2	1

Preamble

This course aims to provide the students, a basic practical knowledge in chemistry. The objective of this course is to develop intellectual and psychomotor skills of the students by providing hands on experience in quantitative, electrochemical and photo-chemical analysis.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO	Course Outcome	TCE Proficiency Scale
CO1	Estimate the chemical water quality parameters of sample water / effluent	TPS3
CO2	Demonstrate presence of calcium ions in milk sample	TPS3
CO3	Determine the surface tension of solvent mixtures	TPS3
CO4	Estimate pH and acid content of samples using pH metric and conductometric titrations	TPS3
CO5	Illustrate the strength of oxidisable materials present in given sample by potentiometric method	TPS3
CO6	Determine Fe^{2+} ion in effluent using colorimetric method	TPS3
CO7	Calculate the efficiency of electroplating	TPS3
CO8	Determine the rate of corrosion of metal & alloy using potentio-dynamic polarisation method	TPS3

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	S	M	L	-	M	-	-	-	L	-	-	-
CO2.	S	M	L	-	M	-	-	-	L	-	-	-
CO3.	S	M	L	-	M	-	-	-	L	-	-	-
CO4.	S	M	L	-	M	-	-	-	L	-	-	-
CO5.	S	M	L	-	M	-	-	-	L	-	-	-
CO6.	S	M	L	-	M	-	-	-	L	-	-	-
CO7.	S	M	L	-	M	-	-	-	L	-	-	-
CO8.	S	M	L	-	M	-	-	-	L	-	-	-

S- Strong; M-Medium; L-Low

List of Experiments/Activities with CO Mapping

Experimental List	CO
Quantitative Analysis	
Estimation of total hardness of water sample	CO1
Estimation of COD of industrial effluent	CO1
Determination of calciumion inmilk sample	CO2

Determination of surface tension of solvent mixture	CO3
Electrochemical and Photochemical Analysis	
Determination of the Phosphoric acid content in soft drinks using conductometric titration	CO4
Determination of pH of soil by pH metric titration	CO4
Potentiometric redox titration ($K_2Cr_2O_7$vs FAS, $KMnO_4$vs FAS)	CO5
Estimation of iron content in water sample using colorimeter	CO6
Estimation of current density of electroplating process using Hull cell	CO7
Determination of rate of corrosion of metal and alloy using potentiodynamic polarisation technique (TAFEL)	CO8

Learning Resources

1. Vogel's Textbook of Quantitative Chemical Analysis (8^{TH}edition, 2014)
2. LaboratoryManual – Department of Chemistry, Thiagarajar College of Engineering (2022)

Course Designers:

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CURRICULUM AND DETAILED SYLLABI

FOR

B. E. DEGREE PROGRAMME
(Electronics and Communication Engineering)

SECOND SEMESTER

FOR THE STUDENTS ADMITTED IN THE

ACADEMIC YEAR 2022-23

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided Autonomous Institution Affiliated to Anna University)
MADURAI – 625 015, TAMILNADU

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22EC210	MATRICES AND LINEAR ALGEBRA

Category	L	T	P	Credit
BSC	2	1	0	3

Preamble

Mathematical functions can be viewed in many different ways and one way of viewing them is through vectors. Most of the algebraic manipulation of functions from an m dimensional space to an n dimensional space can be done using matrices and the tools from linear algebra. This course aims at giving through knowledge on matrices and linear algebra and enables the students to solve problems occurring in an n dimensional space.

Prerequisite

NIL

Course Outcomes

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Demonstrate vector space and subspace	TPS 3	70	60
CO2	Use rank nullity theorem to determine the dimension of the range space	TPS 3	70	60
CO3	Compute the nearest possible solution to the given system of equation	TPS 3	70	60
CO4	Determine an orthonormal basis for the given basis.	TPS 3	70	60
CO5	Use properties of Eigen values to determine Eigen values for higher powers of a matrix.	TPS 3	70	60
CO6	Decompose the given matrix into a product of unitary matrix and singular matrix and determine the Eigen values numerically	TPS 3	70	60
CO7	Determine the matrix representation of a linear transformation and solve the linear system of equations numerically	TPS 3	70	60

Mapping with Programme Outcomes

COs	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	S	M	L	-	-	-	-	-	-	-	-	S	L	-	-
CO2	S	M	L	-	-	-	-	-	-	-	-	S	L	-	-
CO3	S	M	L	-	-	-	-	-	-	-	-	S	L	-	-
CO4	S	M	L	-	-	-	-	-	-	-	-	S	L	-	-
CO5	S	M	L	-	-	-	-	-	-	-	-	S	L	-	-
CO6	S	M	L	-	-	-	-	-	-	-	-	S	L	-	-
CO7	S	M	L	-	-	-	-	-	-	-	-	S	L	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

TPS / CO	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I (%)			CAT – II (%)			Assg. II (%)					
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	-	17	-	-	100	-	-	-	-	-	-	-	-	8
CO2	3	10	15	-	-		-	-	-	-	-	-	-	6	8
CO3	-	-	17	-	-		-	-	-	-	-	-	-	-	8
CO4	4	10	8	-	-		-	-	-	-	-	-	-	6	5
CO5	3	-	13	-	-		-	-	-	-	-	-	-	-	8
CO6	-	-	-	-	-	-	7	10	33	-	-	100	-	9	16
CO7	-	-	-	-	-	-	3	10	37	-	-		-	9	17
Total	**10**	**20**	**70**	**-**	**-**	**100**	**10**	**20**	**70**	**-**	**-**	**100**	**-**	**30**	**70**

Syllabus

Vector Spaces: Vector space, Subspaces, linear independence of vectors, basis and dimension, Row space and Column space, Rank and nullity theorem. [8 hours]

Orthogonality: Orthogonal subspaces, Least square problem, Inner product spaces, Orthonormal sets, The Gram-Schmidt orthogonalization process. [7 hours]

Matrix Eigen Value Problem: Eigen values and Eigen vectors, Properties of eigen values and eigen vectors, orthogonal matrices, Diagonalization, Quadratic forms and Canonical Form, Singular value decomposition, Jacobi method, Power method, Determining Eigen values using matlab. [12 hours]

Linear Transformations: Definition and Examples, Matrix Representations of Linear Transformations, Similarity , Gauss Elimination method, Gauss Jordan method, Solving linear system of equations using matlab [9 hours]

Text Book

- Steven.J. Leon, “Linear Algebra with Applications”, 8th edition, Pearson, 2010
- Erwin Kreszig, “Advanced Engineering Mathematics”, 9th edition, Wiley, 2017.
- Glyn James, “Advanced Modern Engineering Mathematics”, Pearson Education, New Delhi, 2018.
- S. R. K. Iyengar, R. K. Jain, Mahinder Kumar Jain, “Numerical methods for Scientific and Engineering Computations”, New Age International publishers, 6th Edition, 2012.

Reference Books& web resources

- David C. Lay, “Linear Algebra and its applications”, Pearson Addison – Addison Wesley, 3 rd. edition, 2006.
- Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, 44th Edition, New Delhi, 2012.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods	COS
1	**Vector Spaces**		
1.1	Vector space	1	CO1
1.2	Subspaces	1	CO1
	Tutorial	**1**	
1.3	Linear independence of vectors	1	CO2
1.4	Basis and dimension	1	CO2
1.5	Row space and Column space, Rank and nullity theorem	2	CO2
	Tutorial	**1**	

2	**Orthogonality**		
2.1	Orthogonal subspaces	1	CO3
2.2	Least square problem	1	CO3
	Tutorial	**1**	
2.3	Inner product spaces	1	CO4
2.4	Orthonormal sets	1	CO4
2.5	The Gram-Schmidt orthogonalization process	1	CO4
	Tutorial	**1**	
3	**Matrix Eigen Value Problem**		
3.1	Eigen values and Eigen vectors	1	CO5
3.2	Properties of Eigen values and Eigen vectors	1	CO5
	Tutorial	**1**	
3.3	Orthogonal matrices	1	CO6
3.4	Diagonalization	1	CO6
3.5	Quadratic forms and Canonical Form	1	CO6
3.6	Singular value decomposition	1	CO6
	Tutorial	**1**	
3.7	Jacobi method	1	CO6
3.8	Power method	2	CO6
	Determining Eigen values using matlab	**1**	
4	**Linear Transformations**		
4.1	Definition and Examples	1	CO7
4.2	Matrix Representations of Linear Transformations	2	CO7
4.3	Similarity	2	CO7
	Tutorial	**1**	
4.4	Gauss Elimination method	1	CO7
4.5	Gauss Jordan method	1	CO7
	Solving linear system of equations using matlab	**1**	
	Total	36	

Course Designers:

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22EC220	ELECTRONIC DEVICES

Category	L	T	P	Credit
ESC	2	1	0	3

Preamble

This is an introduction course to electronic devices. The course begins with a discussion on how electron energy bands are formed in semiconductors; followed by discussions on equilibrium statistics of electrons and holes, drift, diffusion currents, and generation and recombination processes. It then examines the principles and operations of essential semiconductor devices used in today's electronics: diodes, light detectors and emitters, bipolar junction transistors and MOSFETs. It includes the need for small signal model and large signal model of the devices which is the prerequisite for next level courses. The goal is to develop a solid understanding of the device concepts that will be needed in a broad range of areas from semiconductor to circuit (analog, digital and VLSI) design and engineering.

Prerequisite

NIL

Course Outcomes

CO	Course Outcome Statement	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Describe the energy band diagram of Silicon Semiconductors.	TPS 2	70	70
CO2	Examine the model parameters from the diode data Sheet	TPS 3	70	70
CO3	Interpret the model parameters from the BJT data Sheet	TPS 3	70	70
CO4	Calculate the current gain of the transistors using semiconductor parameters	TPS 3	70	70
CO5	Classify the types of FET based internal structure and operation.	TPS 3	70	70
CO6	Explain the internal structure and principle of operation of photo and power devices.	TPS 2	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	S	M	L	-	L	-	-	L	L	L	-	L	M	-	L
CO2	S	M	L	-	L	-	-	L	L	L	-	L	M	-	L
CO3	S	M	L	-	L	-	-	L	L	L	-	L	M	-	L
CO4	S	S	M	L	L	-	-	L	L	L	-	L	S	-	L
CO5	M	L	-	-	-	-	-	-	L	L	-	L	S	-	L
CO6	S	S	M	M	L	-	-	-	-	-	-	-	S	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II * (%)					
TPS Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	20	-	100			-	-	-	-			-	4	12
CO2	-	10	30				-	-	-	-			-	4	10
CO3	-	10	30				-	-	-	-			-	4	10
CO4	-	-	-	-			-	10	20	100			-	4	10
CO5	-	-	-	-			-	10	30				-	4	10
CO6	-	-	-	-			-	20	20				-	4	10
Total	-	**40**	**60**	**100**			**-**	**30**	**70**	**100**			**-**	**28**	**72**

Syllabus

Semiconductors: Conductors, Semiconductors, Silicon Crystals, Intrinsic Semiconductors, Two Types of Extrinsic Semiconductors, Energy band structure, Energy Levels, Energy Hills **PN Junction Diodes:** Unbiased Diode, Forward Bias, Reverse Bias, Breakdown, Diode current, Current equation, Transition and Diffusion capacitance, Reading Diode datasheet, Rectifier circuit, Zener Diode. **Bipolar Junction Transistors**: Unbiased Transistor, Biased Transistor, Transistor Currents, CE Connection, Base Curve, Collector Curve, Transistor Approximations, Understanding BJT Data Sheet. **Field Effect Transistors**: JFETs, Drain and Transconductance Characteristics, MOSFETs, Depletion Mode MOSFET, Enhancement Mode MOSFET, Ohmic region, Understanding FET Datasheet. **Photo and Power Devices**: Photo diode, LED, LDR, SCR, DIAC, TRIAC.

Text Book

- Albert Paul Malvino and David J Bates," Electronic Principles", 8th Edition, McGraw Hills, 2020.

Reference Books & web resources

- Robert L. Boylestad, Louis Nashelsk, "Electronic Devices and Circuit Theory", 11th Edition, Pearson, 2013
- David A. Bell, "Electronic Devices and Circuits", Oxford University Press, Fifth Edition, 2008.
- Adel S. Sedra and Kenneth C. Smith, "Microelectronic Circuits", Oxford University Press Seventh Edition, 2015.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**SEMICONDUCTOR**	
1.1	Conductors, Semiconductors, Silicon Crystals	1
1.2	Intrinsic Semiconductors	1
1.3	Two Types of Extrinsic Semiconductors	1
1.4	Energy band structure	1
1.5	Energy Levels, Energy Hills	3
2	**P-N JUNCTION**	
2.1	Unbiased Diode, Forward Bias, Reverse Bias,	1
2.2	Breakdown, Diode current	1
2.3	Current equation, Transition and Diffusion capacitance,	1
2.4	Reading Diode datasheet	1
2.5	Rectifier circuit	2
2.6	Zener Diode.	2

3	**BIPOLAR JUNCTION TRANSISTOR (BJT)**	
3.1	Unbiased Transistor	1
3.2	Biased Transistor	1
3.3	Transistor Currents, CE Connection	2
3.4	Base Curve, Collector Curve	2
3.5	Transistor Approximations	1
3.6	Understanding BJT Data Sheet.	1
4	**FIELD EFFECT TRANSISTORS (FET)**	
4.1	JFETs	1
4.2	Drain and Transconductance Characteristics	2
4.3	MOSFETs, Depletion Mode MOSFET	1
4.4	Enhancement Mode MOSFET	1
4.5	Ohmic region	1
4.6	Understanding FET Datasheet	1
5	**PHOTO AND POWER DEVICES**	
5.1	Photo diode, LED, LDR	3
5.2	SCR, DIAC, TRIAC	3
	Total	36

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22EC230	ELECTRIC AND MAGNETIC CIRCUITS

Category	L	T	P	Credit
PCC	3	1	0	4

Preamble

This course is an introduction to electrical and magnetic circuits. It starts with the basic quantities used to characterize circuit operation (like current, voltage, and power) and then enforce several physical laws to form the basis of DC and AC electric circuit analysis. Electric circuits will be examined in time domain under transient and sinusoidal steady-state conditions. Simple magnetic circuit analysis will be done with respective Laws and the operation of transformer will also be studied.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Apply the knowledge of basic circuit laws to simplify DC circuits.	TPS 3	70	70
CO2	Solve DC circuits by using KVL and KCL.	TPS 3	70	70
CO3	Apply network theorems for the analysis of electrical circuits.	TPS 3	70	70
CO4	Determine Complex Impedance, Power factor of single phase and Three phase AC Circuits.	TPS 3	70	70
CO5	Obtain the transient and steady-state response of electrical circuits in Time domain.	TPS 3	70	70
CO6	Apply circuit analysis methods applicable to magnetic circuits.	TPS 3	70	70

Mapping with Programme Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	L	L	L	-	-	L	M	M	-	-	S	L	L
CO2	S	M	L	L	L	-	-	L	M	M	-	-	S	L	L
CO3	S	M	L	L	-	-	-	L	M	M	-	-	S	-	L
CO4	S	M	L	L	-	-	-	L	M	M	-	L	S	-	L
CO5	S	M	L	L	-	-	-	L	M	M	-	L	S	-	L
CO6	S	M	L	L	-	-	-	L	M	M	-	-	S	-	L
Over all	3	2	1	1	0	0	0	1	2	2	0	0	3	0	1
	S	M	L	L	-	-	-	L	M	M	-	-	S	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II * (%)					
TPS Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	10	10	100			-						-	4	6
CO2	-	10	20				-						-	4	14
CO3	-	10	40				-						-	4	15
CO4	-						-	8	25	100			-	4	15
CO5	-						-	4	30				-	-	20
CO6	-						-	8	25				-	4	10
Total	-	**30**	**70**	**100**			**-**	**20**	**80**	**100**			**-**	**20**	**80**

Syllabus

Electric circuit Elements and Kirchhoff's laws: Charge, Voltage, Current and Power; Voltage ,current sources; series and parallel circuit, Voltage and current Divider; KCL and KVL ; **DC Circuit Analysis:** Mesh, super mesh, Node and super Node Analysis **Theorems:** Source Transformation; Superposition; Thévenin's and Norton's equivalent Circuits; Maximum power transfer Theorem; Tellegen's Theorem; Reciprocity Theorem; Δ ↔ Y conversion; **AC Components & Circuits:** Inductor; Capacitor; AC sources, Complex impedance, RL, RC & RLC series and parallel circuits and Phasors; power and Power factors; Duality in Electrical circuits; **Poly Phase circuits:** Single-Phase Three-Wire Systems; Three-Phase Y-Y Connection; The Delta Connection; **AC Steady State Analysis in Time domain :** Mesh, Node Analysis & Theorems on AC circuits ; Resonance. **Transient Analysis in Time domain :** Source Free, DC Driven RL, RC & RLC circuits; **Magnetically coupled circuits:** Self and Mutual Inductance; Dot convention, Energy considerations, Linear transformer; Ideal transformer and Impedance matching; Tuned circuits.

Text Book

- W. H Hayt, J. E Kemmerly and S.M Durbin, "Engineering Circuit Analysis" by 9th Edition (2020), McGraw Hill.

Reference Books

- A. Sudhakar and Shyammohan S. Palli, "Circuits and Networks: Analysis and Synthesis", 5th Edition (2017), McGraw Hill.
- Charles K. Alexander, Matthew N. O. Sadiku "Fundamentals of Electric Circuits" 7th Edition (2022), McGraw Hill.
- Mahmood Nahvi and Joseph Edminister, "Schaum's Outline of Electric Circuits", 7th Edition (2017) McGraw-Hill.
- NPTEL, SC Dutta Roy, Circuit Theory, IITD, http://nptel.iitm.ac.in/video.php?subjectId=10810204
- NPTEL Nagendra Krishnapura, Basic Electrical Circuits, IITM, https://onlinecourses.nptel.ac.in/noc20_ee64/preview

Course Contents and Lecture Schedule

#	Topic	Lecture Hours	Tutorial
1	**Introduction**	1	-
2	Charge, Voltage, Current and Power, Voltage ,current sources	1	-
3	Series and parallel circuit, Voltage and current Divider;	1	1
4	Mesh, super mesh, Node and super Node Analysis	4	1
	Theorems		
5	Source Transformation; Superposition Theorem	1	1
6	Thévenin's and Norton's equivalent Circuits;	2	1

7	Maximum power transfer Theorem; Tellegens Theorem; Reciprocity Theorem;	2	-
8	Δ ↔ Y conversion	1	1
	AC Components & Circuits:		
9	Inductor; Capacitor; AC sources,	1	-
10	AC sources, Complex impedance, RL, RC & RLC series and parallel circuits	2	1
11	Phasors; power and Power factors;	3	-
12	Duality in Electrical circuits;	1	-
	Poly Phase circuits:		
13	Single-Phase Three-Wire Systems;	2	
14	Three-Phase Y-Y Connection; The Delta Connection	2	2
	AC Steady State Analysis in Time domain:		
15	Mesh, Node Analysis & Theorems on AC circuits	2	1
16	Resonance	2	
	Transient Analysis in Time domain		
17	Source Free,	1	1
18	DC Driven RL, RC & RLC circuits	2	1
	Magnetically coupled circuits:		
19	Self and Mutual Inductance	1	-
20	Dot convention, Energy considerations,	1	1
21	Linear and Ideal transformer and Impedance matching	2	-
22	Tuned Circuits	1	
	TOTAL	**36**	**12**

Marks Allocation for Assignment:

Sl. No	Description	Marks
1	Assignment 1 – a) Tutorial Submission b) Experimental Verification of Kirchoff's Laws and Theorems	40
2	Assignment 2 – a) Tutorial Submission b) Power calculations of each electrical and electronic appliances at Residence	40
Total		**80**

Course Designers:

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22EC240	DIGITAL CIRCUIT DESIGN

Category	L	T	P	Credit	TE
PCC	3	0	2	4	Theory

Preamble

The course is offered as theory cum practical course in concurrent with the course on "Electronic Devices". Cell phones and handheld devices of various kinds offer new, competing features almost daily. Underneath the attractive graphicaluser interface of all of these devices sits a digital system that processes data in a binary format. Hence, this course is to give hands on training for the students to understand the knowledge of basic combinational and sequential circuits of digital systems. This course relies on extensive use of Hardware Description Language for describing and implementing digital logic designs on standard ICs.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Explain the of Digital information Systems and number systems.	TPS2	70	70
CO2	Use Boolean algebra and graphical methods to simplify the Logic functions.	TPS3	70	70
CO3	Design a combinational circuit using logic gates.	TPS3	70	70
CO4	Design of synchronous sequential Circuits for a given specification	TPS3	70	70
CO5	Design of asynchronous sequential Circuits for a given specification	TPS3	70	70
CO6	Analyse the Sequential circuits in Moore / Mealy FSM Models	TPS4	70	70

Mapping with Programme Outcomes

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O2
CO1	M	L		-	-	-	-	L	L	L	-	L	L	-	L
CO2	S	M	L	-	-	-	-	L	L	L	-	L	M	L	L
CO3	S	M	L	-	S	-	-	L	L	L	-	L	M	L	L
CO4	S	M	L	L	S	-	-	L	L	L	-	L	M	L	L
CO5	S	S	M	L	-	-	-	L	L	L	-	L	S	-	L
CO6	S	S	M	L	S	-	-	L	L	L	-	L	S	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I			Assessment - II			Terminal Exam (Theory) (%)		
	CAT – I (%)			CAT – II (%)					
TPS / CO	1	2	3	1	2	3	1	2	3
CO1	5	10					-	5	
CO2	5	10	20				-	5	20
CO3		10	40				-	5	20
CO4					-	30	-	5	20
CO5					-	30	-		10
CO6					-	40	-		10
Total	10	30	60	-	-	100		20	80

Syllabus

Theory:

Digital Information Processing: Basis of Digital System, Number systems and Codes, Methods of base conversions, Code Converters and their Applications. **Boolean Algebra and Switching Functions:** Basic postulates and fundamental theorems of Boolean algebra; Standard representation of logic functions – Sum Of Product (SOP) and Product Of Sum (POS) forms; NAND and NOR Implementation - Simplification of switching functions– Karnaugh Maps and Quine- McCluskey tabular methods. **Combinational Logic Design:** Adders/subtractors, Fast adder,Magnitude comparator, Multiplexer Demultiplexer, Encoders, Decoders, Multiplier, and Paritygenerator and Checker, Standard IC Data Sheets and its Descriptions, HDL implementation of combinational circuits. **Synchronous Sequential circuits:** Bistable elements, Latches and flip flops- S-R, JK, D and Master-Slave JK FF, Analysis and Design of Clocked Sequential Circuits, State Minimization and State Assignment, Shift Registers, Counters. HDL implementation of sequential circuits. **Asynchronous Sequential Circuits:** Design and Analysis of asynchronous sequential circuits, cycles, races, and Hazard- Static and Dynamic. Design and Analysis of Moore/Mealy FSM Models

Practical:

1. Verification of Basic and Universal Logic Gates and Boolean Laws and Theorems.
2. Introduction to HDL Coding and simulation of Logic Gates.
3. Design and Implementation of Arithmetic Circuits a. Adder b. Subtractor
4. Design and Implementation of combinational circuits – Multiplexer and Demultiplexer using MSI chips
5. Design and Simulation of Encoder and Decoder using HDL code.
6. Design and Implementation of code converters a) Gray code to Excess-3 code.
   b) BCD to Seven segment display
7. Design and Simulation of Latches and Flip-flips using HDL Code.
8. Design and Implementation of Shift Registers
9. Design and Implementation of Synchronous Mod counters
10. Design and HDL Implementation of Sequence Detectors using FSM Approaches.

Text Books

- Wakerly, John, Digital Design: Principles and Practice (5th edition), Pearson, 2021.
- M. Morris Mano and Michael D. Ciletti, "Digital Design: With an Introduction to the Verilog HDL VHDL, and System Verilog, Sixth Edition, Pearson, 2018.

Reference Books & web resources

- D. D. Givone, Digital Principles and Design, Tata Mc-Graw Hill, New Delhi, 2017.
- Charles. H. Roth, Jr., Fundamentals of Logic Design, Enhanced Seventh Edition,2020
- Thomas L. Floyd, Digital Fundamentals, 11th Edition, Pearson, 2015
- William I. Fletcher," An Engineering Approach to Digital Design,1st Edition reprint 2015.
- NPTEL course Digital Circuits: https://nptel.ac.in/courses/117106086/

Course Contents and Lecture Schedule

Module No.	Topic	No.of Lectures	CO
1	**Digital Information Processing**		
1.1	Basics of Digital Systems, Software and Electronic aspects of Digital Design, Digital ICs.	2	CO1
1.2	Number systems and Codes, Methods of base conversions	1	CO1
1.3	Code Converters and their Applications	1	CO1
2	**Boolean Algebra and Switching Functions**		
2.2	Basic postulates and fundamental theorems of Boolean algebra	1	CO2
2.3	Standard representation of logic functions - SOP and POS forms, NAND and NOR Implementation	2	CO2
2.4	Simplification of switching functions – Karnaugh Map	2	CO2
2.5	Quine-McCluskey Tabular methods	2	CO2
3	**Combinational logic Design**		
3.1	Adders/subtractors, fast adder, magnitude comparator	2	CO3
3.2	Multiplexer Demultiplexers, encoders, decoders	2	CO3
3.3	Multiplier, Parity generator and Checker	2	CO3
3.4	Standard IC Data Sheets and its Descriptions	2	CO3
4	**Synchronous Sequential Logic Design**		
4.1	Bistable elements, Latches	1	CO4
4.2	Flip-flops: - S-R, JK, D and T, Master Slave Flipflop	2	CO4
4.3	Analysis and Design of Clocked Sequential Circuits, State Minimization and State Assignment	3	CO6
4.4	Shift register, Counters**.**	3	CO4
4.5	HDL implementation of sequential circuits.	2	CO4
5	**Asynchronous Sequential Circuits**		
5.1	Design of asynchronous sequential circuits	2	CO5
5.2	Analysis of asynchronous sequential circuits	2	CO5
5.3	Cycles and races, Hazard- Static and Dynamic.	1	CO5
5.4	Design and Analysis of Moore/Mealy FSM Models	1	CO6
	Total	**36**	
Practical Sessions			
5.1	Verification of Basic and Universal Logic Gates and Boolean Laws and Theorems.	2	CO1

5.2	Introduction to HDL Coding and simulation of Logic Gates.	4	CO1
5.3	Design and Implementation of Arithmetic Circuits a. Adder b. Subtractor	2	CO3
5.4	Design and Implementation of combinational circuits – Multiplexer and Demultiplexer using MSI chips	2	CO3
5.5	Design and Simulation of Encoder and Decoder using HDL code.	2	CO3
5.6	Design and Implementation of code converters a) Gray code to Excess-3 code. b) BCD to Seven segment display	4	CO3
5.7	Design and Simulation of Latches and Flip-flips using HDL Code	2	CO4
5.8	Design and Implementation of Shift Registers	2	CO4
5.9	Design and Implementation of Synchronous Mod counters	2	CO5
6	Design and HDL Implementation of Sequence Detectors using FSM Approaches.	2	CO6
	Total	**24**	

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22EC250	FIELD THEORY AND TRANSMISSION LINES

Category	L	T	P	Credit
PCC	2	1	0	3

Preamble

The objective of this course is to provide a conceptual understanding of fundamentals of electromagnetic field theory and transmission lines with an emphasis on their applications in the design and operation of practical communication systems.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Interpret the characteristics of two-wire transmission line and determine its electrical parameters	TPS3	70	65
CO2	Calculate the transmission and reflection parameters of a transmission line	TPS3	70	65
CO3	Understand the fundamentals of vector calculus and coordinate system	TPS2	70	65
CO4	Apply the EM laws to solve the electrostatic problems	TPS3	70	65
CO5	Apply the EM laws to solve the magnetostatic problems	TPS3	70	65
CO6	Apply the maxwell's equations to solve time varying fields	TPS3	70	65

Mapping with Programme Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	-	-	M	L	-	M	M	-	-	-	M		M
CO2	S	M	-	-	M	L	-	M	M	-	-	-	M		M
CO3	M	L	-	-	-	L	-	L	L	-	-	-	M	-	L
CO4	S	M	-	-	M	L	-	M	M	-	-	-	M		M
CO5	S	M	-	-	M	L	-	M	M	-	-	-	M		M
CO6	S	M	-	-	M	L	-	M	M	-	-	-	M		M

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	Assessment 1						Assessment 2						Terminal (%)			
	CAT- 1 (%)			Assignment 1 (%)			CAT- 2 (%)			Assignment 2(%)						
TPS	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	TOTAL (%)
CO1	-	10	30	-	100		-			-			-	4	10	24
CO2	-	10	30	-			-			-			-	4	10	24
CO3	-	20		-			-			-			-	-	-	-
CO4	-	-	-	-	-	-	-	10	25	-	100		-	4	20	24
CO5	-	-	-	-	-	-	-	10	25	-			-	4	20	24
CO6	-	-	-	-	-	-	-	10	20	-			-	4	20	24
TOTAL	100			100			100			100			-	20	80	100

* Assignment 1: (i) Application based problems in CO1, CO2 and CO3
**Assignment 2: (ii) Application based problems in CO4, CO5 and CO6

Syllabus

Introduction – Transmission Lines, types, terminated lossless two-wire line – characteristic impedance, propagation constant, input impedance, VSWR, reflection and transmission co-efficients, return loss, quarter-wave transformer. **Coordinate Systems -** Fundamentals of scalars and vectors, Coordinate systems. **Electrostatics -** Charge and Current Distributions, Coulomb's Law, Gauss's Law, Electric Scalar Potential, Electric Boundary Conditions, Capacitance, Electrostatic Potential Energy. **Magnetostatic -** Magnetic Forces and Torques, Biot–Savart Law, Maxwell's Magnetostatic Equations, Vector Magnetic Potential, Magnetic Boundary Conditions, Inductance, Magnetic Energy. **Maxwell's equations and EM waves -** Equation of continuity, Maxwell's equations for time varying fields, influence of medium, boundary conditions. Wave equation, EM waves in conducting medium, Uniform plane wave equation.

Text Books

- Fawaz T. Ulaby, Umberto Ravaioli, Fundamentals of Applied Electromagnetics, Seventh Edition, Pearson Education, 2015.
- G. S. N. Raju, Electromagnetic Field Theory and Transmission Lines, Pearson education 2009.
- David M. Pozar," Microwave Engineering," John Wiley & Sons, Fourth Edition, 2015.

Reference Books & web resources

- William H. Hayt, John A. Buck, Jaleel M. Akhtar, Engineering Electromagnetics, 9th edition, McGraw-Hill Education, 2020.
- Matthew N. O. Sadiku, Elements of Electromagnetics, Seventh edition, Oxford University Press, 2018.
- Nannapaneni Narayana Rao, Elements of Engineering Electromagnetics, Sixth Edition, Pearson Prentice Hall, 2004.
- D.K. Cheng, Field and wave electromagnetics, Second edition, Pearson (India), 2002.
- John D Kraus and Daniel A Fleisch, Electromagnetics with applications, Fifth Edition, McGraw-Hill, 1999.
- NPTEL course on 'Electromagnetic Waves in Guided and Wireless Media', by Prof. Pradeep Kumar, IIT Kanpur.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Introduction**	
1.1	Transmission Lines, types, terminated lossless two-wire line – characteristic impedance, propagation constant, input impedance	3
1.2	VSWR, reflection and transmission co-efficients, return loss, quarter-wave transformer	3
	Tutorial	2
2	**Coordinate Systems**	
2.1	Fundamentals of scalars and vectors, Coordinate systems	2
	Tutorial	2
3	**Electrostatics**	
3.1	Charge and Current Distributions, Coulomb's Law, Gauss's Law,	3
3.2	Electric Scalar Potential, Electric Boundary Conditions, Capacitance, Electrostatic Potential Energy	3
	Tutorial	2
4	**Magnetostatics**	
4.1	Magnetic Forces and Torques, Biot–Savart Law, Maxwell's Magnetostatic Equations	3
4.2	Vector Magnetic Potential, Magnetic Boundary Conditions, Inductance, Magnetic Energy	3
	Tutorial	2
5	**Maxwell's equation and EM waves**	
5.1	Equation of continuity, Maxwell's equations for time varying fields, influence of medium	3
5.2	boundary conditions. Wave equation, EM waves in conducting medium, Uniform plane wave equation	3
	Tutorial	2
	Total	36

Course Designers

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- Dr.S.Kanthamani skmece@tce.edu
- Dr.K.Vasudevan kvasudevan@tce.edu

22EC260	PROBLEM SOLVING USING COMPUTERS

Category	L	T	P	Credit	TE
ESC	2	0	2	3	Practical

Preamble

This course aims to provide students with an understanding on the role of computation in problem solving. It focuses on problem analysis, algorithm development, top-down design, modular programming, debugging and testing. The students will learn the required background programming knowledge, including stream I/O, loops, functions, structures, arrays, pointers and memory management

Prerequisite

NIL

Course Outcomes

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Use constructs of C programming language in problem solving.	TPS3	70%	70%
CO2	Develop algorithms to perform sorting, searching and text processing.	TPS3	70%	70%
CO3	Use function and recursion to establish modularity in programming	TPS3	70%	70%
CO4	Use pointers and derived data types like structures and union in solving complex problems.	TPS3	70%	70%
CO5	Write programs to create text and database files.	TPS3	70%	70%
CO6	Apply problem solving methodology in implementing mathematical and engineering problems.	TPS3	70%	70%

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	S	M	M	-	S	-	-	-	S	M	-	-	M	-	L
CO2	S	M	M	-	S	-	-	-	S	M	-	-	M	-	L
CO3	S	M	M	-	S	-	-	-	S	M	-	-	M	-	L
CO4	S	M	M	-	S	-	-	-	S	M	-	-	M	-	L
CO5	S	M	M	-	S	-	-	-	S	M	-	-	M	-	L
CO6	S	M	M	-	S	-	-	-	S	M	-	-	M	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	Assessment-1						Assessment-2						Terminal - Practical					
	CAT1						CAT2											
TPS Scale	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
CO1	-	12	28	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-
CO2	-	4	16	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-
CO3	-	4	36	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-
CO4	-	-	-	-	-	-	-	12	28	-	-	-	-	-	20	-	-	-
CO5	-	-	-	-	-	-	-	4	16	-	-	-	-	-	10	-	-	-
CO6	-	-	-	-	-	-	-	4	36	-	-	-	-	-	20	-	-	-
Total	-	20	80	-	-	-	-	20	80	-	-	-	-	-	100	-	-	-

Syllabus

Theory:

Problem Solving Methodology: problem specification and analysis, algorithm design, flowchart, programs, program testing and verification. **Basics of Programming:** data types and its representation, variables, keywords, Operators, operator precedence, types of expression, Control Structures: Selection structure, looping Structure. **Array and string handling algorithms:** 1-D, 2-D arrays, **strings sorting:** bubble sort, searching: linear and binary search, text processing: key word search, text editing. **Modular Programming and Functions:** Function declaration, function definition, function call-call by value - call by reference, storage classes, Recursive functions, library functions. **Pointers & Memory management:** Pointers and memory addressing, Arrays and pointer, Pointers and Functions, Pointers to pointers, pointer and string arrays, Void and function pointers, use of malloc - realloc-free- heaps in memory management. **Derived data types**: structures- Arrays of Structures – Passing Structures to Functions – Structure with Pointers, enum, typedef **File Handling:** read, write and update text files

Practical:

List of Experiments

1. Programs to explore fundamental programming constructs
   a. Find the range of all primary data types.
   b. Use of different types of operators and expressions.
2. Programs using decision making, case control and looping statements
   a. Print twin prime numbers in a given range
   b. Finding greatest common divisor using Euclid's method
3. Programs using 1-D and 2-D arrays
   a. Bubble sort algorithms
   b. Matrix multiplication
   c. Histogram
4. Programs using strings
   a. Linear pattern search
   b. Text editing
5. Programs using recursive and non-recursive functions
   a. Binary search
   b. Finding n^{th} Fibonacci number
6. Programs using pointers
   a. Implement experiments 2- 5 (Selective programs) using pointers
   b. Programs using memory allocation
7. Programs to create database files using file structures
8. Solving numerical methods/engineering problems (sample)
   a. Linear convolution
   b. Bitwise operations to set specific bit fields

Text Book

- Kernighan, Brian, and Dennis Ritchie. “The C Programming Language”, 2nd ed. Upper Saddle River, NJ: Prentice Hall, 1988.

Reference Books & web resources

- Yashwanth P Kanetkar, “Let us C”, 18th ed., BPB edition, 2021.
- Schildt Herbert, “C: The Complete Reference”, 4th Edition, Mc Graw Hill, 2017.
- George S. Tselikis, Nikolaos D. Tselikas, “C: From Theory to Practice”, 2nd ed., CRC Press, 2017.
- Randal E. Bryant and David R. O'Hallaron, Computer Systems: A Programmer's Perspective, Third Edition, Pearson, 2016.
- Paul Deitel, Harvey Deitel, “C: How to program”, 7th ed., '', Pearson Education, 2013.
- Adam Hoover, “System Programming with C and Unix”, 1st ed., Pearson Education, 2010.
- V. Rajaraman, Computer Programming in C, PHI Learning, 2004.
- E. Balagurusamy, Programming in Ansi C, 3rd ed., Tata McGraw-Hill Publication, New Delhi, 2004.
- Paul Anderson and Gail C Anderson, “Advanced C: Tips and Techniques”, Hayden Book,1988.
- NPTEL Course on Introduction to programming in C by Prof Satyadev Nandakumar, IIT Kanpur https://nptel.ac.in/courses/106104128
- NPTEL Course on Problem Solving through Programming in C by Prof Anupam Basu, IIT Kharagpur: https://nptel.ac.in/courses/106105171

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Problem Solving Methodology**	
1.1	Problem specification and analysis, algorithm design, flowchart, programs, program testing and verification	1
2	**Basics of Programming**	
2.1	Data types and its representation, variables, keywords,	
2.2	Operators, operator precedence, types of expressions	1
2.3	**Branching and Looping**	
2.4	Conditional Expression and control structures – IF, IF-else, Switch	2
2.5	Looping Structure- While Loops, Do-While Loops, For Loops	2
2.6	Jumping statements- Break and Continue, Goto	1
3	**Arrays and Array handling algorithms**	
3.1	1-D arrays	1
3.2	Sorting: selection sort, bubble sort	1
3.3	Searching: linear and binary search	1
3.4	2-D arrays	1
3.5	Character array – Strings	1
3.6	Text processing: key word search, text editing	1
4	**Functions**	
4.1	Function declaration, function definition, function call-call by value, Using arrays as function arguments	1
4.2	Recursive functions	1
4.3	Library functions	1
4.4	Storage classes	1
5	**Pointers &Memory management**	
5.1	Pointers and memory addressing, Arrays and pointer	1

	arithmetic	
5.2	Pointers and Functions- call by reference, Pointers to pointers	1
5.3	Pointer and string arrays, Void and function pointers	1
5.4	Memory management functions: malloc, calloc, realloc, free - use of heap in memory management	1
6	**Derived data types & File Handling**	
6.1	Structures- Union- typedef - Arrays of Structures - Passing Structures to Functions	1
6.2	Structure Pointers – Structures within Structures	1
6.3	Read, write and modify text files	1
	Theory	24
	Practical	24
	Total	48

Course Designer(s):

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- Dr.M.Senthilarasi msiece@tce.edu

22CHAA0	ENVIRONMENTAL SCIENCE

Category	L	T	P	Credit
BS	1		1	0

(Common to all branches)

Preamble

The objective of this course is to make the students learn the basic concepts of environment, ecology, and to create awareness on current environmental issues, and develop
a sustainable environment by participating in various activities on conserving natural resources and protecting the environment.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Describe the importance and progression of ecological system	TPS2	A	80
CO2	Explain the significance of natural resources	TPS2	A	80
CO3	Examine the effects of pollution on environment and human beings	TPS3	A	80
CO4	Practice the suitable solid waste management for segregation and reuse of waste	TPS3	A	80
CO5	Explain renewable energy resources for sustainable environment	TPS2	A	80
CO6	Perform Environment oriented group activities	TPS4	A	80

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	M	L	-	-	-	L	S	-	-	-	-	-
CO2.	M	L	-	-	-	-	L	L	-	-	-	-
CO3.	S	M	L	-	-	-	S	-	-	-	-	-
CO4.	M	M	L	-	-	-	S	L	L	-	-	-
CO5.	M	L	-	-	-	-	S	-	L	-	-	-
CO6.	S	S	M	L	M	M	M	M	S	M	M	-

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT						Assignment#						Terminal***					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1		20					NA						Presentation on case study report					
CO2		20																
CO3			20															
CO4			20															
CO5		20																
CO6																		

Assignment: Marks will be given for the review I &II of case study presentation.

*** Case study presentation and evaluation

- Each group comprise of maximum three students
- Students will submit the case study report similar to final year project report
- Evaluation of case study presentation is based on the approved rubrics

Method of Evaluation

a)Internal assessment

S.No	Description	Max.marks	Final conversion
1	CAT	60	30
2	Assignment marks (from Review I&II)	2×20 =40	20
Total			50

b) End semester examination – Case study presentation

Performance Index	Marks per Individual
Originalityof the work	20
Data collected	20
Suggestion to overcomefor the identified issues	20
FinalPresentation	40
Total	100

Model Titles for Case Study:

1. Environmental impacts of rubber industry in Virudhunagar district
2. Solid waste and waste water management in TCE hostel.
3. Status of workers in fireworks industry in Sivakasi region
4. A study on impacts of tanneries on ground water and soil quality in Dindigul district.
5. Effect of pharmaceutical industry on groundwater quality in poikaraipatty village, AlagarKovil.
6. Environmental impacts of quarry industries in MelurTaluk.
7. Environmental effect of Kudankulam atomic power plant.
8. Effect on ground water and soil quality by dyeing industries in Tiruppur.
9. Effect of textile wastes in Karur District.
10. Segregation of waste and its recycling by Madurai Municipality at Vellakkal

Syllabus

Environment and Ecosystem - Multidisciplinary nature of environment- Ecosystem-Structure and Functions, Energy flow in ecosystem-Ecological succession- Natural resources -Over exploitation, Conservation. **Environmental pollution and control -** Environmental pollution – Types (Air, Water, Soil)and Effects–Control measures, Solid waste management, Environmental Impact Assessment.**Sustainable Environment–**Carbon footprint, Carbon and water neutrality, Sustainable development goals, Renewable energy resources (Solar, Wind, Tidal, Biomass), Atom economy,Carbon vs Hydrogen economy, Linear economy vs Circular economy, Environmental ethics – issues, solution

Awareness and activities:

- ✓ Lectures by Environmentalist
- ✓ Group meeting on water management
- ✓ Awareness on modern pollution control measures
- ✓ Drive on e-waste segregation and disposal
- ✓ Field visit to treatment systems
- ✓ Preparation of seed ball and plantation
- ✓ Slogan, Poster, Essay writing, Role play events

Text Book

1. Kaushik, A &Kaushik, C.P, Environmental Science and Engineering, 6thEdition, New Age International, 2018.
2. ErachBharucha, Text book of Environmental studies for Undergraduate courses, 2ndEdtion, UGC, 2013.

Reference Books& web resources

1. O.P. Gupta, Elements of Environmental Pollution Control, Khanna Publishing House, New Delhi
2. Metcalf & Eddy, Waste Water Engineering, Mc-Graw Hill, New York, 2013, ISBN: 077441206.
3. Aldo Vieira, Da Rosa, Fundamentals of renewable energy processes, Academic Press Oxford, UK; 2013. ISBN: 9780123978257.
4. www.indiaenvironmentportal.org.in
5. www.teriin.org
6. www.cpcp.nic.in
7. www.sustainabledevelopment.un.org
8. www.conserve-energy-future.com

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Environment and Ecosystem**	
1.1	Multidisciplinary nature of environment	1
1.2	Structure and Function of Ecosystem. Energy flow in ecosystem – Universal energy flow model	2
1.3	Ecological succession	1
1.4	Natural resources - Over exploitation, Conservation	1

Module No.	Topic	No. of Periods
2	**Environmental pollution and control**	
2.1	Environmental pollution – Types(Air, Water, Soil) and Effects	2
2.2	Control measures: Air pollution (Bag filter, Cyclone separator, Electrostatic Precipitator)	1
2.3	Industrial waste water treatment – Primary, Secondary, Tertiary	1
2.4	Solid waste management	1
2.5	Environmental Impact Assessment – Components, Processes and methods	1
3	**Sustainable Environment**	
3.1	Concept of carbon credit and carbon foot print, Carbon and water neutrality	1
3.2	Sustainable development goals – An overview	1
3.3	Renewable energy resources – Solar, Wind, Tidal, Biomass	2
3.4	Sustainable environment: Atom economy, Carbon vs Hydrogen economy, Linear economy vs Circular economy,	1
3.5	Environmental ethics: Issues and solution	1
4	**Awareness and activities**	
4.1	Lectures by environmentalist	1
4.2	Awareness on modern pollution control measures	1
4.3	Group activity on waste management	1
4.4	Drive on e-waste segregation and disposal	1
4.5	Field visit to treatment systems	1
4.6	Plantation using seed ball	1
4.7	Slogan, Poster, Essay writing, Role play events	1
	Total	24

Course Designer(s):

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CURRICULUM AND DETAILED SYLLABI

FOR

B. E. DEGREE PROGRAMME
(Electronics and Communication Engineering)

THIRD SEMESTER

FOR THE STUDENTS ADMITTED IN THE

ACADEMIC YEAR 2022-23

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided Autonomous Institution Affiliated to Anna University)
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22EC310	PROBABILITY AND STATISTICS

Category	L	T	P	Credit
BSC	2	1	0	3

Preamble

An electronics and communication engineering student needs to have some basic statistical tools and techniques to apply in diverse applications in digital signal processing communications systems and networks, radar systems, power systems that requires an understanding of Probability distributions, Joint probability distributions, covariance, correlation and Testing of Hypotheses. The course is designed to impart the knowledge and understanding of the above concepts to Electronics and Communication Engineers and apply them in their areas of specialization.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

Cos	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Apply the concept of probability and conditional probability to solve real world problems	TPS3	70	60
CO2	Use standard distributions to find the expected life time of electrical components.	TPS3	70	60
CO3	Apply the concept of Joint Probability Distributions and covariance, correlation of Joint Probability Distributions and random samples random samples.	TPS3	70	60
CO4	Apply the concepts of two functions of two random variables.	TPS3	70	60
CO5	Apply the concept of testing the hypotheses for single samples by using various tests for difference of proportions and means.	TPS3	70	60
CO6	Apply the concept of testing the hypotheses for two samples by using various tests for difference of proportions and means.	TPS3	70	60

Mapping with Programme Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	S	S	S	S	-	M	-	-	M	-	-	S	S	-	-
CO2	S	S	S	S	-	M	-	-	M	-	-	S	S	-	-
CO3	S	S	S	S	-	M	-	-	M	-	-	S	S	-	-
CO4	S	S	S	S	-	M	-	-	M	-	-	S	S	-	-
CO5	S	S	S	S	-	M	-	-	M	-	-	S	S	-	-
CO6	S	S	S	S	-	M	-	-	M	-	-	S	S	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

TPS / CO	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I (%)			CAT – II (%)			Assg. II (%)					
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	3	10	20	-	-	70	-	-	-	-	-		-	6	11
CO2	7	10	28	-	-		-	-	-	-	-		-	6	15
CO3	-	-	22	-	-		-	-	10	-	-	70	-	6	11
CO4	-	-	-	-	-		3	10	20	-	-		-	6	11
CO5	-	-	-	-	-		3	-	25	-	-		-	6	8
CO6	-	-	-	-	-		4	10	15	-	-		-	-	14
MATLAB	-	-	-	-	-	30				-	-	30	-	-	-
Total	10	20	70	-	-	100	10	20	70	-	-	100	-	30	70

Syllabus

Probability Distributions: Introduction to Probability**:** Sample space and events - Definition and axioms of probability - Conditional Probability - Baye's theorem - Independent events - Random variables - Expected Values – Discrete Probability distribution: Binomial Distribution - Poisson Distribution – Continuous Probability distribution: Normal and Exponential Distributions - Higher Order Moments - Moment generating function. [14 hours]

Joint Probability Distributions: Jointly distributed Random Variables – Two Discrete Random Variables -Two Continuous Random Variables –Independent Random Variables – Conditional Distributions – Expected Values, Covariance and Correlation: Covariance – Correlation. [6 hours]

Functions of random Variables: Functions of one random variable – Sums of independent random variables – Sum of discrete random variables – Minimum of two independent random variables - Maximum of two independent random variables – Laws of large numbers – The central limit theorem. [6 hours]

Tests of Hypothesis Based on a Single Sample: Hypotheses and Test Procedures – z-Tests for Hypotheses about a Population Mean – The One Sample t test – Test Concerning a Population Proportion. [5 hours]

Inferences Based on Two Samples: zTests and Confidence Intervals for a Difference between Two Population Means – The Two Sample t-test and Confidence Interval – Inferences Concerning a Difference Between Population Proportions [5 hours]

Text Book

- Jay L. Devore, Probability and Statistics for Engineering and the Sciences, 9th Edition, Cengage Learning India Pvt Ltd, New Delhi, 2014.
- Oliver C. Ibe, Fundamentals of Applied Probability and Random Processes, Elsevier, 2015.
- Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, "Probability & Statistics for Engineers & Scientists", Pearson, New Delhi, 2016.

Reference Books& web resources

- Richard A. Johnson, "Miller &Freund's, Probability and Statistics for Engineers", Prentice Hall, New Delhi, 2017.
- Douglas C. Montgomery and George C. Runger, "Applied Statistics and Probability for Engineers", Wiley India, New Delhi,2018.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Probability Distribution**	
1.1	Introduction to Probability**:** Sample space and events, Definition and axioms of probability	1
1.2	Conditional Probability, Baye's theorem	2

Module No.	Topic	No. of Periods
	Tutorial	1
1.3	Independent events	1
1.4	Random variables, Expected Values	**1**
1.5	Discrete Probability distribution: Binomial, Poisson distributions	2
	Tutorial	1
1.6	Continuous Probability distribution: Normal Distributions Exponential Distributions	2
	Tutorial	1
1.9	Higher order moments, Moment generating function	2
2	**Joint Probability Distributions**	
2.1	Jointly distributed Random Variables – Two Discrete Random Variables	1
2.2	Two Continuous Random Variables - Independent Random Variables	1
	Tutorial	1
2.3	Conditional Distributions	1
2.4	Expected Values, Covariance	1
2.5	Correlation	1
3	**Functions of random Variables**	
3.1	Sums of independent random variables, Sum of discrete random variables	1
3.2	Minimum of two independent random variables, Maximum of two independent random variables	1
	Tutorial	**1**
3.3	Two functions of two random variable	1
3.4	Laws of large numbers – The central limit theorem.	1
	Tutorial	**1**
4	**Tests of Hypothesis Based on a Single Sample**	
4.1	Hypotheses and Test Procedures	1
4.2	z-Tests for Hypotheses about a Population Mean	1
	Tutorial	**1**
4.3	The One Sample t test	1
4.4	Test Concerning a Population Proportion.	1
5	**Inferences Based on Two Samples**	
5.1	Z Tests and Confidence Intervals for a Difference between Two Population Means	1
5.2	The Two Sample t-test and Confidence Interval	2
	Tutorial	**1**
5.3	Inferences Concerning a Difference Between Population Proportions	1
	Total	36

Course Designers:

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- Dr. S. Suriyakala ssamat@tce.edu

22EC320	ANALOG CIRCUIT DESIGN	Category	L	T	P	Credit	TE
		PCC	3	0	2	4	Theory

Preamble

This course is an introduction to basic knowledge about the principle of operation of semiconductor electronic devices like diodes, transistors. It will enable the students to learn about the use of transistors in analog circuits like single and multi-stage amplifier, feedback amplifier, Differential amplifier, power amplifier and oscillators. It also gives information about the current mirror circuits used for biasing in Integrated Circuits and their applications in the field of electronics industry.

Prerequisite

Basic knowledge on Electronic Devices.

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Compute the impedance and gain parameters of transistor amplifier circuits.	TPS 3	70	70
CO2	Understand the frequency response of transistor amplifier circuits.	TPS 2	70	70
CO3	Demonstrate the effect of negative feedback on amplifier performance parameters.	TPS 3	70	70
CO4	Use the condition for oscillation in a transistor circuit to establish sustained oscillation.	TPS 3	70	70
CO5	Calculate the power conversion efficiency of large signal amplifiers.	TPS 3	70	70
CO6	Construct the inverting and non-inverting mode applications of operational amplifier.	TPS 3	70	70
CO7	Calculate the component values for the given timing specification for multivibrator circuit using IC 555.	TPS 3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	L	L	L	-	-	-	L	L	-	-	S	L	L
CO2	S	M	L	L	L	-	-	-	L	L	-	-	S	L	L
CO3	S	M	L	L	L	-	-	-	L	L	-	-	S	-	L
CO4	S	M	L	L	L	-	-	-	L	L	-	L	S	-	L
CO5	S	M	L	L	L	-	-	-	L	L	-	L	S	-	L
CO6	S	M	L	L	L	-	-	-	L	L	-	-	S	-	L
CO7	S	M	L	L	L	-	-	-	L	L	-	-	S	-	L
Overall	3	2	1	1	1	0	0	1	1	1	0	0	3	0	1
	S	M	L	L	L	-	-	L	M	M	-	-	S	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I			Assessment - II			Terminal Exam (%)		
	CAT – I (%)			CAT – II (%)					
TPS / CO	1	2	3	1	2	3	1	2	3
CO1	-	10	10	-			-	4	10
CO2	-	10	20	-			-	4	10
CO3	-	05	20	-			-	4	15
CO4	-	05	20	-			-	2	15
CO5	-			-	4	30	-	2	10
CO6	-			-	8	25	-	2	10
CO7	-			-	8	25	-	2	10
Total	-	**30**	**70**	**-**	**20**	**80**	**-**	**20**	**80**

Psychomotor Skill	Practical
Perception	-
Set	-
Guided Response	-
Mechanism	100
Complex Overt Responses	-
Adaptation	-
Origination	-

Syllabus

Small Single Amplifiers: Q- Point, Self-bias- CE and CS, h-model of BJT and MOSFET, Small signal analysis of Amplifiers, Low frequency, Midband frequency and High frequency model of Transistors. [8]

Feedback Amplifiers and Oscillators: Feedback concept, negative and Positive feedback, voltage/ current, series/shunt feedback, Bark hausen criterion, Colpitts, Hartley's, Phase shift, Wein bridge and crystal oscillators. [8]

Large Signal Amplifiers: Class A, B, AB, C, Conversion Efficiency. [4]

Operational Amplifier: Ideal OPAMP, Differential Amplifier, Constant Current Source (Current Mirror), Open and Closed loop Circuits, Inverting and Non-Inverting amplifiers, Voltage follower, Buffer circuit. [6]

Applications of Operational Amplifier: Adder, Integrator and Differentiator, Comparator, Schmitt Trigger, Instrumentation Amplifier, Log and Anti-Log Amplifiers, Voltage to current and Current to voltage converter. [5]

Multivibrators: Bistable, Astable, Monostable multivibrators using IC 555 Timer, Applications of 555 Timer. [5]

Practical:

1. Design, simulate and demonstrate a single stage amplifier.
2. Design, simulate and demonstrate a series and shunt feedback amplifier.
3. Design, simulate and demonstrate a LC oscillator.
4. Design, simulate and demonstrate a RC oscillator.
5. Design, simulate and demonstrate a class-B power amplifier.
6. Design, simulate and demonstrate a Differential Amplifier using Op-amp.
7. Design, simulate and demonstrate an inverting and non-inverting amplifier.
8. Design, simulate and demonstrate application of operational amplifier circuits.
9. Design, simulate and demonstrate Astable and Monostable multivibrators.

Text Book

- Boylested and Nashelsky, "Electronic Devices and Circuit Theory", 11th edition, Pearson Education India, 2015.

Reference Books& web resources

- Adel S. Sedra and Kenneth C. Smith, "Microelectronic Circuits: Theory and Application",7th Edition, Oxford University Press, 2017.

- Serigo Franco, “Design with Operational Amplifiers & Analog Integrated Circuits”, 4th edition, McGraw Hill, 2014.
- https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-012-microelectronic-devices-and-circuits-fall-2009/readings/.
- NPTEL video lecture on “Analog Electronic Circuits” https://nptel.ac.in/courses/108102095/.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours	Practical
	Small Signal Amplifiers		-
1.	Q-Point, Self-Bias-CE and CS	2	-
2.	h-model of BJT and MOSFET	2	-
3.	Small signal analysis of Amplifiers	1	2
4.	Low frequency model of Transistor	1	2
5	Midband frequency and High frequency model of Transistor	2	-
	Feedback Amplifiers and Oscillators		
6.	Feedback concepts	1	-
7.	Negative and Positive feedback	1	-
8.	Voltage/Current feedback	1	2
9.	Series/Shunt feedback	1	-
10	Barkhausen criterion, Colpitts Oscillator	1	2
11.	Hartley Oscillator	1	-
12.	Phase shift Oscillator	1	2
13.	Wein bridge and crystal oscillator	1	-
	Large Signal Amplifiers		-
14.	Class A amplifier	1	-
15.	Class B amplifier	1	2
16.	Class AB amplifier	1	-
17.	Class C and Conversion Efficiency	1	-
	Operational Amplifiers		
18.	Ideal OPAMP	1	-
19.	Differential Amplifier	1	2
20.	Constant current source (Current mirror)	1	-
21.	Open and Closed loop circuits	1	-
22.	Inverting and Non-inverting Amplifiers	1	-
23.	Voltage follower, Buffer circuit	1	2
	Applications of Operational Amplifier		
24.	Adder, Integrator and Differentiator	1	-
25.	Comparator and Schmitt trigger	1	2
26.	Instrumentation Amplifier	1	-
27.	Log and Anti-Log Amplifiers	1	-
28.	Voltage to current and Current to voltage converter.	1	2
	Multivibrators		
29.	Bistable multivibrators using IC 555 Timer	1	-
30.	Astable and Monostable multivibrator using IC 555 Timer	2	2
31.	Application of 555 Timer	2	2
	TOTAL	**36**	**24**

Course Designers:

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22EC330	NETWORK ANALYSIS AND SYNTHESIS

Category	L	T	P	Credit
BSC	2	1	0	3

Preamble

The goal of this course is to broaden the student's understanding of network analysis beyond the basic concepts. It covers sophisticated network analysis in frequency domain, understanding pole-zero concept, analysis of two-port networks, synthesis of simple networks and basics of filter design.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Apply Laplace transform to formulate and solve electric network problems	TPS 3	70	60
CO2	Identify the properties and characteristics of network functions with respect to pole zero plot	TPS 3	70	60
CO3	Determination of two port network Z, Y, h and ABCD parameters	TPS 3	70	60
CO4	Determine network function of Advanced Networks - Ladder, Lattice, Bridged T Networks	TPS 3	70	60
CO5	Synthesize passive one-port networks using standard Foster and Cauer forms.	TPS 3	70	60
CO6	Apply two-port network analysis in the design of filters.	TPS 3	70	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	L	L	L	-	-	L	M	M	-	-	M	L	L
CO2	S	M	L	L	L	-	-	L	M	M	-	-	M	L	L
CO3	S	M	L	L	-	-	-	L	M	M	-	-	M	-	L
CO4	S	M	L	L	-	-	-	L	M	M	-	L	M	-	L
CO5	S	M	L	L	-	-	-	L	M	M	-	L	M	-	L
CO6	S	M	L	L	-	-	-	L	M	M	-	-	M	-	L
Overall	3	2	1	1	0	0	0	1	2	2	0	0	2	0	1
	S	M	L	L	-	-	-	L	M	M	-	-	M	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II *(%)					
TPS Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	10	20	100			-						-	4	10
CO2	-	10	20				-						-	4	10
CO3	-	10	30				-						-	4	15
CO4	-						-	10	20	100			-	-	15
CO5	-						-	10	30				-	4	15
CO6	-						-	10	20				-	4	15
Total	-	**30**	**70**	**100**			**-**	**30**	**70**	**100**			**-**	**20**	**80**

Syllabus

Laplace transform- Laplace transform of Electrical signals: step, Impulse and periodic functions- Initial and final value Theorem- Inverse transform- Analysis of electric DC networks. **S- Domain Analysis of AC Networks:** Interpretation of complex frequency- Network function for one-port and two-port, poles and zeros with restrictions for driving point functions and transform functions, stability by Routh-Hurwitz criterion. **Two Port Parameters:** Z-Y-h-ABCD parameters - Equivalent circuit model- Interrelationship of different parameters Interconnection of two port networks- calculation of network function for ladder and Lattice networks. **Network Synthesis**: Positive and real function (PRF), properties of PRF, testing of driving point functions, even and odd function, one terminal pair network driving point synthesis with LC, RL and RC elements, Foster and Cauer form. **Synthesis of Filters:** Low pass filters, high pass filters, band pass filters, band reject filters, constant k- and m-derived filters.

Text Book

- Van Valkenburg M.E., —Introduction to Modern Network Synthesis, Wiley Eastern, 1960 (reprint 1986).
- Van Valkenburg M.E, —Network Analysis, Prentice Hall India, 2014

Reference Books

- Ravish R. Singh, "Network Analysis and Synthesis", McGraw-Hill Education, 2013
- Abhijit Chakrabarti, “Circuit Theory Analysis and Synthesis” Dhanpat Rai & Co.; Seventh - Revised edition- 2018.
- Franklin Kuo, —Network Analysis and Synthesis||, 2nd Ed.,Wiley India,2006.
- Sudhakar, A. Shyammohan, “Circuits and Network”, 5th Edition, Tata McGraw Hill, 2015.
- S. K. Bhattacharya, —Network Analysis and Synthesis, || Pearson Education India.2015.
- “Network Analysis and Synthesis”, Wadhwa, New Age,2007.
- Dr. K.M. Soni, “Fundamentals of Network Analysis & Synthesis”, S.K. Kataria & Sons, 9th Edition,2019.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours	Tutorial
	Introduction to the Course, COs POs	1	-
1	**Laplace Transform (6)**		
2	Definition of Laplace Transform	1	-
3	Basic Theorems of Laplace Transform, Laplace transform of some basic functions	1	-
4	Application of Laplace transforms in solving Integro-differential equations and simultaneous differential equations	1	
5	Application of Laplace Transform Method to DC Circuit Analysis	1	2
	S- Domain Analysis of AC Networks: (6)		
6	Interpretation of complex frequency in S-Plane	1	-
7	Network function for one-port and two-port Networks,	1	-
8	Pole -Zero Diagram, Significance of Poles and Zeros	1	-
9	Poles and zeros with restrictions for driving point functions and transform functions,	1	-
10	Stability by Routh-Hurwitz criterion	1	1
	Two Port Parameters: (6)		
11	Relationships of Two-Port Variables	1	-
12	Two Port Parameters – z,y,h and ABCD, Image Impedance Equivalent circuit Model	1	1
13	Conditions for Reciprocity and Symmetry	1	-
14	Interrelationships between Two-Port Parameters	1	-
15	Terminated Two-Port Networks	1	-
	Ladder and Lattice Networks (5)		

16	Interconnection of Two-Port Networks	1	
17	Ladder Networks, Lattice and Bridged T Networks	1	2
18	Image Parameters of Two port Networks	1	-
	Network Synthesis: **(6)**		
19	Elements of Realizability, Positive Real Functions (PRF) Properties of PRF	1	
20	Basic Realization Procedures	1	1
21	Synthesis of one port networks with two kinds of elements-RL,RC,LC & Properties of Functions	1	2
	Synthesis of Filters: (6)		
22	Classification of Filters, Filter Networks, Characteristic Impedances	1	
23	Constant K Filters	1	2
24	m-derived Filters	1	1
	TOTAL	**24**	**12**

Marks Allocation for Assignment:

Sl. No	Description	Marks
1	Assignment 1 – a) Tutorial Submission b) Identification of Real world Two port networks	40
2	Assignment 2 – a) Tutorial Submission b) Synthesis of Networks using C	40
Total		**80**

Course Designers:

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22EC340	COMPUTER ORGANIZATION AND MICROPROCESSOR

Category	L	T	P	Credit	TE
PCC	3	0	2	4	Theory

Preamble

This course on Computer Organization and Microprocessor is designed as a theory and practical course that aims to provide students with a deep understanding of computer system architecture and organization. The course covers various topics, including the evolution and performance of computer systems, central processing units and computer hardware, x86 and MIPS32 processors, and multi-core architecture. Through experiments, students will gain hands-on experience in designing and implementing programs for data transfer, arithmetic operations, floating-point arithmetic, code conversion, stack implementation, array handling, recursion programs, and IO system service calls using x86 and MIPS32 architectures. Upon completion of the course, students will have a strong foundation in computer organization and microprocessor architecture and be equipped to design efficient and optimized programs for modern computer systems.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Understand the evolution, performance, organization, and architecture of computer systems.	TPS2	70	70
CO2	Understand the structure and function of CPU and computer hardware components.	TPS2	70	70
CO3	Apply the knowledge of x86 processors, to frame ASM coding for data transfer and arithmetic computations.	TPS3	70	70
CO4	Apply knowledge of MIPS32 architecture to design and optimize efficient programs for maximum performance and resource utilization.	TPS3	70	70
CO5	Apply knowledge of vector processors, multicore processors, network on chip, and Raspberry Pi SBC building blocks to design and implement efficient parallel programs	TPS3	70	70
CO6	Apply the principles of BIOS system calls and I/O system service calls to effectively communicate with and control computer hardware devices.	TPS3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO2
CO1	M	L	-	-	-	-	-	L	L	L	L	L	L	-	L
CO2	M	M	L	L	-	-	-	L	L	L	L	L	-	L	L
CO3	S	M	L	-	S	-	-	L	L	L	L	L	M	L	L

CO 4	S	M	L	L	S	L	-	L	L	L	L	L	M	L	L
CO 5	S	M	L	L	-	L	-	L	L	L	L	L	M	-	L
CO 6	S	L	L	L	-	-	-	L	L	L	L	L	-	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I			**Assessment - II**			**Terminal Exam** (%)		
	CAT – I (%)			**CAT – II** (%)					
TPS / CO	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1	-	20	-	-	-	-	-	20	-
CO2	-	20	20	-	-	-	-	-	20
CO3	-	20	20	-	-	-	-	20	-
CO4	-	-	-	-	30	15	-	-	20
CO5	-	-	-	-	30	15	-	-	15
CO6	-	-	-	-		10	-	-	5
Total	-	**60**	**40**	**-**	**60**	**40**	**-**	**40**	**60**

Psychomotor Skill	**Practical**
Perception	-
Set	-
Guided Response	-
Mechanism	100
Complex Overt Responses	-
Adaptation	-
Origination	-

Syllabus

Computer System: Evolution and Performance, organization and architecture. Structure and Function, Generations of computer. IAS computer Structure and operation. CISC and RISC, Evolution of the Intel x86 and ARM architecture. Performance assessment [5]

Central Processing Unit and Computer Hardware: CPU building blocks and its functions, ALU, Register organization. Instruction sets, Addressing modes and functions. Instruction Pipelining. Bus interconnection. Memory Management**:** Cache and its organization, Internal External memory and virtual memory and DMA [8]

x86 Processors: Architecture and Modes of operations, memory segments and Programming mode. Instruction sets, assembler directives. Stack, and interrupts. Memory Banking. ASM Coding for data transfer and arithmetic computations. Introduction to IA32 architecture. [6]

MIPS32 Architecture: MIPS32 instructions, programming model, CPU performance measuring. Pipelining of the Mips32 Data Path, Amadhal laws, Multi-cycle Operations in MIPS32 and exploiting Instruction Level Parallelism [9]

Multi-Core Architecture: Vector Processors, Introduction to Tiled Chip Multicore Processors, Network On Chip and Raspberry PI SBC-Buliding Blocks. [8]

Practical:

1. x86 programming for data Transferring and arithmetic operation [2]
2. x86 Floating point arithmetic operations [2]
3. x86 BIOS system call for Input/output device [2]
4. MIPS32 Integer arithmetic operation [2]
5. MIPS32 Logical operations [2]

6. MIPS32 Floating point arithmetic [2]
7. Implementing of code conversions in MIPS32 [2]
8. MIPS32 Stack implementation [2]
9. Array handling in MIPS32 [2]
10. Recursion Program [2]
11. IO System Service Calls [2]
12. Handling Interrupts in MIPS32 [2]

Note:

- Experiments 1, 2 and 3 will be carried out by EMU8086 simulator which runs on all recent computers.
- Experiments 4 to 12 will be carried out by QTSPIM simulator runs on Windows, and Linux computers.

Text Book

- William Stallings, Computer Organisation and Architecture- Designing for Performance", 9th Edition, Pearson Education series, 2014.
- Robert Britton, "MIPS Assembly Language Programming", Pearson/Prentice Hall, 2004

Reference Books& web resources

- K. Bhurchandi, A. K. Ray, Advanced Microprocessor and Peripherals, McGraw Hill Education, 3rd Edition, 2017.
- Patterson, D. A., and J. L. Hennessy. Computer Organization and Design: The Hardware/Software Interface, 5th ed. San Mateo, CA: Morgan Kaufman, 2013. ISBN: 1558606041.
- https://onlinecourses.nptel.ac.in/noc22_cs88/course.
- https://onlinecourses.nptel.ac.in/noc21_cs82/course.

Course Contents and Lecture Schedule

Module No.	Topic	No.of Lectures	CO
1	**Computer System**		
1.1	Evolution and Performance, organization and architecture. Structure and Function, Generations of computer.	2	CO1
1.2	IAS computer Structure and operation. CISC and RISC,	2	CO1
1.3	Evolution of the Intel x86 and ARM architecture. Performance assessment	1	CO1
2	**Central Processing Unit and Computer Hardware**		
2.1	CPU building blocks and its functions, ALU, Register organization.	2	CO2
2.2	Instruction sets, Addressing modes and functions.	2	CO2
2.3	Instruction Pipelining. Bus interconnection.	2	CO2
	Memory Management**:** Cache and its organization, Internal External memory and virtual memory and DMA	2	CO2
3	**x86 Processors**		
3.1	Architecture and Modes of operations, memory segments and Programming mode.	2	CO3

3.2	Instruction sets, assembler directives.	1	CO3
3.3	Stack, and interrupts. Memory Banking. ASM Coding for data transfer and arithmetic computations.	2	CO3
	Introduction to IA32 architecture.	1	CO3
4	**MIPS32 Architecture**		
4.1	MIPS32 instructions, programming model, CPU performance measuring.	3	CO4
4.2	Pipelining of the Mips32 Data Path	2	CO4
4.3	Amadhal laws, Multi-cycle Operations in MIPS32	2	CO4
4.4	exploiting Instruction Level Parallelism	2	CO6
5	**Multi-Core Architecture**		
5.1	Vector Processors	2	CO5
5.2	Introduction to Tiled Chip Multicore Processors.	2	CO5
5.3	Network On Chip	2	CO5
5.4	Raspberry PI SBC-Building Blocks	2	CO5
Total		**36**	
Practical			
6	x86 programming for data Transferring and arithmetic operation	2	CO3
7	x86 Floating point arithmetic operations	2	CO3
8	x86 BIOS system call for Input/output device	2	CO6
9	MIPS32 Integer arithmetic operation	2	CO4
10	MIPS32 Logical operations	2	CO4
11	MIPS32 Floating point arithmetic	2	CO4
12	Implementing of code conversions in MIPS32	2	CO4
13	MIPS32 Stack implementation	2	CO4
14	Array handling in MIPS32	2	CO4
15	Recursion Program	2	CO4
16	IO System Service Calls	2	CO6
17	Handling Interrupts in MIPS32	2	CO6
Total		**24**	

Course Designers:

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22EC350	SIGNALS AND SYSTEMS

Category	L	T	P	Credit
PCC	3	1	0	4

Preamble

Signals and Systems arise in a wide variety of fields such as communications, aeronautics astronautics, acoustics, seismology, biomedical engineering and speech processing. Signals are functions of one or more independent variables. Signals contain information about the behaviour or nature of some phenomenon. They vary continuously in time or at discrete points in time. Systems respond to particular signals by producing other signals or some desired behaviour. Systems that respond to or process signals lead naturally to two parallel frameworks for signal and system analysis, one for phenomena and processes that are described in continuous in time and one for those that are described in discrete in time. In this course, students will be able to analyse signals and systems and design systems to enhance or restore signals that have been degraded.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Characterize and classify the given continuous and discrete signals and systems	TPS 3	70	70
CO2	Carry out time domain analysis of continuous time systems	TPS 3	70	70
CO3	Carry out time domain analysis of discrete time systems	TPS 3	70	70
CO4	Analyze continuous time periodic signals using Fourier Series.	TPS 4	70	70
CO5	Analyze continuous time non-periodic signals using Fourier Transform.	TPS 4	70	70
CO6	Convert a continuous time signal into discrete time sequence using Nyquist Sampling Theorem	TPS 3	70	70
CO7	Carry out discrete time analysis using z-Transform.	TPS 3	70	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	S	M	L	-	-	-	-	-	-	M	-	-	M	M	-
CO2	S	M	L	-	-	-	-	-	-	M	-	-	M	M	-
CO3	S	M	L	-	-	-	-	-	-	M	-	-	M	M	-
CO4	S	S	M	L	S	-	-	-	-	M	-	-	S	M	-
CO5	S	S	M	L	S	-	-	-	-	M	-	-	S	M	-
CO6	S	M	L	-	-	-	-	-	-	M	-	-	M	M	-
CO7	S	M	L	-	-	-	-	-	-	M	-	-	M	M	-
Overall	S	M	L	-	-	-	-	-	-	M	-	-	M	M	-

S- Strong; M-Medium; L-Low

Assessment Pattern:

	Assessment – I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assignment I (%)			CAT – II (%)			Assignment II (%)					
TPS / CO	2	3	4	2	3	4	2	3	4	2	3	4	2	3	4
CO1	10	10	-	100			-	-	-	-			2	10	-
CO2	10	20	-				-	-	-	-			2	10	-
CO3	10	20	-				-	-	-	-			2	-	10
CO4	-	-	20				-	-	-	-			4	-	10
CO5	-	-	-	-			-	10	20	100			4	10	-
CO6	-	-	-	-			10	20	-				2	20	-
CO7	-	-	-	-			10	30	-				4	10	-
Total	**30**	**50**	**20**	**100**			**20**	**60**	**20**	**100**			**20**	**60**	**20**

Syllabus

Signals and Systems: Signals, Signal Operations, Classification of Signals, Continuous time Signal Models, Systems, Classification of continuous time Systems, Signal operations on discrete time signals, Discrete Signal Models, Classification of discrete time systems, **Time-Domain Analysis of Continuous-Time Systems:** System response to internal conditions: the zero-input response, Unit impulse response, *System response to external input: zero-state response*: Convolutional Integral, Interconnected System; *System stability***:** BIBO and Asymptotic Stability**,** *Intuitive Insights into System Behaviour***:** Time Constant, Resonance Phenomenon, **Time-Domain Analysis of Discrete-Time Systems:** System response to internal conditions: the zero-input response, unit impulse response, *System response to external input: zero-state response:* Convolutional Sum, Properties of convolution sum, Interconnected Systems, *System stability:* BIBO and Asymptotic Stability**,** *Intuitive Insights into System Behaviour:* Time Constant, Resonance Phenomenon, **Continuous-Time Signal Analysis-The Fourier Series:** Periodic signal representation by trigonometric Fourier series, Existence and convergence of the Fourier series, Exponential Fourier series, LTIC response to periodic inputs, Generalized Fourier series: Signals as vectors, **Continuous-Time Signal Analysis-The Fourier Transform:** Aperiodic signal representation by Fourier integral, Fourier Transforms of useful functions, Properties of Fourier Transform, Signal transmission through LTIC systems, **Sampling:** Sampling Theorem, Signal Reconstruction, **Discrete-Time System Analysis Using the z-Transform:** Properties of z-Transform, z-Transform Solution of Linear Difference Equations, Frequency Response of Discrete-Time Systems, Frequency Response from Pole-Zero Location, Connection between the Laplace Transform and the z-Transform, The Bilateral z-Transform.

Text Book

- Principles of Linear Systems and Signals: B.P. Lathi (2nd Edition), Oxford University Press, 2009.

Reference Books& web resources

- Alan V.Oppenheim, Alan S.Willsky and S.Hamid Nawab, “Signals & Systems”, PrenticeHall of India, Second Edition, 2011.
- James H.McClellen, Ronald W.Schafer, Mark A.Yoder ,”Signal Processing First”, Pearson Education, 2003.
- Rodger E.Ziemer, William H.Tranter and D.Ronald Fannain “Signals & Systems Continuous and Discrete”, Pearson Education, 2002.
- Simon Haykin, Barry Van Veen,” Signals and Systems”, Wiely, 2nd Edition, 2002.
- Sophocles J.Orfanidis “Introduction to Signal Processing”, Prentice Hall, 1996.
- Ashok Ambardar, “Digital Signal Processing: A Modern Introduction”, Nelson Engg, 2007.
- https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/index.htm

Course Contents and Lecture Schedule

No.	Topic	Lecture/ Tutorial Hours	COs
1	Signals and Systems		
1.1	Signals, Signal Operations, Classification of Signals	1	CO1
1.2	Continuous time Signal Models, Systems	2	CO1
1.3	Classification of continuous time Systems	1	CO1
1.4	Signal operations on discrete time signals	1	CO1
1.5	Discrete Signal Models, Classification of discrete time systems	2	CO1
2	**Time-Domain Analysis of Continuous-Time Systems**		
2.1	System response to internal conditions: The zero-input response, Unit impulse response	1	CO2
2.2	System response to external input: zero-state response	1	CO2
2.3	Convolutional Integral, Interconnected System	2	CO2
2.4	System stability**:** BIBO and Asymptotic Stability	2	CO2
2.5	Intuitive Insights into System Behaviour: Time Constant, Resonance Phenomenon	2	CO2
3	**Time-Domain Analysis of Discrete-Time Systems**		
3.1	System response to internal conditions: the zero-input response unit impulse response	2	CO3
3.2	System response to external input: zero-state response-Convolutional Sum	2	CO3
3.3	Properties of convolution sum, Interconnected Systems	1	CO3
3.4	System stability**:** BIBO and Asymptotic Stability	2	CO3
3.5	Intuitive Insights into System Behaviour**:** Time Constant, Resonance Phenomenon	1	CO3
4	**Continuous-Time Signal Analysis-The Fourier Series**		
4.1	Periodic signal representation by trigonometric Fourier series	2	CO4
4.2	Existence and convergence of the Fourier series	2	CO4
4.3	Exponential Fourier series	2	CO4
4.4	LTIC response to periodic inputs, Generalized Fourier series: Signals as vectors	2	CO4
5	**Continuous-Time Signal Analysis-The Fourier Transform**		
5.1	Aperiodic signal representation by Fourier integral	2	CO5
5.2	Fourier Transforms of useful functions	2	CO5
5.3	Properties of Fourier Transform, Signal transmission through LTIC systems	3	CO5
6	**Sampling**		
6.1	Sampling Theorem, Signal Reconstruction	3	CO6
7	**Discrete-Time System Analysis Using the z-Transform**		
7.1	Properties of z-Transform, z-Transform Solution of Linear Difference Equations	2	CO7
7.2	Frequency Response of Discrete-Time Systems, Frequency Response from Pole-Zero Location	2	CO7
7.3	Connection between the Laplace Transform and the z-Transform, The Bilateral z-Transform	3	CO7
Total		**48**	

Course Designers:

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- Dr.G.Ananthi gananthi@tce.edu

22EC360	OBJECT ORIENTED PROGRAMMING

Category	L	T	P	Credit
ESC	3	0	0	3

Preamble

This course aims to provide students with broad theoretical and practical skills in object-oriented programming. This course focuses on various OOP concepts like Class, Object, Encapsulation, Inheritance and Polymorphism. It also focuses on various libraries and Swing for programming an interactive real-world application.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency %	Expected Attainment %
CO1	Use programming constructs like Data types, Control structures, looping statements.	TPS 3	70	70
CO2	Construct object-oriented programs for the given scenario using object-oriented concepts like abstraction, encapsulation, polymorphism and inheritance.	TPS 3	70	70
CO3	Apply JAR, package, and exception handling mechanism for the given problem.	TPS 3	70	70
CO4	Implement various libraries like String, I/O, Collection classes and JDBC.	TPS 3	70	70
CO5	Develop interactive, user friendly software for real world applications using swing and Event Handling.	TPS 3	70	70
CO6	Construct Java based solutions with functional programming and design patterns for various domain areas	TPS 3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	L		L			M				M	M	L	
CO2	S	M	L		L			M				M	M	L	
CO3	S	M	L		L			M				M	M	L	
CO4	S	M	L		S			M				M	M	M	M
CO5	S	M	L		S			S	S	S		S	M	M	M
CO6	S	M	L		S			S	S	S		S	M	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II * (%)					
TPS / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	10	10	100			-						-	4	6
CO2	-	10	20				-						-	4	14
CO3	-	10	40				-						-	4	15
CO4	-						-	10	40	100			-	4	15
CO5	-						-	10	20				-	-	20
CO6	-						-	10	40				-	4	10
Total	-	**30**	**70**	**100**			**-**	**20**	**80**	**100**			**-**	**20**	**80**

Syllabus

Programming Constructs: Data types, Arrays, Control structures- Selection, Looping and Jump statements **Object Oriented Programming Concepts:** Object Oriented Paradigms, Encapsulation Object, Class, Method, Inheritance, Polymorphism–Method overloading, Method overriding, dynamic method dispatch, Abstract class and Interfaces **Exception Handling:** JAR, Create and import packages, Exception handling, Exception hierarchy- Try and Catch, Multiple catch, Nested try, throw, Built in exceptions and User defined exceptions **Libraries:** User-defined packages, String Handling - Methods, I/O – File Reading and Writing, StringTokenizer, Collections – Arraylist, linked list, HashSet, Linked Hashset, Tree Set, JDBC **Swing & Event Handling:** Swing components, Event handling, Event ListenersInterfaces - Action Listener, Focus Listener, Item Listener, Key Listener, Mouse Listener, Text Listener, AWT components - Frame, Label, Button, TextField, CheckBox, CheckBoxGroup, Choice, List, Layout – grid, card **Design Patterns:** Creational, Structural and Behavioral Design Patterns **Functional Programming:** Lambda expressions, functional interfaces, Stream API, immutability, pure functions, higher order functions, Recursion.

Text Book

- Herbert Schildt, “Java: The Complete Reference”, McGraw-Hill. Ninth Edition, 2014.

Reference Books

- Tony Gaddis, Starting Out with Java: From Control Structures through Objects, 4/E, Addison-Wesley, 2009.
- Grady Booch, Robert Maksimchuk, Michael Engel, Bobbi Young, Jim Conallen, Kelli Houston: Object Oriented Analysis and Design with Applications, Third Edition, May 2007.
- H.M. Deitel and P.J. Deitel, C How to program Introducing C++ and Java, Fourth Edition, Pearson Prentice Hall, 2005.
- Paul Deitel and Harvey Deitel, “Java How to Program (Early Objects)”, Pearson, Eleventh Edition, 2017.
- E.Balagurusamy, “Programming with Java” , McGraw-Hill, Fifth Edition, 2014.
- Kathy Sierra, “Head First Java”, Shroff publications, Second edition, 2005.
- Cay S. Horstmann and Gary Cornell, “Core Java, Volume I - Fundamentals”, Prentice Hall, Ninth Edition, 2013.
- Cay S. Horstmann and Gary Cornell, “Core Java, Volume II – Advanced Features : 2”, Prentice
- Erich Gamma. Richard Helm, Ralph Johnson, John Vlissides, “Design Patterns-Element of Reusable Object-Oriented Software”, Pearson Education India, 2004.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
1	**Introduction**	**1**
2	**Programming Constructs:** Data types, Arrays	1
3	Control structures- Selection	1
4	Control structures- Looping and Jump statements	1
	Object Oriented Programming Concepts:	
5	Object Oriented Paradigms	1
6	Encapsulation Object, Class, Method	2
7	Inheritance	1
8	Polymorphism–Method overloading, Method overriding, dynamic method dispatch	2
9	Abstract class and Interfaces	2
	Exception Handling:	
10	JAR	1
11	Create and import packages	1

12	Exception handling, Exception hierarchy- Try and Catch	1
13	Multiple catch and Nested try	2
14	throw	1
	Built in exceptions	1
15	User defined exceptions	1
	Libraries:	
16	User-defined packages, String Handling - Methods	1
17	I/O – File Reading and Writing	1
18	String Tokenizer	
19	Collections – Array list, linked list Hash Set, Linked Hash set, Tree Set	1
20	JDBC	1
	Swing & Event Handling:	
21	Swing components, Event handling, Event Listeners Interfaces - Action Listener, Focus Listener, Item Listener, Key Listener, Mouse Listener, Text Listener	2
22	AWT components - Frame, Label, Button, TextField, CheckBox, CheckBoxGroup, Choice, List, Layout – grid, card	2
	Design Patterns:	
23	Creational Design Patterns	2
24	Structural and Behavioral Design Patterns	2
	Functional Programming:	
25	Lambda expressions, functional interfaces	2
26	Stream API, immutability, pure functions	1
27	Higher order functions, Recursion.	1
	TOTAL	**36**

Course Designers:

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- Dr.R.A.Alaguraja, alaguraja@tce.edu

22ES390	DESIGN THINKING

Category	L	T	P	Credit
ESC	1	-	4	3

Preamble

Design has been defined as a "systematic, intelligent process in which designers generate, evaluate, and specify concepts for devices, systems, or processes whose form and function achieve clients' objectives or users' needs while satisfying a specified set of constraints". Human-centered design is defined as a process and a set of techniques used to create new solutions for the world. Solutions include products, services, environments, organizations, and modes of interaction. The reason this process is called "human-centered" is because it starts with the people we are designing for. This course facilitates the development of students' professional skills through their team engagement in developing conceptual design for a local community problem.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Identify a specific social need to be addressed	TPS 3	70	80
CO2	Identify stakeholder's requirements for the societal project	TPS 3	70	80
CO3	Develop measurable criteria in which design concepts can be evaluated	TPS 3	70	80
CO4	Develop prototypes of multiple concepts using user's feedback	TPS 3	70	80
CO5	Select the best design solution among the potential solutions with its functional decomposition	TPS 5	70	80

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	L	-	-	M	M	M	L	M	M	S
CO2	S	M	L	-	-	M	M	M	L	M	M	S
CO3	S	M	L	-	-	M	M	M	L	M	M	S
CO4	S	M	L	-	M	M	M	M	L	M	M	S
CO5	S	S	M	L	M	M	M	M	L	M	M	S

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Phases	Deliverables	Marks	Course Outcomes
Continuous Assessment			
Review 1 – Problem Identification	Technical Report	10	CO1 and CO2
Review 2 – Specification Development	Technical Report	20	CO3
Review 3 -Conceptual Design	Technical Report	20	CO4 and CO5
End-Semester Examination			
Demonstration	Prototype	60	CO1, CO2, CO3, CO4 and CO5
Poster Presentation	Poster	40	

- Reports are to be submitted at each review. The report and presentation will be evaluated based on Rubrics

- Demonstration and Poster presentation will be evaluated by two faculty members nominated by their respective Head of the Department.

Syllabus

1.0 Project Identification: Needs Assessment, Stakeholder Identification, Stakeholder Requirement Project Time Constraint.
2.0 Specification Development: Description Problem Environment, Creation of Stakeholder's Profiles Development of Low-cost Prototypes, Development of Task-Analysis, Comparison with Benchmark Products, Development of Customer Specification, Development of Evaluation Criteria,
3.0 Conceptual Design: Conduct of Functional Decomposition, Brainstroming of possible solutions, Creation of Prototypes for Multiple Concepts, Refinement of Design Specification on users' feedback, Evaluation of Potential Solutions, Selection of best design

Learning Resources

1. Learning Material prepared by TCE faculty members
2. https://www.ideo.com/
3. https://engineering.purdue.edu/EPICS

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours		Course Outcome
		In-Class	Hands-on	
1.	**Project Identification**: Introduction to Human-Centered Design	1	-	CO1
1.1	Needs Assessment	1	2	CO1
1.2	Identification of Stakeholders	1	2	CO2
1.3	Identification of Stakeholder Requirements		2	CO2
1.4	Project Time Constraint	1	2	CO2
2.	**Specification Development**			
2.1	Description Problem Environment	1	2	CO3
2.2	Creation of Stakeholder's Profiles		2	CO3
2.3	Development of Low-cost Prototypes	1	2	CO3
2.4	Development of Task-Analysis	1	2	CO3
2.5	Comparison with Benchmark Products	1	2	CO3
2.6	Development of Customer Specification		2	CO3
2.7	Development of Evaluation Criteria	1	2	CO3
3.	**Conceptual Design**			
3.1	Conduct of Functional Decomposition	1	2	CO4
3.2	Brainstroming of possible solutions	1	2	CO4
3.3	Creation of Prototypes for Multiple Concepts	1	2	CO4
3.4	Refinement of design Specification on users' feedback		2	CO4
3.5	Evaluation of Potential Solutions	1	2	CO5
3.6	Selection of best design		2	CO5
	Total	12	34	

Course Designers:

1. Dr.S.J.Thiruvengadam sjtece@tce.edu

CURRICULUM AND DETAILED SYLLABI

FOR

B. E. DEGREE PROGRAMME
(Electronics and Communication Engineering)

FOURTH SEMESTER

FOR THE STUDENTS ADMITTED IN THE

ACADEMIC YEAR 2022-23

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided Autonomous Institution Affiliated to Anna University)
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22EC410	OPTIMIZATION

Category	L	T	P	Credit
BSC	2	1	0	3

Preamble

An engineering UG student needs to have some basic mathematical tools and techniques to apply in diverse applications in Engineering. Optimization is a scientific approach to decision making that seeks to best design and operate a system, usually under conditions requiring the allocation of scarce resources. Various techniques of optimization have been dealt on the title "Optimization". Because of the complexity of most real-world optimization problems, it has been necessary to reduce the complexity of the problem by either simplifying the problem or constraining it by making reasonable assumptions. The course is designed to impart the knowledge and understanding the concepts on optimization techniques.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

Cos	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Formulate mathematical models of Linear Programming (LP),	TPS3	70	60
CO2	Solve Linear Programming Problems (LPP) by appropriate techniques and evaluate the behaviour under different range of parameters.	TPS3	70	60
CO3	Determine the optimum solutions of transportation and assignment problems	TPS3	70	60
CO4	Determine the optimum values of non-linear programming problems using search methods.	TPS3	70	60
CO5	Determine the optimum values of non-linear programming problems using descent methods	TPS3	70	60
CO6	Apply the concepts of convex optimization	TPS3	70	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	S	S	S	S	M	-	-	-	-	-	-	S	S	-	-
CO2	S	S	S	M	M	-	-	-	-	-	-	S	S	-	-
CO3	S	S	S	S	M	-	-	-	-	-	-	S	S	-	-
CO4	S	S	S	S	M	-	-	-	-	-	-	S	S	-	-
CO5	S	S	S	M	-	-	-	-	-	-	-	S	S	-	-
CO6	S	S	S	M	-	-	-	-	-	-	-	S	S	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

TPS / CO	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I (%)			CAT – II (%)			Assg. II (%)					
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	-	17	-	-	70	-	-	-	-	-	-	-	-	8
CO2	7	10	33	-	-		-	-	-	-	-	-	-	12	13
CO3	3	10	20	-	-		-	-	-	-	-	-	-	6	11
CO4	-	-	-	-	-	-	3	10	15	-	-	70	-	6	8
CO5	-	-	-	-	-	-	-	-	28	-	-		-	-	14
CO6	-	-	-	-	-	-	7	10	27	-	-		-	6	16
MATLAB	-	-	-	-	-	30	-	-	-	-	-	30	-	-	-
Total	**10**	**20**	**70**	**-**	**-**	**100**	**10**	**20**	**70**	**-**	**-**	**100**	**-**	**30**	**70**

Syllabus

Linear Programming: Formulation - Graphical Method and Simplex Method – Big-M Method – Two Phase Method - Primal-Dual Relations - Dual Simplex Method [12 hours]

Transportation problems: Transportation problems and solutions (North-West Corner Rule, Least Cost Method, Vogel's Approximation Method) – Solution using MODI Method - Assignment problems – Solution using Hungarian Method – Travelling Salesman Problems. [6 hours]

Nonlinear Programming: Unimodal Function – Fibonacci Method – Golden Section Method - Univariate Method – Steepest Descent (Cauchy) Method - Conjugate Gradient (Fletcher–Reeves) Method**.** **Convex Optimization:** Introduction to convex programming problem **-** Kuhn-Tucker Conditions – Cutting plane method - Basic Approach of the Penalty Function Method – Penalty Function Method for Problems with Mixed Equality and Inequality Constraints [18 hours]

Text Books

- Singiresu S. Rao, "Engineering Optimization Theory and Practice", 5th edition, John Wiley & Sons, Inc, 2020.
- Hamdy A. Taha, "Operations Research - An Introduction", 10th Edition, Pearson Education Limited 2017.

Reference Books & web resources

- Frederick Hillier, Gerald Lieberman, "Introduction to Operations Research" Tenth Edition, Tata McGraw Hill, 2015.
- Winston, Wayne L, and Jeffrey B. Goldberg, "Operations Research: Applications and Algorithms", 7th edition, Thomson/Brooks/Cole Belmont, CA, 2004.
- Ravindran, Don. T. Philips and James J. Solberg, "Operations Research- Principles and Practice", Second Edition, John Wiley and Sons, 2007.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Linear Programming**	
1.1	Introduction-Linear Programming, Formulation	2
	Tutorial	1
1.2	Graphical Method	1
1.3	Simplex Method	1
	Tutorial	**1**
1.4	Big-M Method	1
1.5	Two Phase Method	1
	Tutorial	1
1.6	Primal-Dual Relations	1

1.7	Dual Simplex Method	2
2	**Transportation problems**	
2.1	Introduction - Transportation problems and solutions, North-West Corner Rule	1
2.2	Least Cost Method, Vogel's Approximation Method	1
	Tutorial	1
2.3	Solution using MODI Method	1
2.4	Assignment problems - Solution using Hungarian Method	1
2.5	Travelling Salesman Problems.	1
3	**Nonlinear Programming:**	
3.1	Introduction-Nonlinear programming Unimodal Function	1
3.2	Fibonacci Method	1
	Tutorial	1
3.3	Golden Section Method	1
3.4	Univariate Method	1
3.5	Steepest Descent (Cauchy) Method	2
	Tutorial	1
3.6	Conjugate Gradient (Fletcher–Reeves) Method**.**	2
3.7	Introduction to convex programming problem, Kuhn-Tucker Conditions – -–	2
	Tutorial	1
3.8	Cutting plane method	1
3.9	Basic Approach of the Penalty Function Method	1
3.10	Penalty Function Method for Problems with Mixed Equality and Inequality Constraints	2
	Tutorial	1
	Total	36

Course Designers:

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22ECL10	VECTOR SPACES, PROBABILITY AND OPTIMIZATION (for Lateral entry students)

Category	L	T	P	Credit
BSC	2	1	0	3

Preamble

An electronics and communication engineering student needs to have Mathematical functions can be viewed in many different ways and one way of viewing them is through vectors. Most of the algebraic manipulation of functions from an m dimensional space to an n-dimensional space can be done using matrices and the tools from linear algebra. Some basic statistical tools and techniques to apply in diverse applications in digital signal processing communications systems and networks that requires an understanding of Probability distributions. Optimization is a scientific approach to decision making that seeks to best design and operate a system, usually under conditions requiring the allocation of scarce resources. The course is designed to impart the knowledge and understanding of the above concepts and apply them in their areas of specialization.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

Cos	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Demonstrate vector space and subspace	TPS3	70	65
CO2	Determine an orthonormal basis for the given basis	TPS3	70	65
CO3	Solve the linear programming using graphical and simplex method	TPS3	70	65
CO4	Determine the optimum solutions of transportation and assignment problems	TPS3	70	65
CO5	Apply the concept of probability and conditional probability to solve real world problems	TPS3	70	65
CO6	Use standard distributions to find the expected life time of electrical components.	TPS3	70	65

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	L	-	-	-	-	-	-	-	S	S	L	-	-
CO2	S	M	L	-	-	-	-	-	-	-	S	S	L	-	-
CO3	S	M	L	-	-	-	-	-	-	-	S	S	L	-	-
CO4	S	M	L	-	-	-	-	-	-	-	S	S	L	-	-
CO5	S	M	L	-	-	-	-	-	-	-	S	S	L	-	-
CO6	S	M	L	-	-	-	-	-	-	-	S	S	L	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

TPS CO	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I (%)			CAT – II (%)			Assg. II (%)					
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	4	10	19	-	-	30	-	-	-	-	-	-	-	6	11
CO2	3	-	31	-	-	40	-	-	-	-	-	-	-	3	14
CO3	3	10	20	-	-	30	-	-	-	-	-	-	-	3	14
CO4	-	-	-	-	-	-	4	10	19	-	-	30	-	6	11
CO5	-	-	-	-	-	-	3	-	25	-	-	30	-	3	10
CO6	-	-	-	-	-	-	3	10	26	-	-	40	-	9	10
Total	**10**	**20**	**70**	-	-	**100**	**10**	**20**	**70**	-	-	**100**	-	**30**	**70**

Syllabus

Vector Spaces: Vector space, Subspaces, linear independence of vectors, basis and dimension **Orthogonality**: Orthonormal sets, The Gram-Schmidt orthogonalization process. [12 hours]

Linear Programming: Graphical Method and Simplex Method **Transportation problems:** Transportation problems and solutions (Vogel's Approximation Method) – Optimal Solution using MODI method - Assignment problems: Solution using Hungarian Method. [12 hours]

Probability: Introduction to Probability**:** Sample space and events - Definition and axioms of probability - Conditional Probability - Baye's theorem **Random variables and Distributions:** Random variables - Expected Values – Discrete Probability distribution: Binomial Distribution - Continuous Probability distribution: Normal distribution [12 hours]

Text Book

- Steven.J. Leon, "Linear Algebra with Applications", 9th edition, Pearson, 2015
- P.K.Gupta and D.S.Hira, "Operations Research", 7th edition, S.Chand and company Pvt Ltd, Inc, 2014
- Jay L. Devore, Probability and Statistics for Engineering and the Sciences, 9th Edition, Cengage Learning India Pvt Ltd, New Delhi, 2014.

Reference Books & web resources

- David.C.Lay, "Linear Algebra and its applications", Pearson Addison – Addison Wesley, 3 rd edition, 2006.
- Richard A. Johnson, "Miller &Freund's, Probability and Statistics for Engineers", Prentice Hall, New Delhi, 2017.
- Singiresu S. Rao, "Engineering Optimization Theory and Practice", 5th edition, John Wiley & Sons, Inc, 2020.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Vector Spaces**	
1.1	Vector space	2
	Tutorial	1
1.2	Subspaces	1
1.3	Linear independence of vectors	1
1.4	Basis and dimension	1

Module No.	Topic	No. of Periods
1.5	**Orthogonality**: Orthonormal sets	2
	Tutorial	1
1.6	The Gram-Schmidt orthogonalization process	2
	Tutorial	1
2	**Linear Programming**	
2.1	Graphical Method	2
	Tutorial	1
2.2	Simplex Method	3
2.3	Transportation problems and solutions - Vogel's Approximation Method	1
2.4	Optimal Solution using MODI method	2
	Tutorial	1
2.5	Assignment problems: Solution using Hungarian Method	2
3	**Probability**	
3.1	Introduction to Probability**:** Sample space and events Definition and axioms of probability	1
3.2	Conditional Probability	1
	Tutorial	1
3.3	Baye's theorem	2
3.4	**Random variables and Distributions** - Random variables	1
3.5	Expected Values	2
	Tutorial	1
3.6	Discrete Probability distribution: Binomial Distribution	1
3.7	Continuous Probability distribution: Normal distribution	2
	Total	**36**

Course Designer(s):

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22EC420	MIXED SIGNAL CIRCUIT DESIGN

Category	L	T	P	Credit
PCC	3	0	0	3

Preamble

This course is to knowledge of link between analog world and digital world as in the name of mixed signal circuit. It is performed by sampling and hold circuit, DAC and ADC. The course mainly presents state-of-the-art Sample and hold circuits, digital-to-analog converters, a range of analog-to-digital converters, and phase locked loop concepts.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Demonstrate the performance parameters of Sample and Hold Circuits	TPS 3	70	70
CO2	Demonstrate the performance parameters of comparators	TPS 3	70	70
CO3	Interpret Data Converter Specifications	TPS 3	70	70
CO4	Design Digital-to-analog converters	TPS 3	70	70
CO5	Design Analog-to-digital converters	TPS 3	70	70
CO6	Understand the Phase locked loop concepts	TPS 2	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	L	L	-	-	-	-	-	M	-	-	M	-	-
CO2	S	M	L	L	-	-	-	-	-	M	-	-	M	-	-
CO3	S	M	L	L	-	-	-	-	-	M	-	-	M	-	-
CO4	S	M	L	L	-	-	-	-	-	M	-	-	M	-	-
CO5	S	M	L	L	-	-	-	-	-	M	-	-	M	-	-
CO6	S	M	L	L	-	-	-	-	-	M	-	-	M	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II * (%)					
TPS / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	10	20	100			-						-	4	10
CO2	-	10	20				-						-	4	10
CO3	-	10	30				-						-	4	15
CO4	-						-	10	20	100			-	4	15
CO5	-						-	10	30				-	4	15
CO6	-						-	30	-				-	15	-
Total	-	**30**	**70**	**100**			**-**	**50**	**50**	**100**			**-**	**35**	**65**

Syllabus

Sample and Hold Circuits: Performance of sample-and-hold circuits – Testing of sample and holds, MOS sample-and-hold basics, CMOS sample and hold circuits, Switch capacitor amplifiers, Switch capacitor power amplifiers, Switch capacitor filters. [8]

Comparators: Comparator specifications – input offset and noise, hysteresis. Opamp as a comparator – input-offset voltage errors, charge-injection errors, making charge-injection signal independent, minimizing errors due to charge-injections. [6]

Data Converter Specifications: Ideal D/A converter, ideal A/D converter, quantization noise, deterministic approach, stochastic approach, signed codes, performance limitations, resolution, offset and gain error, accuracy and linearity [5]

Digital-to-analog converters (DAC): Decoder-based converters – resistor string converters, folded resistor-string converters, binary-weighted resistor converters, R-2R-based converters, Thermometer-code converters [5]

Analog-to-digital converters (ADC): Integrating converters, flash converters, Successive-approximation converters, Pipelined A/D converters and Sigma Delta Converters [6]

Phase locked loop: Basic phase-locked loop architecture, voltage-controlled oscillator, divider, phase detector, loop filer, the PLL in lock [6]

Text Book

- Tony Chan Carusone, D avid A. Johns, Kenneth W. Martin "Analog Integrated Circuit Design", Wiley, 2nd Edition, 2011.
- David A. Johns and Ken Martin: Analog Integrated Circuit Design, Wiley India, 2008.
-

Reference Books & web resources

- Phillip Allen and Douglas R. Holberg "CMOS Analog Circuit Design" Elsevier, 2011.
- Willy M. C. Sansen "Analog Design Essentials" Springer, 2006.
- Behzad Razavi "Design of Analog CMOS Integrated Circuits" McGraw Hill, 2nd Edition, 2015.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Sample and Hold Circuits	
1	Performance of sample-and-hold circuits	2
2	Testing of sample and holds	1
3	MOS sample-and-hold basics, CMOS sample and hold circuits,	2
4	Switch capacitor amplifiers, Switch capacitor power amplifiers.	2
5	Switch capacitor filters	1
	Comparators	
6	Comparator specifications	1
7	Input offset and noise	1
8	Hysteresis	1
9	Opamp as a comparator – input-offset voltage errors	1
10	Charge-injection errors, making charge-injection signal independent, minimizing errors due to charge-injections	2
	Data Converters Specifications	
11	Ideal D/A converter	1
12	Ideal A/D converter	1
13	Quantization noise, deterministic approach, stochastic approach	1
14	Signed codes, performance limitations	1
15	Resolution, offset and gain error, accuracy and linearity	1

	Digital-to-Analog Converters (DAC)	
16	Decoder-based converters – resistor string converters	1
17	Folded resistor-string converters, binary-weighted resistor converters	2
18	R-2R-based converters, Thermometer-code converters	2
	Analog-to-Digital Converters (ADC)	
19	**I**ntegrating converters	2
20	Flash converters, Successive-approximation converters	2
21	Pipelined A/D converters and Sigma Delta Converters	2
	Phase Locked Loop	
22	Basic phase-locked loop architecture	2
23	Voltage-controlled oscillator, divider	2
24	Phase detector, loop filer, the PLL in lock	2
	TOTAL	**36**

Course Designers:

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22EC430	RF CIRCUIT DESIGN	Category	L	T	P	Credit	TE
		PCC	3	0	2	4	Theory

Preamble

The subject begins with the introduction of basic building blocks of the RF front-end and their functionalities from the perspective of mobile phone architecture. The microwave network analysis and its application were introduced in the second module. The third module covers the impedance matching between the interconnects and the terminating components/devices. The scattering parameter-based design and analysis of RF passive devices were given in fourth module. The final module provides stability criteria, design and analysis of active devices such as amplifiers and oscillators. The design theory is validated with the CAD simulation, fabrication and measurements in the laboratory.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Understand the RF front-end blocks in a GSM cellular phone and the component behaviour at RF/Microwave frequencies	TPS2	70	70
CO2	Design and validate the lumped and distributed matching networks	TPS3	70	70
CO3	Design and validate Power divider and Coupler	TPS3	70	70
CO4	Design and validate Filters for GSM frequencies	TPS3	70	70
CO5	Design and develop linear amplifier for the GSM applications	TPS3	70	70
CO6	Design an oscillator for the given specifications	TPS3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	L		-	-	-	-	L	L	L	-	L	L	-	L
CO2	S	M	L	-	M	-	-	L	L	L	-	L	M	L	L
CO3	S	M	L	-	M	-	-	L	L	L	-	L	M	L	L
CO4	S	M	L	-	M	-	-	L	L	L	-	L	M	L	L
CO5	S	M	L	-	M	-	-	L	L	L	-	L	M	L	L
CO6	S	M	L	-	M	-	-	L	L	L	-	L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I			Assessment – II			Terminal Exam (%)		
	CAT – I (%)			CAT – II (%)					
TPS / CO	1	2	3	1	2	3	1	2	3
CO1	-	20	-	-	-	-	-	6	-
CO2	-	10	30	-	-	-	-	2	16
CO3	-	10	30	-	-	-	-	4	16
CO4	-	-	-	-	10	20	-	2	16
CO5	-	-	-	-	15	20	-	4	16
CO6	-	-	-	-	15	20	-	2	16
Total	-	**40**	**60**	**-**	**40**	**60**	-	**20**	**80**

Psychomotor Skill	Practical
Perception	-
Set	-
Guided Response	-
Mechanism	100
Complex Overt Responses	-
Adaptation	-
Origination	-

Syllabus

Introduction: RF front-end blocks and functionalities in mobile phone, microwave sources and waveguides, EM Spectrum, RF/Microwaves versus DC and Low AC signals, behaviour of electronic components at microwave frequencies. [5]

Microwave Network Analysis: S-parameters, ABCD parameters – examples. [3]

Matching Networks: Lumped and Single stub matching – LC matching, Stub matching - Series and Shunt type. [6]

RF Passive Devices: Power dividers: Properties of dividers, Design of equal and un-equal power divider. Couplers: Properties of couplers, Design of Quadrature hybrid couplers and Rat-race coupler. Filters: Filter parameters and types, Filter design by insertion loss method, Butterworth filter transformations - Design of lumped and stepped impedance filters. [12]

RF Active Devices: RF/Microwave Linear Amplifiers: Amplifier parameters, transistor topologies, Stability criterion, Design of maximum gain amplifier (MGA) design, Gain-bandwidth product, Gain and Power budget analysis. **Oscillators:** Oscillator versus amplifier design, Condition of stable oscillations, One-port negative resistance oscillator design. [10]

Practical:

- Design and synthesis of planar transmission lines [2 Hours]
- Design & Simulation of L-section matching [2 Hours]
- Design & Simulation of Single-Stub matching [2 Hours]
- Design & Simulation of equal and un-equal power divider [2 Hours]
- Design & Simulation of Quadrature hybrid couplers and Rat-race coupler [4 Hours]
- Design & Simulation of Lumped and Distributed low pass filter [4 Hours]
- Design & Simulation of a linear amplifier [2 Hours]
- Study of Spectrum and Network analysers [2 Hours]
- PCB prototype fabrication and measurement of RF passive devices for GSM applications [4 Hours]

Text Book

- David M. Pozar, “Microwave Engineering”, John Wiley & Sons, Fourth Edition, 2015.
- Les Besser and Rowan Gilmore, “Practical RF circuit Design for Modern Wireless Systems- Passive circuits and Systems”, Vol.1, Artech House Publishers, Boston, London 2008.

Reference Books& web resources

- Matthew M. Radmanesh, "Radio frequency and Microwave Electronics Illustrated", Pearson Education Asia, 2001.
- G L Matthaei, L Young, and E M T Jones, “Microwave filters, impedance matching networks and coupling structures”, Artech House, 1985.
- Dr. Grish Kumar, Microwave theory and techniques, NPTEL.

Course Contents and Lecture Schedule

Module No.	Topic	No.of Lectures	CO
1	**INTRODUCTION**		
1.1	RF front-end blocks and functionalities in mobile phone	1	CO1
1.2	microwave sources and waveguides, EM Spectrum, RF/Microwaves versus DC and Low AC signals	2	CO1
1.3	Behaviour of electronic components at microwave frequencies	2	CO1
2	**MICROWAVE NETWORK ANALYSIS**		
2.1	S-parameters, ABCD parameters – examples	3	CO2
3	**MATCHING NETWORKS**		
3.1	Lumped and Single stub matching – LC matching	3	CO2
3.2	Stub matching - Series and Shunt type	3	CO2
4	**RF PASSIVE DEVICES**		
4.1	Power dividers: Properties of dividers	1	CO3
4.2	Design of equal and un-equal power divider	3	CO3
4.3	Couplers: Properties of couplers, Design of Quadrature hybrid couplers and Rat-race coupler.	4	CO3
4.4	Filters: Filter parameters and types, Filter design by insertion loss method	1	CO4
4.5	Butterworth filter transformations - Design of lumped and stepped impedance filters	3	CO4
5	**RF ACTIVE DEVICES**		
5.1	RF/Microwave Linear Amplifiers: Amplifier parameters, transistor topologies, Stability criterion	3	CO5
5.2	Design of maximum gain amplifier (MGA) design, Gain-bandwidth product, Gain and Power budget analysis	3	CO5
5.3	Oscillators: Oscillator versus amplifier design, Condition of stable oscillations	2	CO6
5.4	One-port negative resistance oscillator design	2	CO6
	Total	**36**	

Practical Sessions			
3.1	Design and synthesis of planar transmission lines	2	CO2
3.2	Design & Simulation of L-section matching	2	CO2
3.3	Design & Simulation of Single-Stub matching	2	CO2
4.1	Design & Simulation of equal and un-equal power divider	2	CO3
4.2	Design & Simulation of Quadrature hybrid couplers and Rat-race coupler	4	CO3
4.3	Design & Simulation of Lumped and Distributed low pass filter	4	CO4
5.1	Design & Simulation of a linear amplifier	2	CO5
5.2	Study of Spectrum and Network analysers	2	CO2,CO3,CO4,CO5
5.3	PCB prototype fabrication and measurement of RF passive devices for GSM applications	4	CO2,CO3,CO4
Total		**24**	

Course Designers:

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22EC440	MICROCONTROLLER AND EMBEDDED SYSTEM

Category	L	T	P	Credit	TE
PCC	3	0	2	4	Theory

Preamble

This course on Microcontrollers and Embedded Systems provides an in-depth understanding of the architecture, programming, and interfacing of microcontrollers and embedded systems. Students will learn the fundamental concepts of microcontroller-based system design, including the basics of assembler, compilers, and interpreters, data types, syntax, preprocessors, and debugging techniques. The course also covers the organization and mapping of memory in ARM-based embedded systems, communication protocols, GPIOs, timers, and ADC and DAC peripherals. Practical programming skills in developing and debugging programs for embedded systems using 8051 and ARM microcontrollers will be emphasized. By the end of the course, students will be equipped with the knowledge and skills to design and develop efficient and effective embedded systems.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Understand the architecture of microcontrollers, including internal and external memory, registers, and instruction sets.	TPS2	70	70
CO2	Apply the basics of assemblers, compilers, interpreters, and debugging techniques, and apply this knowledge to write efficient and effective code in C for embedded systems.	TPS3	70	70
CO3	Understand the architecture of ARM microcontrollers, including general purpose and special registers, exceptions, interrupts, and stack operations.	TPS2	70	70
CO4	Apply the knowledge of ARM system design to develop programs for ARM-based embedded systems and interface with peripherals such as GPIOs, timers, ADC, and DAC.	TPS3	70	70
CO5	Apply knowledge of synchronous and asynchronous communication, as well as UART, SPI, I2C, and CAN, to develop programs for embedded systems that involve communication peripherals.	TPS3	70	70
CO6	Apply interrupt handling and embedded system programming for reliable and efficient firmware development in microcontroller-based systems.	TPS3	70	70

Mapping with Programme Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O2
CO1	M	L		-	-	-	-	M	M	L	L	L	L	-	L
CO2	S	M	L	L	-	L	-	M	M	L	L	L	M	L	L
CO3	M	L	L	-	S	-	-	M	M	L	L	L	L	L	L
CO4	S	M	L	L	S	L	-	M	M	L	L	L	M	L	L
CO5	S	M	L	L	-	L	-	M	M	L	L	L	M	-	L
CO6	S	M	L	L	-	L	-	M	M	L	L	L	M	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I			**Assessment - II**			**Terminal Exam** (%)		
	CAT – I (%)			**CAT – II** (%)					
TPS / CO	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1	-	20	-	-	-	-	-	20	-
CO2	-	20	20	-	-	-	-	-	20
CO3	-	20	20	-	-	-	-	20	-
CO4	-	-	-	-	30	15	-	-	20
CO5	-	-	-	-	30	15	-	-	15
CO6	-	-	-	-		10	-	-	5
Total	-	**60**	**40**	**-**	**60**	**40**	**-**	**40**	**60**

Psychomotor Skill	**Practical**
Perception	-
Set	-
Guided Response	-
Mechanism	100
Complex Overt Responses	-
Adaptation	-
Origination	-

Syllabus

8051 Microcontroller Architecture: Introduction and Overview of microprocessor and microcontrollers. Internal architecture and registers. Internal and External memory. Instructions sets and Addressing modes. Interrupts and Peripherals: GPIOs, Timers. UART. Applications of microcontrollers. Interface Programming [10]

Embedded C programming: Assembler, Compilers and interpreter. Data types and its syntax, preprocessors. IDE and refereeing to its manuals. Startup code. Continuous while loop. Accessing of internal, external memory of code and data memory. Look up tables. Debugging techniques. Build system [4]

ARM-Microcontroller: Thumb-technology and applications of ARM, Architecture of ARM Evolution of ARM. General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence. Instruction set and CMSIS and HAL Library. Programming concepts [7]

ARM Embedded system and Interfacing: ARM system design, Memory organization and memory mapping. AMBA Bus architecture protocols. Peripherals GPIOs, Timers with various modes of operation. Accessing ADC and DAC [8]

Communication Peripherals: Introduction to synchronous and Asynchronous communication. UART with RS232 and RS485 signal scheme, SPI, I2C and CAN. Interrupt handling and Embedded system programming [7]

Practical:

1. Programming in cross compiler Keil for 8051microcontroller (CO2)
   - Assembling and simulating an ASM code for accessing GPIO and external memory
   - Develop the user define a function to a switch connected in PORT1 and outputting the data to the LEDs connected in PORT0 using appropriate argument and return type
   - Methods to invoke breakpoints and step-by-step execution of the code
   - Calculating the delay for the given clock frequency
2. Embedded C programming in cross-compiler Keil for 8051 microcontrollers (CO2)
   - Compiling and simulating the embedded C code for performing the computation like root of the equation, and performing convolution operation.
   - An arithmetic computation
   - Methods to invoke break points and step by step execution of the C code
   - Calculating the delay for the given clock frequency
3. Developing the C program for accessing GPIO and Timer peripherals in 8051 boards (CO2)
   - Develop a user function for a software delay “SoftDelay_ms(no of milli-seconds)” and use this function for blinking the LEDs in Port 0
   - Plot the error in the delay function when the argument changes from 1 to 1000 in the order of 100
   - Develop a user function for a hardware delay “HardDelay_ms(no of milli-seconds)” and use this function for blinking the LEDs in Port 0
   - Plot the error in the delay function when the argument changes from 1 to 1000 in the order of 100
4. Invoking interrupt services in the Embedded C programming and to realize it in 8051/ARM target board (CO6)
   - Control the LEDs in PORT-0 by the external interrupts INT0 and INT1
   - Blink the LEDs using a Timer peripheral interrupt which runs periodic time of intervals
5. Establishing serial communication between target board and computer (CO4)
   - Develop a user function in the C code for serial transmission with a defined baud rate to transmit a character and a string as an argument. Use interrupt-driven and polling methods
   - Develop a user function in the C code for serial reception with a defined baud rate to transmit a character and a string as an argument. Use interrupt-driven method
6. Accessing analog signal into the 8051/ARM system through ADC (CO4)
   - Develop the C code for accessing external ADC through parallel or serial communication and show the result in LEDs or in serial transmission
   - Access the ADC and display the sent data to LEDs
   - Show the analog input data in CRO
7. Design a setup for a display system to display the data in 7 segment LED (CO5)
   - Develop the LUT for 7 segment pattern to display the list of characters including blank
   - The Number X is displayed and incremented up to 9 for every period of time and it is updated in a single display
   - The number X range from 0 to 9999 is displayed for every period of time and it is updated in a single display. BCD conversion is done before displaying
   - For all the above objective\, user defined function is required
8. Design a display system to display the numbers and characters in LCD module (CO5)
   - Develop a function to display the array of stored alpha numeric string in LCD module
   - The arguments are needed to control the display position and clear the LCD
   - The text sent by PC is displayed in LCD module in 8051 target board

Text Book

- "The 8051 Microcontroller and Embedded Systems Using Assembly and C" by Muhammad Ali Mazidi, Rolin D. McKinlay, and Janice G. Mazidi
- ARM System Developer's Guide Designing and Optimizing System Software Andrew N. Sloss Dominic Symes Chris Wright. ELSEVIER inc 2005.

Reference Books& web resources

- https://www.nxp.com/docs/en/data-sheet/LPC1769_68_67_66_65_64_63.pdf
- NPTEL Video Lecture on "Microprocessor and Microcontroller", weblink: https://onlinecourses.nptel.ac.in/noc19_ee11/course
- Virtual Lab on "Real Time Embedded System", weblink: https://nptel.ac.in/courses/108102045/24

Course Contents and Lecture Schedule

#	Topic	No. of Lectures	CO
1	**8051 Microcontroller Architecture**		
1.1	Introduction and Overview of microprocessor and microcontrollers.	2	CO1
1.2	Internal architecture and registers. Internal and External memory.	2	CO1
1.3	Instructions sets and Addressing modes.	2	CO1
1.4	Interrupts and Peripherals: GPIOs, Timers. UART.	2	CO1
1.5	Applications of microcontrollers. Interface Programming	2	CO1
2	**Embedded C programming**		
2.1	Assembler, Compilers and interpreter. Data types and its syntax, preprocessors.	1	CO2
2.2	IDE and refereeing to its manuals. Startup code. Continuous while loop.	1	CO2
2.3	Accessing of internal, external memory of code and data memory. Look up tables. Debugging techniques. Build system	2	CO2
3	**ARM-Microcontroller**		
3.1	Thumb-technology and applications of ARM, Architecture of ARM Evolution of ARM.	2	CO3
3.2	General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence.	2	CO3
3.3	Instruction set and CMSIS and HAL Library.	2	CO3
3.4	Programming concepts	1	CO3
4	**ARM Embedded system and Interfacing**		
4.1	ARM system design, Memory organization and memory mapping.	2	CO4
4.2	AMBA Bus architecture protocols.	2	CO4
4.3	Peripherals GPIOs, Timers with various modes of operation.	2	CO4
4.4	Accessing ADC and DAC	2	CO4
5	**Communication Peripherals**		
5.1	Introduction to synchronous and Asynchronous communication.	2	CO5
5.2	UART with RS232 and RS485 signal scheme programming	2	CO5
5.3	SPI, I2C and CAN	2	CO5
5.4	Interrupt handling and Embedded system	1	CO6
	Total	**36**	
Practical			
6	Programming in cross compiler Keil for 8051microcontroller	**3**	CO2
7	Embedded C programming in cross-compiler Keil for 8051 microcontrollers	**3**	CO2
8	Developing the C program for accessing GPIO and Timer peripherals in 8051 boards	**3**	CO2
9	Invoking interrupt services in the Embedded C programming and to realize it in 8051/ARM target board	**3**	CO6

10	Establishing serial communication between target board and computer	**3**	CO5
11	Accessing analog signal into the 8051 system through ADC	**3**	CO4
12	Design a setup for a display system to display the data in 7 segment LED	**3**	CO5
13	Design a setup for a display system to display the numbers and characters in LCD module	**3**	CO5
Total		**24**	

Course Designers:

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22EC450	DISCRETE TIME SIGNAL PROCESSING	Category	L	T	P	Credit	TE
		PCC	3	0	2	4	Theory

Preamble

Signal Processing is the field that deals with use of digital computers and processors to perform a wide variety of operations to alter and process digitally recorded signals. In this course, both an in-depth and an intuitive understanding of the theory behind modern discrete-time signal processing systems and applications are provided. This course lays down foundation to be able to gain understanding of specialized courses like speech signal processing, image processing, radar signal processing and data analysis. Further, in practical session, hands on training are given to the students in understanding the theory of signals and systems and practicing the algorithms used in discrete time signal processing.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Determine the frequency domain representation of aperiodic discrete time signals.	TPS 3	70	70
CO2	Compute DFT and IDFT coefficients of a given discrete time sequence using Fast Fourier Transform algorithms	TPS 3	70	70
CO3	Design FIR and IIR filters for the given specifications using Window method and bilinear transformation & impulse invariant techniques respectively	TPS 3	70	70
CO4	Design FIR and IIR filters based on pole-zero placements in z-domain	TPS 3	70	70
CO5	Draw the implementation structure of FIR and IIR discrete time systems using block diagram and signal flow graph representation.	TPS 3	70	70
CO6	Compute statistical parameters like mean, correlation and power spectral density of a given random variable or random processes at the output of LTI system	TPS 3	70	70
CO7	Apply sampling rate conversion and multi-rate signal processing in the digital domain based on the given application.	TPS 3	70	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	S	M	L	-	S	-	-	M	M	-	-	-	M	L	-
CO2	S	M	L	-	S	-	-	M	M	-	-	-	M	L	-
CO3	S	M	L	-	S	-	-	M	M	-	-	-	M	L	-
CO4	S	M	L	-	-	-	-	-	-	-	-	-	M	-	-
CO5	S	M	L	-	S	-	-	M	M	-	-	-	M	L	-
CO6	S	M	L	-	S	-	-	M	M	-	-	-	M	L	-
CO7	S	M	L	-	S	-	-	M	M	-	-	-	M	L	-
Overall	S	M	L	-	S	-	-	M	M	-	-	-	M	L	-

S- Strong; M-Medium; L-Low

Assessment Pattern:

	Assessment - I			Assessment - II			Terminal Exam (%)		
	CAT – I (%)			CAT – II (%)					
TPS / CO	1	2	3	1	2	3	1	2	3
CO1	-	10	20	-	-	-	-	2	10
CO2	-	20	20	-	-	-	-	4	10
CO3	-	10	20	-	-	-	-	4	15
CO4	-	-	-	-	5	20	-	2	10
CO5	-	-	-	-	5	20	-	2	10
CO6	-	-	-	-	5	20	-	4	15
CO7	-	-	-	-	5	20	-	2	10
Total	-	**40**	**60**	**-**	**20**	**80**	**-**	**20**	**80**

Psychomotor Skill	Practical
Perception	-
Set	-
Guided Response	-
Mechanism	100
Complex Overt Responses	-
Adaptation	-
Origination	-

Syllabus

Fourier Analysis of Discrete-Time Signals: Discrete-time Fourier Transform (DTFT), Properties of DTFT, LTI discrete-time system analysis by DTFT **Discrete Fourier Transform (DFT):** Fourier representation of Finite duration sequences, Properties of DFT, Linear Convolution using DFT, Direct computation of the DFT, Decimation-in Time and Decimation in frequency FFT algorithms. **Discrete Time Filters:** Filter specifications, LTI Systems as frequency selective filters, Design of FIR filters by Windowing, Design of Discrete-Time IIR Filters from Continuous-Time Filters, Filter Design by Impulse Invariance, Bilinear Transformation, Design of Discrete-Time Butterworth Filter, Filter design based on Pole/zero: Linear Phase filter, Averaging filters, Comb Filters, Notch Filters, Resonators. **Structures for Discrete Time Systems** Basic Structures for IIR Systems: Direct Forms, Cascade Form, Parallel Form, Basic Network Structures for FIR Systems: Direct Form, Structures for Linear-Phase FIR Systems. **Random Signal Processing:** Random process: definition, stationary process, mean, correlation and covariance functions, ergodic process, transmission of random process through LTI systems, power spectral density, Gaussian process, noise, narrow band noise, noise reduction and signal enhancement, Optimum Linear filters: Wiener filter and linear prediction. **Multirate Signal Processing:** Review of Sampling theorem, Decimation, Interpolation, Sampling rate conversion by a rational factor I/D, Quadrature Mirror Filter, Polyphase Filter Structures.

Practical:

1. Time Domain response of LTI System (Convolution, Correlation)
2. Frequency response of LTI System (DTFT, z-Transform)
3. Fourier Analysis of Signals Using the Discrete Fourier Transform (DFT, FFT)
4. FIR Filter Design using windowing and frequency sampling methods
5. IIR Filter Design: Butterworth and Chebyshev filters
6. Filter design based on Pole-zero: Average Filter, Comb, Notch, Resonators
7. Random Signal Processing: Wiener filters, Linear Prediction

8. Random Signal Processing: Noise reduction and signal enhancement filter
9. Multirate Signal Processing: Decimation, Interpolation, Sampling rate conversion by I/D
10. Real Time Signal Processing Applications: Data acquisition using ADALM 1000
11. Real Time Signal Processing Applications: Filtering using DSP processor

Text Book

- Alan V.Oppenheim, Ronald W. Schafer, “Discrete time signal processing”, Prentice Hall, Third Edition, 2010.
- John G.Proakis and Dimitris G.Manolakis, “Digital Signal Processing Principles, Algorithms and Applications”, Prentice-Hall of India, Fourth Edition, 2006.

Reference Books& web resources

- Buck, Daniel, Singer, “Computer Explorations in Signals and Systems Using MATLAB”, Prentice Hall, 2nd Ed., 2001.
- Vinay K. Ingle, John G.Proakis, “Digital Signal Processing using MATLAB” Cengage Learning, Third Edition, 2012.
- Woon-Seng Gan, Sen.M.Kuo, Embedded Signal Processing with Micro Signal Architecture, John Wiley Sons, 2007
- Richard Newbold, “Practical applications in Digital Signal Processing, Pearson Prentice Hall, 2012.
- https://archive.nptel.ac.in/courses/117/105/117105134/

Course Contents and Lecture Schedule

No.	Topic	Lecture Hours	COs
1	**Fourier Analysis of Discrete-Time Signals**		
1.1	Discrete-time Fourier Transform (DTFT)	1	CO1
1.2	Properties of DTFT	2	CO1
1.3	LTI discrete-time system analysis by DTFT	1	CO1
2	**Discrete Fourier Transform (DFT)**		
2.1	Fourier representation of Finite duration sequences	1	CO2
2.2	Properties of DFT	2	CO2
2.3	Linear Convolution using DFT, Direct computation of the DFT	1	CO2
2.4	Decimation-in Time and Decimation in frequency FFT algorithms.	2	CO2
3	**Discrete Time Filters**		
3.1	Filter specifications, LTI Systems as frequency selective filters	1	CO3
3.2	Design of FIR filters by Windowing	1	CO3
3.3	Design of Discrete-Time IIR Filters from Continuous-Time Filters	1	CO3
3.4	Filter Design by Impulse Invariance, Bilinear Transformation,	1	CO3
3.5	Design of Discrete-Time Butterworth Filter	1	CO3
3.6	Filter design based on Pole/zero: Linear Phase filter	2	CO4
3.7	Averaging filters, Comb Filters	2	CO4
3.8	Notch Filters, Resonators	1	CO4
4	**Structures for Discrete Time Systems**		
4.1	Basic Structures for IIR Systems: Direct Forms	1	CO5
4.2	Cascade Form, Parallel Form	1	CO5
4.3	Basic Network Structures for FIR Systems:	1	CO5
4.4	Direct Form, Structures for Linear-Phase FIR Systems	1	CO5
5	**Random Signal Processing**		
5.1	Random process: definition, stationary process, mean	1	CO6
5.2	correlation and covariance functions ergodic process	1	CO6

5.3	transmission of random process through LTI systems, power spectral density	1	CO6
5.4	Gaussian process, noise, narrow band noise	2	CO6
5.5	noise reduction and signal enhancement	1	CO6
5.6	Optimum Linear filters: Wiener filter and linear prediction.	2	CO6
6	**Multirate Signal Processing**		
6.1	Review of Sampling theorem, Decimation	1	CO7
6.2	Interpolation, Sampling rate conversion by a rational factor I/D	1	CO7
6.3	Quadrature Mirror Filter	1	CO7
6.4	Polyphase Filter Structures	1	CO7
	Total Hours	**36**	
Practical Sessions			
1	Time Domain response of LTI System (Convolution, Correlation)	2	CO1
2	Frequency response of LTI System (DTFT, z-Transform)	2	CO1
3	Fourier Analysis of Signals Using the Discrete Fourier Transform (DFT, FFT)	2	CO2
4	FIR Filter Design using windowing and frequency sampling methods	2	CO3
5	IIR Filter Design: Butterworth and Chebyshev filters	2	CO3
6	Filter design based on Pole-zero: Average Filter, Comb, Notch, Resonators	2	CO4
7	Random Signal Processing: Wiener filters, Linear Prediction	2	CO6
8	Random Signal Processing: Noise reduction and signal enhancement filter	2	CO6
9	Multirate Signal Processing: Decimation, Interpolation, Sampling rate conversion by I/D	2	CO7
10	Real Time Signal Processing Applications: Data acquisition using ADALM 1000	2	CO7
11	Real Time Signal Processing Applications: Filtering using DSP processor	4	CO7
	Total Hours	**24**	

Course Designers:

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2. Dr.M.N.Suresh mnsece@tce.edu
3. Dr.P.G.S.Velmurugan pgsvels@tce.edu

22EC460	DATA SCIENCE

Category	L	T	P	Credit
ESC	2	0	0	2

Preamble

Data science is an interdisciplinary field that draws on skills from mathematics, computer science, and statistics. This course will enable students to learn the fundamental concepts circumventing data science, and its applications.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Describe the taxonomy of Data	TPS 2	70	70
CO2	Explore the current practices in Data Analytics	TPS 2	70	70
CO3	Identify the key roles for the Data Ecosystem	TPS 2	70	70
CO4	Identify the Key roles for a successful analytics project	TPS 2	70	70
CO5	Apply the Data Analytics Life Cycle components to data science projects.	TPS 3	70	70
CO6	Apply data preparation and modelling techniques to data science related problem specifications.	TPS 3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	L	-	-	-	-	-	-	-	-	-	-	L	-	-
CO2	M	L	-	-	-	-	-	-	-	-	-	-	L	-	-
CO3	M	L	-	-	-	-	-	-	-	-	-	-	L	-	-
CO4	M	L	L	-	-	-	-	-	-	-		-	L		-
CO5	S	M	L	-	-	-	-	-	-	-	-	-	M	-	-
CO6	S	M	L	-	-	-	-	-	-	-	-	-	M	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Ass. I * (%)			CAT – II (%)			Ass. II * (%)					
TPS / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	5	20		100			-	-	-	-			4	5	-
CO2	10	25					-	-	-	-			4	5	-
CO3	15	25					-	-	-	-			4	5	-
CO4	-	-	-				10	10		100			4	5	-
CO5	-	-	-	-			5	10	20				2	5	20
CO6	-	-	-	-			5	10	30				2	5	30
Total	30	70	-	100			20	30	50	100			20	30	50

Syllabus

Taxonomy of Data: Basics of Data Structures **-** Overview of Big Data –Introduction to analytics - Data Repositories. **Data Analytics**- Overview - Analytics in a Data Science Project - Key roles for a successful analytics project. **Data Analytics Life Cycle (DALC) –** Overview- Different phases in a DALC**. Phase I Discovery**- Learning the Business Domain, Resources, Framing the Problem, identifying key stakeholders, Interviewing the Analytics Sponsor, Developing initial hypotheses, Identifying potential data Sources. **Phase II-Data Preparation**- Preparing the analytic Sandbox, Performing ETLT, Learning about the data, Data conditioning,

Survey and Visualize data using common tools for the Data Visualization Phase. **Phase III-Model Planning-** Data exploration and variable selection, Model selection, Common tools for the model planning phase. **Phase IV-Model Building**- Common tools for the model building phase, **Phase V-Communicate Results, Phase VI-Operationalize.**

Reference Books

- Data Science & Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data. Wiley., Dietrich, D., Heller, B., & Yang, B, Wiley, First Edition, 2015. (Chapters 1.0, 1.1, 1.2, 2.0, 2.1 - 2.7)
- Big Data: A Beginner's Guide to Using Data Science for Business, Eliot P. Reznor, CreateSpace Independent Publishing Platform, 2017.
- Data Analytics: A Practical Guide to Data Analytics for Business, Beginner to Expert, Fahl, J, CreateSpace Independent Publishing Platform, 2017.

Course Contents and Lecture Schedule

Module No.	Topic	Lecture Hours
1	**Taxonomy of Data**	
1.1	Basics of Data Structures	1
1.2	Overview of Big Data	1
1.3	Introduction to analytics	1
1.4	Data Repositories	1
2	**Data Analytics**	
2.1	Overview	1
2.2	Analytics in a Data Science Project	1
2.3	Key roles for a successful analytics project	1
3	**Data Analytics Life Cycle (DALC)**	
3.1	Overview	1
3.2	Different phases in a DALC	1
4	**Phase I Discovery**	1
4.1	Resources, Framing the Problem	1
4.2	Identifying key stakeholders	1
4.3	Interviewing the Analytics Sponsor	1
4.4	Developing initial hypotheses	1
4.5	Identifying potential data Sources	1
5	**Phase II-Data Preparation**	
5.1	Preparing the analytic Sandbox	1
5.2	Performing ETLT	1
5.3	Learning about the data, Data conditioning	1
5.4	Survey and Visualize data using common tools for the Data Visualization Phase.	1
6	**Phase III-Model Planning**	
6.1	Data exploration and variable selection	1
6.2	Model selection	1
6.3	Common tools for the model planning phase	1
7	**Phase IV-Model Building**	1
8	**Phase V-Communicate Results**	1
9	**Phase VI-Operationalize**	1
	Total	**25**

Course Designers:

Dr S T Padmapriya stpca@tce.edu

22CHAB0	CONSTITUTION OF INDIA

Category	L	T	P	Credit
AC	2	0	0	0

Preamble

On the successful completion of the course, the students will be able to explain the basic features and fundamental principles of Constitution of India. The Constitution of India is the supreme law of India. Parliament of India cannot make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. The Parliament of India has been empowered to amend the Constitution under Article 368, however, it cannot use this power to change the "basic structure" of the constitution, which has been ruled and explained by the Supreme Court of India in its historical judgments. The Constitution of India reflects the idea of "Constitutionalism" – a modern and progressive concept historically developed by the thinkers of "liberalism" – an ideology which has been recognized as one of the most popular political ideology and result of historical struggles against arbitrary use of sovereign power by state. The historic revolutions in France, England, America and particularly European Renaissance and Reformation movement have resulted into progressive legal reforms in the form of "constitutionalism" in many countries. The Constitution of India was made by borrowing models and principles from many countries including United Kingdom and America.

The Constitution of India is not only a legal document but it also reflects social, political and economic perspectives of the Indian Society. It reflects India's legacy of "diversity". It has been said that Indian constitution reflects ideals of its freedom movement; however, few critics have argued that it does not truly incorporate our own AICTE Model Curriculum for Mandatory Courses & Activities (Non-Credit) for Undergraduate Degree in Engineering & Technology ancient legal heritage and cultural values. No law can be "static" and therefore the Constitution of India has also been amended more than one hundred times. These amendments reflect political, social and economic developments since the year 1950. The Indian judiciary and particularly the Supreme Court of India has played an historic role as the guardian of people. It has been protecting not only basic ideals of the Constitution but also strengthened the same through progressive interpretations of the text of the Constitution. The judicial activism of the Supreme Court of India and its historic contributions has been recognized throughout the world and it gradually made it "as one of the strongest court in the world"

Course Outcome:

On the successful completion of the course students will be able to

CO1	Explain the meaning of the constitution law and constitutionalism and Historical perspective of the Constitution of India	Understand
CO2	Explain the salient features and characteristics of the Constitution of India, scheme of the fundamental rights and the scheme of the Fundamental Duties and its legal status	Understand
CO3	Explain the Directive Principles of State Policy, Federal structure and distribution of legislative and financial powers between the Union and the States, and Parliamentary Form of Government in India	Understand
CO4	Explain the amendment of the Constitutional Powers and Procedure, the historical perspectives of the constitutional amendments in India, and Emergency Provisions.	Understand
CO5	Explain the Local Self Government – Constitutional Scheme in India, Scheme of the Fundamental Right to Equality,	Understand
CO6	Explain the scheme of the Fundamental Right to certain Freedom under Article 19, and Scope of the Right to Life and Personal Liberty under Article 21	Understand

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	-	-	-	M	-	M	-	L	-	-
CO2	M	L	-	-	-	M	-	M	-	L	-	-
CO3	M	L	-	-	-	M	-	M	-	L	-	-
CO4	M	L	-	-	-	M	-	M	-	L	-	-
CO5	M	L	-	-	-	M	-	M	-	L	-	-
CO6	M	L	-	-	-	M	-	M	-	L	-	-

S- Strong; M-Medium; L-Low

Syllabus

1. Meaning of the constitution law and constitutionalism
2. Historical perspective of the Constitution of India
3. Salient features and characteristics of the Constitution of India
4. Scheme of the fundamental rights
5. The scheme of the Fundamental Duties and its legal status
6. The Directive Principles of State Policy – Its importance and implementation
7. Federal structure and distribution of legislative and financial powers between the Union and the States
8. Parliamentary Form of Government in India – The constitution powers and status of the President of India
9. Amendment of the Constitutional Powers and Procedure
10. The historical perspectives of the constitutional amendments in India
11. Emergency Provisions : National Emergency, President Rule, Financial Emergency
12. Local Self Government – Constitutional Scheme in India
13. Scheme of the Fundamental Right to Equality
14. Scheme of the Fundamental Right to certain Freedom under Article 19
15. Scope of the Right to Life and Personal Liberty under Article 21

Assessment Pattern

Bloom's category	Continuous Assessment Tests		Seminar
	1	2	-
Remember	40	40	0
Understand	60	60	100
Apply	0	0	0
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

References

1. Durga Das Basu, 'Introduction to The Constitution of India', LexisNexis Butterworths Wadhwa, 20th Edition, Reprint 2011.
2. Constitution of India, National Portal of India, Web link: https://www.india.gov.in/my-government/constitution-india

Course Designers:

1. Adapted from AICTE Model Curriculum for Undergraduate Degree Courses in Engineering & Technology, Volume-II, January 2018.

CURRICULUM AND DETAILED SYLLABI

FOR

B. E. DEGREE PROGRAMME
(Electronics and Communication Engineering)

FIFTH SEMESTER

FOR THE STUDENTS ADMITTED IN THE

ACADEMIC YEAR 2022-23

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided Autonomous Institution Affiliated to Anna University)
MADURAI – 625 015, TAMILNADU

Phone : 0452 – 2482240, 41
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22EC510	DATA COMMUNICATION NETWORKS

Category	L	T	P	Credit
ESC	3	0	0	3

Preamble

The goal of this course is to introduce the students to state-of-the-art network protocols and architectures. This course includes networking technologies such as Ethernet, Wireless local area network, and wireless personal area network, multiple access technologies, routing algorithms, subnetting of internetworking, and error/congestion/flow control techniques. This course also covers the QoS provisioning and network security.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Build a reliable data networks using LAN technologies such as ETHERNET, WLAN and WPAN	TPS 3	70	70
CO2	Apply the distributed and centralized routing protocols for the networks	TPS 3	70	70
CO3	Apply internetworking techniques to configure subnetting.	TPS 3	70	70
CO4	Analyze the concepts of reliable data transfer and congestion control of TCP and Application layer	TPS 4	70	65
CO5	Analyze the performance parameters such as delay, throughput of a network and QoS parameters.	TPS 4	70	65
CO6	Apply cryptographic algorithms and security mechanisms for secured networks.	TPS 3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	L	-	-	-	-	L	M	M	-	-	M	-	L
CO2	S	M	L	-	-	-	-	L	M	M	-	-	M	-	L
CO3	S	M	L	-	-	-	-	L	M	M	-	-	M	-	L
CO4	S	S	M	L	-	-	-	L	M	M	-	L	S	L	L
CO5	S	S	M	L	-	-	-	L	M	M	-	L	S	L	L
CO6	S	M	L	-	-	-	-	L	M	M	-	-	M	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I							Assessment - II							Terminal Exam(%)		
	CAT – I(%)			Assg. I *(%)				CAT – II(%)			Assg. II *(%)						
TPS / Scale / CO	1	2	3	1	2	3	4	1	2	3	1	2	3	4	1	2	3
CO1	-	10	20	100				-							-	4	10
CO2	-	10	20					-							-	4	15
CO3	-	10	30					-							-	4	15
CO4	-							-	10	20	100				-	-	15
CO5	-							-	10	30					-	4	15
CO6	-							-	10	20					-	4	10
Total	-	**30**	**70**	**100**				**-**	**30**	**70**	**100**				**-**	**20**	**80**

Syllabus

Fundamentals & Link Layer: Network requirements, OSI and Internet reference models, Packet and Circuit Switching, Data Link layer Services – Framing - Error Detection – Parity check, CRC, Reliable Flow control – Stop and wait ARQ and Sliding window ARQ. **Media Access & Inter Networking**: Media access control - CSMA/CD-802.3 Ethernet Physical Properties, Encoding - Wireless LANs – CSMA/CA-802.11, Spread Spectrum techniques and Distribution systems, WPAN – Bluetooth, Zigbee, Internetworking – Ipv4, Datagram Fragmentation, IPv6, sub-netting - Classfull, CIDR, other network layer protocols – ARP, ICMP, DHCP. **Routing**: Interior Routing protocols – RIP (Bellman-Ford), OSPF (Dijkstra's), routing metrics, Exterior routing protocols - BGP, Generalized forwarding and SDN-OpenFlow protocol. **Transport Layer &**: **Application Layer** Overview of Transport layer – UDP, Reliable byte stream (TCP) - Connection management - TCP State transition diagram, Congestion control techniques. Application layer protocols - SMTP, FTP, DNS and HTTP. **Network Performance**: Delay, Packet Loss and Throughput, Bandwidth and two-way Latency (RTT), High speed networks, Application performance needs. **Quality Of Service**: Application Requirements – Differentiated services and Integrated Services – Resource Reservation Protocol (RSVP), Expedited Forwarding- per Hop Behaviour (EF-PHB) **Network Security**: Security services and mechanisms, Cryptography Techniques– DES and RSA.

Text Book

- Larry L. Peterson, Bruce S. Davie, “Computer Networks: A Systems Approach”, Sixth Edition, Morgan Kaufmann Publishers, 2021.

Reference Books

- James F. Kurose, Keith W. Ross, “Computer Networking – A Top-Down Approach Featuring the Internet”, Fifth Edition, Pearson Education, 2009.
- Nader. F. Mir, “Computer and Communication Networks”, Prentice Hall Publishers, 2010.
- Web Page http://www.cse.iitd.ernet.in/~vinay/courses/CSL858.html
- NPTEL Video Lecture on “Computer Networks”, weblink: https://onlinecourses.nptel.ac.in/noc19_ee11/course

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
1	**Introduction to the Course, COs POs**	1
	Fundamentals & Link Layer	
2	Network requirements, OSI and Internet reference models	1
3	Packet and Circuit Switching	1
4	Data Link layer Services - Framing	1
5	Error Detection – Parity check, CRC	1
6	Reliable Flow controls - Stop and wait ARQ	1
7	Sliding window ARQ	1

	Media access & inter networking	
8	Media access control, CSMA/CD-802.3 Ethernet Physical Properties, Encoding	2
9	Wireless LANs - CSMA/CA-802.11, Spread Spectrum techniques and Distribution systems	2
10	WPAN – Bluetooth, Zigbee,	1
11	Internetworking – Ipv4, Datagram Fragmentation	1
12	IPv6, subnetting	1
13	Classfull, CIDR, other network layer protocols – ARP, ICMP, DHCP.	2
	Routing	
14	Interior Routing protocols – RIP (Bellman-Ford),	1
15	OSPF(Dijkstra's), routing metrics	1
16	Exterior routing protocols - BGP, Generalized forwarding	1
17	SDN- OpenFlow	1
	Transport Layer & Application Layer	
18	Overview of Transport layer	1
19	UDP, Reliable byte stream (TCP) - Connection management	1
20	TCP State transition diagram, Congestion control techniques	2
21	SMTP,FTP,DNS and HTTP	2
	Network Performance	
22	Throughput, Bandwidth and Latency	1
23	High speed networks, Application performance needs	2
	Quality of Service	
24	Application Requirements – Differentiated services and Integrated Services	1
25	Resource Reservation Protocol (RSVP), Expedited Forwarding- per Hop Behaviour (EF-PHB	2
	Network Security	
26	Security services and mechanisms	1
27	Cryptography Techniques– DES	2
28	RSA	1
	TOTAL	**36**

Course Designers:

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- Dr. E. Murugavalli murugavalli@tce.edu

22EC520	VLSI CIRCUITS AND SYSTEMS

Category	L	T	P	Credit
PCC	3	0	0	3

Preamble

The course aims at understanding the basic concepts of Digital CMOS VLSI circuit by studying logic design, physical structure and fabrication of MOS devices and how they are combined to build systems for efficient data processing.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Construct CMOS logic circuits and Layouts	TPS3	70	60
CO2	Understand VLSI design flow and fabrication of CMOS Integrated circuits	TPS2	70	60
CO3	Examine the electrical characteristics of CMOS logic circuits.	TPS3	70	60
CO4	Examine the electronic aspects of CMOS logic circuits.	TPS4	70	60
CO5	Combinational Circuit Design using Advanced CMOS logic design techniques	TPS3	70	60
CO6	Construct CMOS VLSI system components	TPS3	70	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	M	L	L	-	-	-	-	-	-	-	M	-	-
CO2	M	M	L	-	-	-	-	-	-	-	-	-	M	-	-
CO3	S	M	M	L	L	-	-	-	-	-	-	-	M	-	-
CO4	S	S	M	L	L	-	-	-	-	-	-	-	S	-	-
CO5	S	M	M	M	L	-	-	-	-	-	-	-	M	-	-
CO6	S	M	M	M	L	-	-	-	-	-	-	-	M	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II *(%)					
TPS Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	10	30	100			-						-	4	10
CO2	-	20					-						-	8	-
CO3	-	10	30				-						-	4	20
CO4	-						-	10	20	100			-	2	20
CO5	-						-	10	30				-	2	15
CO6	-						-	10	20				-	-	15
Total	-	**40**	**60**	**100**			**-**	**30**	**70**	**100**			**-**	**20**	**80**

Syllabus

CMOS Logic and Layout Design: CMOS Logic and Layout Design: MOSFETs as Switches, Logic Gates and their static CMOS implementation, Transmission Gate Circuits, FET sizing, Stick Diagram and Layout Design Rules.

Fabrication of CMOS Integrated Circuits: VLSI Design Flow, Integrated Circuit Fabrication Process: Oxidation, Diffusion, Ion Implantation, Photolithography and Twin-tub CMOS Process, Trends in CMOS Technology.

Electrical Characteristics of CMOS Logic: MOS Threshold Voltage Equation, nFET Current-Voltage Equations, The FET RC Model.

Electronics Analysis of CMOS Logic: Switching Characteristics, DC Characteristics of CMOS Inverter Logical Effort, Analysis of Complex Logic Gates, Power Dissipation, Interconnect Delay Model, Crosstalk and Interconnect Scaling.

Advanced CMOS Logic Circuits: Mirror Circuits, Pseudo- nMOS, Tri-state Circuits, locked CMOS, Dynamic CMOS and Dual Rail Logic Networks.

CMOS VLSI System Components: Multiplexors, Binary Decoders, Priority Encoders, Latches, D-Flip Flop, Registers, Full Adder, Binary Multiplier, SRAM, DRAM and Logic Arrays, Switch level Modelling (Verilog HDL)

Text Book

- Uyemura, John P," Introduction to VLSI Circuits and Systems". Wiley & Sons, 8th Reprint 2015.

Reference book & web resources

- N. Weste and David Harris," CMOS VLSI Design: A circuits and systems perspective" 4th Edition, Pearson, 2022.
- N. Weste and K. Eshraghian, "Principles of CMOS VLSI Design", Second Edition, Addison-Wesley, 1993.
- Jan M. Rabaey, "Digital Integrated Circuits: A Design Perspective", Prentice Hall, Second Edition, 2006.
- R. Jacob Baker, "CMOS: Circuit Design, Layout, and Simulation", Wiley-IEEE, Revised Second Edition, 2008.
- Wayne Wolf, "Modern VLSI Design: System on Chip", Pearson Education, 2002.
- MIT Open courseware: http://ocw.mit.edu/courses/electrical-engineering-andcomputer-science/6-374-analysis-and-design-of-digital-integrated-circuits/.
- By Prof. Sudeb Dasgupta, IIT Roorkee, CMOS Digital VLSI Design https://onlinecourses.nptel.ac.in/noc22_ee08/
- Dr.Nandita Dasgupta, VLSI Design, NPTEL Video Lectures: http://www.nptelvideos.in/2012/12/vlsi-design.html

Course Contents and Lecture Schedule

No.	Topic	Lecture Hours	COs
1	**CMOS Logic and Layout Design**		
1	Introduction	1	
1.1	MOSFETs as Switches	1	CO1
1.2	Logic Gates and their static CMOS implementation	1	CO1
1.3	Transmission Gate Circuits	2	CO1
1.4	FET sizing	1	CO1
1.5	Stick Diagram and Layout Design Rules	2	CO1
2	**Fabrication of CMOS Integrated Circuits:**		
2.1	VLSI Design Flow	1	CO2
2.2	Integrated Circuit Fabrication Process	0.5	CO2
2.3	Oxidation	0.5	CO2
2.4	Diffusion	0.5	CO2

2.5	Ion Implantation	0.5	CO2
2.6	Photolithography and Twin-tub CMOS Process	0.5	CO2
2.7	Trends in CMOS Technology	0.5	CO2
3	**Electrical Characteristics of CMOS Logic**.		
3.1	MOS Threshold Voltage Equation	2	CO3
3.2	nFET Current-Voltage Equations	2	CO3
3.3	The FET RC Model	2	CO3
4	**Electronic Analysis of CMOS Logic**		
4.1	Switching Characteristics	2	CO4
4.2	DC Characteristics of CMOS Inverter	1	CO4
4.3	Logical Effort	1	CO4
4.4	Analysis of Complex Logic Gates	1	CO4
4.5	Power Dissipation	1	CO4
4.6	Interconnect Delay Model	1	CO4
4.7	Crosstalk and Interconnect Scaling	1	CO4
5	**Advanced CMOS Logic Circuits**		
5.1	Mirror Circuits, Pseudo- nMOS,	2	CO5
5.2	Tri-state Circuits, locked CMOS	1	CO5
5.3	Dynamic CMOS	1	CO5
5.4	Dual Rail Logic Networks	1	CO5
6	**CMOS VLSI System Components:**		
6.1	Multiplexors, Binary Decoders, Priority Encoders,	1	CO6
6.2	Latches, D-Flip Flop, Registers	1	CO6
6.3	Full Adder, Binary Multiplier,	1	CO6
6.4	SRAM, DRAM and Logic Arrays,	1	CO6
6.5	Switch level Modelling (Verilog HDL)	1	CO6

Course Designers:

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22EC530	ANTENNAS AND WAVE PROPAGATION

Category	L	T	P	Credit	TE
PCC	2	0	2	3	Theory

Preamble

One of the main competencies that a present-day RF engineer has to acquire is the capability to design antennas for wireless applications such as cellular and navigational applications. The objective of this course is to provide an in-depth understanding of modern antenna concepts, and practical antenna design for various applications. The course also focuses practical approach to simulate, prototype antennas for a given wireless specification and measure various antenna parameters.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Understand the role of antenna in real world applications and study the antenna parameters.	TPS2	70	70
CO2	Understand the concepts of wire, loop, aperture antennas.	TPS2	70	70
CO3	Understand array concept and design antenna arrays for wireless applications	TPS3	70	70
CO4	Understand the radiation mechanism and design Horn, reflector, Helical antennas	TPS3	70	70
CO5	Design and develop Microstrip, Planar inverted F antenna and multiband antennas for cellular applications	TPS3	70	70
CO6	Measure the antenna parameters and Explain the process of radio wave propagation in the atmosphere	TPS2	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO2
CO1	M	L	L	-	-	-	-	-	M	-	-	M	L	-	M
CO2	M	M	L	-	-	-	-	-	M	-	-	M	L	-	M
CO3	S	M	M	L	S	M	M	L	M	M	M	M	M	M	M
CO4	S	M	M	L	S	M	M	L	M	M	M	M	M	M	M
CO5	S	M	M	L	S	L	L	L	M	M	M	M	M	M	M
CO6	M	L	L	-	-	L	L	L	M	-	-	M	L	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I			Assessment - II			Terminal Exam (%) (Theory)		
	CAT – I (%)			CAT – II (%)					
TPS / CO	1	2	3	1	2	3	1	2	3
CO1	-	20	-	-	-	-	-	15	-
CO2	-	20	20	-	-	-	-	15	-
CO3	-	20	20	-	-	-	-	15	-
CO4	-	-	-	-	20	20	-	-	20
CO5	-	-	-	-	20	20	-	-	20
CO6	-	-	-	-	20	-	-	15	-
Total	-	60	40	-	60	40	-	60	40

Syllabus

Theory:

Fundamental Concepts of Antenna: Antenna in real world applications-Cellular, Satellite, and RADAR. Radiation mechanism, Antenna parameters- Radiated power, radiation pattern, Beamwidth, Power intensity, Directivity, Gain, Effective aperture, Impedance bandwidth, VSWR polarization- Field regions. Friss transmission equation.

Radiation from Wires, Loops and aperture: Infinitesimal dipole-small dipole, finite length dipole, Half wavelength dipole, Wire antennas: Folded dipole, loop antenna, Aperture antennas, Huygens principle.

Antenna Arrays: Isotropic Broadside and End fire array, Pattern multiplication, N element array, Phased array, Cellular applications, Yagi-Uda, Log periodic array, FSS, IRS.

Horn, Reflector and Circularly polarized Antennas: Radiation from Horn, Reflector antennas, Principle of circular polarization, Helical, Spiral antennas.

Planar Antennas: Microstrip patch- Basic characteristics, design, feeding methods, MPA tuning for bandwidth and polarization, Planar Inverted F antenna -Principle, design, Multiband antennas for typical wireless applications.

Antenna Measurements and Wave propagation: Radiation pattern and Gain measurements, Radomes, Anechoic chamber, Mode of propagation in different environment (Ground wave, sky wave and tropospheric wave propagation, Characteristics and Parameters, Cellular link calculations.

Practical:

1. Design and testing of wire antennas (monopole, dipole and loop)- FM reception
2. EM Field strength measurement in college campus - WiFi, Cellular band.
3. Radiation pattern testing of Wire, printed Yagi-Uda antenna–VHF/UHF, ISM reception
4. Design and simulation Patch antenna and array - ISM, X band application
5. Design and simulation of PIFA for cellular application
6. Design and simulation antennas for GPS application
7. Antenna Gain measurement- X band Horn and S band printed antennas
8. Antenna measurements with Spectrum and Network analysers

Text Book

- C. A. Balanis, "Antenna Theory and Design", 4th Ed., John Wiley & Sons., 2016.
- F.E.Terman, “Electronic and Radio Engineering”, Mc Graw Hill, 1985.

Reference Books& web resources

- W. L. Stutzman, and G. A. Thiele, "Antenna Theory and Design", 2nd Ed., John Wiley & Sons., 1998.
- John D.Kraus, ”Antennas for all Applications”, Tata McGraw Hill ,2002

- NPTEL Course Antenna and wave propagation: https://nptel.ac.in/courses/ 108101092/
- WWW.amanogawa.con
- www, orbanmicrowave.com
- Course handouts prepared by RF Special interest Group, TCE

Course Contents and Lecture Schedule

Module No.	Topic	Lecture Hours
1	**Fundamental Concepts of Antenna**	
1.1	Antenna in real world applications-Cellular, Satellite, and RADAR.	1
1.2	Radiation mechanism ,Antenna parameters- Radiated power, radiation pattern, Beamwidth, Power intensity, Directivity, Gain	2
1.3	Effective aperture, Impedance bandwidth, VSWR polarization-Field regions. Friss transmission equation.	2
2	**Radiation from Wires, Loops and aperture:**	
2.1	Infinitesimal dipole-small dipole, finite length dipole, Half wavelength dipole	2
2.2	Wire antennas: Folded dipole, loop antenna, Aperture antennas, Huygens principle.	2
3	**Antenna Arrays:**	
3.1	Isotropic Broadside and End fire array, Pattern multiplication, N element array	2
3.2	Phased array, Cellular applications, Yagi-Uda, Log periodic array, FSS, IRS.	2
4	**Horn, Reflector and Circularly polarized Antennas:**	
4.1	Radiation from Horn, Reflector antennas	2
4.2	Principle of circular polarization, Helical, Spiral antennas.	2
5	**Planar Antennas:**	
5.1	Microstrip patch- Basic characteristics, design, feeding methods, MPA tuning for bandwidth and polarization	2
5.2	Planar Inverted F antenna -Principle, design, Multiband antennas for typical wireless applications.	2
6	**Antenna Measurements and Wave propagation**:	
6.1	Radiation pattern and Gain measurements, Radomes, Anechoic chamber	1
6.2	Mode of propagation in different environment (Ground wave, sky wave and tropospheric wave propagation, Characteristics and Parameters, Cellular link calculations.	2
Theory		**24**
Practical		**24**
Total		**48**

Course Designers:

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22EC540	SENSORS AND INSTRUMENTATION

Category	L	T	P	Credit
BSC	2	0	0	2

Preamble

This syllabus offers a concise yet comprehensive exploration of sensors and instrumentation, essential for understanding and utilizing measurement technologies. Students will delve into sensor principles, classification, and characteristics, including calibration standards. The diverse array of sensor types, interface circuits, and shielding techniques will be covered, preparing students to design and implement precise measurement systems. Through practical applications and theoretical understanding, students will gain the knowledge and skills to innovate in fields ranging from industrial automation to biomedical engineering.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Understand sensors and transducers, including classification, measurement units, calibration, and standards.	TPS 2	70	60
CO2	Identify and describe various sensor types, from position to specialized sensors for environmental and physiological signals.	TPS 2	70	60
CO3	Design interface circuits like amplifiers and converters to ensure accurate signal processing from sensors.	TPS 3	70	60
CO4	Apply techniques to reduce electromagnetic interference and ensure signal integrity in sensor applications.	TPS 3	70	60
CO5	Understand how to effectively use data acquisition systems and virtual instruments in practical situations to achieve specific objectives.	TPS 2	70	60
CO6	Apply the integration of sensors and electronic circuits to design accurate measurement systems suitable for various applications.	TPS 3	70	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	L	L	L	-	-	L	M	M	-	-	L	L	L
CO2	M	M	L	L	L	-	-	L	M	M	-	-	L	L	L
CO3	S	M	L	L	-	-	-	L	M	M	-	-	M	-	L
CO4	S	M	L	L	-	-	-	L	M	M	-	L	M	-	L
CO5	M	M	L	L	-	-	-	L	M	M	-	L	L	-	L
CO6	S	M	L	L	-	-	-	L	M	M	-	-	M	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II *(%)					
TPS Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	35	-	100			-						-	15	
CO2	-	35	-				-						-	15	
CO3	-	-	30				-						-		15
CO4	-						-	15	20	100			-	5	15
CO5	-						-	30					-	15	
CO6	-						-	15	20				-	5	15
Total	-	**70**	**30**	**100**			**-**	**60**	**40**	**100**			**-**	**55**	**45**

Syllabus

Sensor and Transducer: Introduction, Sensor Classification, Units of Measurements. Sensor Characteristics: Transfer Function, specifications. Transducer Classification and Characteristics. Calibration and Standards.

Sensor Types: Position, Displacement, Level, Velocity and Acceleration, Force, Strain, Tactile Sensors, Humidity and Moisture Sensors, Temperature Sensors, Pressure Sensors, and Sensors for EEG and ECG signals.

Interface Electronic Circuits: Input Characteristics, Amplifiers: Instrumentation Amplifier, Charge Amplifiers, Light-to-Voltage Converters, V/F Converters, and Capacitance-to-Voltage Converters. Bridge Circuits, Kelvin Four-Wire and Six-wire Sensing.

Electromagnetic Interference and Shielding: Inherent Noise, Mechanical Noise, See beck Noise, Electric Shielding, Magnetic Shielding, Bypass Capacitors, Ground Planes, Ground Loops, and Ground Isolation.

Instruments: Data Acquisition System, Virtual Instruments, Bio-Medical, and Smart Sensors.

Text Book

- Jacob Fraden, “Handbook of Modern Sensors Physics, Designs, and Applications” Fourth Edition, Springer, 2010, Reprint 2014.
- D. V. S. MURTY, “Transducers and Instrumentation”, Prentice Hall India Pvt., Limited, 2004, Reprint 2010.
- R.S. Khandpur, Handbook of Biomedical Instrumentation, 3rd Edition, Mc Graw Hill, 2014.

Reference Books

- Albert D. Helfrick and William D. Cooper “Modern Electronic Instrumentation and Measurement Techniques” Pearson, 2016.
- Measurement and Instrumentation Theory and Application, Reza Langari Alan S. Morris Elsevier 2017.
- A.K.Sawhney, “A Course in Electrical and Electronic Measurements and Instrumentation (Nineteenth Revised Edition 2011 Reprint 2014), Dhanpatrai & co.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Sensor and Transducer	
1	Introduction, Sensor Classification, Units of Measurements.	1
2	Sensor Characteristics: Transfer Function, specifications.	1
3	Transducer Classification and Characteristics. Calibration and Standards.	1
	Sensor Types	
4	Position, Displacement, Level, Velocity and Acceleration	2
5	Force, Strain, Tactile Sensors,	1
6	Humidity and Moisture Sensors,	1
7	Temperature Sensors, Pressure Sensors,	1
8	Sensors for EEG and ECG signals.	1
	Interface Electronic Circuits	
9	Input Characteristics, Amplifiers: Instrumentation Amplifier, Charge Amplifiers	1
10	Light-to-Voltage Converters, V/F Converters,	1
11	Capacitance-to-Voltage Converters.	1
12	Bridge Circuits, Kelvin Four-Wire and Six-wire Sensing.	2
	Electromagnetic Interference and Shielding	
13	Inherent Noise, Mechanical Noise, See beck Noise,	2
14	Electric Shielding, Magnetic Shielding,	2
15	Bypass Capacitors, Ground Planes, Ground Loops, and Ground Isolation.	2
	Instruments	
16	Data Acquisition System, Virtual Instruments,	2
17	Bio-Medical, and Smart Sensors.	2
	TOTAL	**24**

Course Designers:

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22EC550	ANALOG AND DIGITAL COMMUNICATION

Category	L	T	P	Credit
PCC	2	1	0	3

Preamble

The course "22EC550: Analog and Digital Communication Systems" is offered in the fifth semester and is the first course on communication systems. This course aims at designing Analog and Digital communication systems that are used for the transmission of information from source to destination. A detailed quantitative framework for analog and digital transmission techniques is addressed.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Examine the analog modulation methods in time and frequency domains to understand their characteristics and performance attributes.	TPS 3	70	70
CO2	Analyze the performance of analog modulation schemes in the presence of additive white Gaussian noise.	TPS 4	70	70
CO3	Describe the principle of pulse modulation techniques namely PAM, PPM PCM, DPCM and DM	TPS 3	70	70
CO4	Apply estimation and detection theory for the development of digital communication transmitters and receivers for various digital modulation schemes and analyze their BER performances	TPS 3	70	70
CO5	Apply synchronization techniques to mitigate issues such as timing offset and frequency offset.	TPS 3	70	70
CO6	Determine the minimum number of bits per symbol required to represent the source and the maximum rate at which reliable communication can take place over the channel	TPS 3	70	70
CO7	Detect and correct the errors introduced in the channel using error control coding schemes	TPS3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	L	-	-	-	-	L	L	L	-	L	M	L	L
CO2	S	S	M	L	-	-	-	L	L	L	-	L	S	L	L
CO3	S	M	L	-	-	-	-	L	L	L	-	L	M	L	L
CO4	S	M	L	-	-	-	-	L	L	L	-	L	M	L	L
CO5	S	M	L	-	-	-	-	L	L	L	-	L	M	L	L
CO6	S	M	L	-	-	-	-	L	L	L	-	L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II *(%)					
TPS Scale / CO	2	3	4	1	2	3	1	2	3	1	2	3	2	3	4
CO1	10	20		100			-	-	-	-			4	10	
CO2	10	10	20				-	-	-	-			4	-	15
CO3	10	20					-	-	-	-			2	10	
CO4	-	-		-			-	05	20	100			2	15	
CO5	-	-		-			-	05	20				2	10	
CO6	-	-		-			-	05	20				2	10	
CO7	-	-		-				05	20				4	10	
Total	**30**	**50**	**20**	**100**			**-**	**20**	**80**	**100**			**20**	**65**	**15**

Syllabus

Analog Communication Systems: Amplitude Modulation, Double Side Band Suppressed Carrier Modulation, Single side band Modulation, Vestigial Side band Modulation, Angle Modulation Systems: Narrow band and wideband FM, Generation and demodulation of FM waves, Phase Modulation systems, Noise Analysis on analog communication systems.

Analog to Digital Transition Systems: Pulse Amplitude Modulation, Pulse Position Modulation, Pulse Code Modulation, DPCM, Delta Modulation. **Digital Modulation:** Complex baseband representation, Spectral description of random processes: Pulse Shaping, Modulation degrees of freedom, Linear modulation, Orthogonal & biorthogonal modulation, Differential modulation. **Digital Demodulation:** Hypothesis testing, Signal space concepts, Optimal reception in AWGN, Performance analysis of ML reception. **Synchronization and non-coherent communication:** Receiver design requirements, Parameter estimation for synchronization, Non-coherent communication, Performance of non-coherent communication. **Information Theory:** Entropy, Mutual Information, Capacity of AWGN channel, Shannon theory basics, Capacity for standard constellations. **Channel Coding:** Binary convolutional codes, Turbo Codes, Low density parity check codes.

Text Book

- Simon Haykin, “Communication Systems”, Wiley Student Edition, 4 Edition - 2006
- Upamanyu Madhow, “Fundamentals of Digital Communication”, Cambridge University Press 2008, First Edition – 2008
- Bernard Sklar, “Digital Communications: Fundamentals and Applications”, Prentice Hall; 2nd edition – 2017.

Reference Books

- John G. Proakis, Masoud Salehi, “Communication System Engineering”, Prentice Hall, 2nd Edition, - 2002.
- Simon Haykin, “Digital Communications”, Wiley India, - 2017 4th Edition.
- https://nptel.ac.in/courses/117105144.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Analog Communication Systems:	
1	Amplitude Modulation, Double Side Band Suppressed Carrier Modulation,	1
2	Vestigial Side band Modulation, Single side band Modulation	1
3	Angle Modulation Systems: Narrow band and wideband FM,	2
4	Generation and demodulation of FM waves	1
5	Phase Modulation systems	1
6	Noise Analysis on analog communication systems	2
	Analog to Digital Transition Systems	

7	Pulse Amplitude Modulation, Pulse Position Modulation,	1
8	Pulse Code Modulation, DPCM	2
9	Delta Modulation	1
	Digital Modulation	
10	Complex baseband representation, Spectral description of random processes	1
11	Pulse Shaping, Modulation degrees of freedom	2
12	Linear modulation, Orthogonal & biorthogonal modulation	1
13	Differential modulation	1
	Digital Demodulation	
14	Hypothesis testing	1
15	Signal space concepts	1
16	Optimal reception in AWGN	2
17	Performance analysis of ML reception	1
	Synchronization and non-coherent communication	
18	Receiver design requirements	1
19	Parameter estimation for synchronization	1
20	Non-coherent communication	2
21	Performance of non-coherent communication	2
	Information Theory	
22	Entropy, Mutual Information	1
23	Capacity of AWGN channel	1
24	Shannon theory basics	1
25	Capacity for standard constellations	1
	Channel Coding	
26	Binary convolutional codes	1
27	Turbo Codes	1
28	Low density parity check codes	2
	TOTAL	**36**

Course Designers:

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22EC570	DATA COMMUNICATION NETWORKING LABORATORY

Category	L	T	P	Credit
ESC	0	0	2	1

Preamble

The goal of this course is to supplement the theory course '22EC510 Data Communication Networks' by giving hands on practice on structured network cabling, router configuration, socket programming and the implementation of communication protocols.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO	Course Outcome	TCE Proficien-cy Scale	Expected Proficien-cy in %	Expected Attainmen-t Level %
CO1	Use network utility commands to explore the communication network	TPS3	80	80
CO2	Demonstrate structured cabling concepts using Straight through, Cross over and Rollover cables	TPS3	80	80
CO3	Use the routing algorithms and configure routers using Packet Tracer/e-Sim CISCO simulator	TPS3	80	80
CO4	Analyze the network performance using packet sniffer tools – NETMON /Wireshark	TPS4	80	75
CO5	Apply Socket Programming to build/configure network applications	TPS3	80	80
CO6	Analyze the performance of MAC and routing protocols using network simulator	TPS4	80	75

Mapping with Programme Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO2
CO1	S	M	L	-	S	-	-	M	M	M	-	M	M	M	L
CO2	S	M	L	-	S	-	-	M	M	M	-	M	M	M	L
CO3	S	M	L	-	S	-	-	M	M	M	-	M	M	M	L
CO4	S	S	M	L	S	-	-	M	M	M	-	M	S	M	L
CO5	S	M	L	-	S	-	-	M	M	M	-	M	M	M	L
CO6	S	S	M	L	S	-	-	M	M	M	-	M	S	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Model Exam (%)			Terminal Exam (%)		
TPS / CO	**2**	**3**	**4**	**2**	**3**	**4**
CO1	-	10	-	-	10	-
CO2	-	10	-	-	10	-
CO3	-	10	-	-	10	-
CO4	-	10	20	-	10	20
CO5	-	10	-	-	10	-
CO6	-	10	20	-	10	20
Total	**-**	**60**	**40**	**-**	**60**	**40**

Experiment List

1. Explore the network utility commands such as IPCONFIG, NSLOOKUP, PING, TRACERT, NETSTAT, and ARP.
2. Implement Structured cabling concepts for TIA/EIA-358B standard to connect different network components using the following types:
    a. Straight through cable
    b. Cross over cable
    c. Roll over cable
3. Develop program to find the following:
    a. IP address and host name of local host
    b. IP address of the given host
    c. compare the given IP address and host name
4. Implement port scanning program
    a. Ito find the open ports of local host
    b. Scan the range of server ports at the client
5. Implement routing concepts
    a. to apply routing protocols such as RIP and OSPF using Packet Tracer
    b. to configure the CISCO routers using e-Sim Simulator for the given inter-connected subnets using IOS modes and commands
    c. to find routing table, trace path between devices and verify the connectivity
6. Use Protocol Analyzer/ Sniffing Tools - Wireshark/ NETMON to capturing network data traffic
    a. to explore HTTP and DNS services
    b. to explore TCP and UDP services
    c. to explore IP services
    d. to explore link layer services
7. Develop the following client-server models using Socket programming for TCP and UDP protocols
    a. Time Server
    b. Chat Server
    c. File Server
8. Analyze the network performance of the given network using network simulator package - NetSim
    a. to find the latency and throughput of MAC protocols
    b. to find the packet delivery ratio and throughput of routing protocols
9. Develop IoT based mini projects / prototype development for remote process control applications.

Text Book

- Larry L. Peterson, Bruce S. Davie, “Computer Networks: A Systems Approach”, Sixth Edition, Morgan Kaufmann Publishers, 2021.
- James F. Kurose, Keith W. Ross, “Computer Networking – A Top-Down Approach Featuring the Internet”, Fifth Edition, Pearson Education, 2009.
- Virtual Lab of IIT Kharagpur, Weblink: http://vlabs.iitkgp.ernet.in/ant/
- Lab Manual in LMS, Weblink https://murugavalli.gnomio.com/

Course Designers:

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22EC580	ANALOG AND DIGITAL COMMUNICATION LABORATORY

Category	L	T	P	Credit
PCC	0	0	2	1

Preamble

This course is offered in the fifth semester in concurrent with the theory course 22EC550 - Analog and Digital Communication Systems. The purpose of this course is to give hands on training to the students in understanding the theory of communications and practicing sessions used in analog and digital communication systems. Students can easily design, simulate, and analyze models of analog and digital communication systems using the open-source GNU Radio software.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Design and implement up and down conversion techniques using GNU Radio for analog communication systems namely AM, DSB-SC, SSB, and narrowband and wideband FM signals.	TPS4	80	75
CO2	Design and implement various modulation techniques including ASK, PSK, FSK, and QAM using GNU Radio, demonstrating proficiency in signal generation, modulation, and spectral analysis for digital communication systems.	TPS4	80	75
CO3	Apply pulse shaping techniques to shape a digital modulated waveform using GNU Radio, demonstrating proficiency in designing and implementing pulse shaping filters to control the spectral properties of the transmitted signal.	TPS3	80	75
CO4	Construct and visualize signal constellations digital modulation schemes using GNU Radio and Python	TPS3	80	75
CO5	Design and implement matched filters using GNU Radio to achieve optimal signal detection and symbol recovery in communication system.	TPS4	80	75
CO6	Develop and simulate end-to-end digital communication systems using GNU Radio, demonstrating proficiency in designing and integrating signal processing blocks such as modulation, coding, filtering, and demodulation to emulate real-world communication scenarios.	TPS4	80	75

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO2
CO1	S	S	M	L	S	-	-	M	M	M	-	M	S	M	L
CO2	S	S	M	L	S	-	-	M	M	M	-	M	S	M	L
CO3	S	M	L	-	S	-	-	M	M	M	-	M	M	M	L
CO4	S	M	L	-	S	-	-	M	M	M	-	M	M	M	L
CO5	S	S	M	L	S	-	-	M	M	M	-	M	S	M	L
CO6	S	S	M	L	S	-	-	M	M	M	-	M	S	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Model Exam (%)			Terminal Exam (%)		
TPS / CO	**2**	**3**	**4**	**2**	**3**	**4**
CO1	-	10	10	-	10	10
CO2	-	10	10	-	10	10
CO3	-	10	-	-	10	-
CO4	-	10	-	-	10	-
CO5	-	10	10	-	10	10
CO6	-	10	10	-	10	10
Total	**-**	**60**	**40**	**-**	**60**	**40**

Experiment List

1. Generation of complex baseband signal using GNU radio.
2. Up and down conversion for a pair of real baseband signal using GNU radio.
3. AM, DSB-SC and SSB modulation using GNU radio.
4. Narrowband and Wideband FM generation using GNU radio.
5. Linear modulation methods (ASK, PSK, FSK and QAM) in GNU radio.
6. ASK using Pulse Shaping filters.
7. Constructing and visualizing constellations using GNU radio using Python.
8. Matching filtering in GNU radio.
9. Bit error rates for various constellations using GNU radio.
10. End-to-end digital communication system simulation in GNU radio.

Text Book

- Alexander M. Wyglinski and Di Pu Digital Communication Systems Engineering with Software-defined Radio, Artech House Publishers, First edition, 2013.
- Travis F. Collins, Robin Getz, Di Pu, and Alexander M. Wyglinsk, Software-Defined Radio for Engineers, 2018, ISBN-13: 978-1-63081-457-1.
- Cory Clark, Software Defined Radio: with GNU Radio and USRP, McGraw-Hill Professional, First edition, 2009.

Course Designers:

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22CHAC0	ESSENCE OF INDIAN KNOWLEDGE

Category	L	T	P	Credit
AC	2	0	0	0

Preamble

On the successful completion of the course, the students will be able to explain the concept of Indian Traditional Knowledge along with Indian Modern Knowledge. Traditional Knowledge Systems or Indigenous Knowledge Systems are a body of knowledge, which is very ancient and deep rooted. They have their origins in the remote past. Their systematization and canonization gave rise to the elite (the Greater Tradition) science. The nature of Traditional Knowledge System is diverse. It covers, among other things, literary, artistic and scientific works; songs, dances, medical treatments and practices; manufacturing and industry; and agricultural technologies and techniques. There is a dramatically growing national and international interest in incorporating Traditional Knowledge Systems, including Traditional Ecological Knowledge, into truly participatory approaches to development.

Course Outcome:

On the successful completion of the course students will be able to

CO1	Explain the concept of Traditional Knowledge and Modern knowledge of India.	Understand
CO2	Explain the need and importance of protecting Traditional Knowledge, Knowledge sharing, and Intellectual property rights over Traditional Knowledge.	Understand
CO3	Explain about the use of Traditional Knowledge to meet the basic needs of human being.	Understand
CO4	Explain the rich biodiversity materials and knowledge preserved for practicing traditional lifestyle.	Understand
CO5	Explain the use of Traditional Knowledge in Manufacturing and Industry.	Understand
CO6	Explain about the cultural expression and modern applications of Traditional Knowledge	Understand

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	L	-	-	-	S	M	M	M	M	-	L	M	-	M
CO2	M	L	-	-	-	S	M	M	M	M	-	L	M	-	M
CO3	M	L	-	-	-	S	M	M	M	M	-	L	M	-	M
CO4	M	L	-	-	-	S	M	M	M	M	-	L	M	-	M
CO5	M	L	-	-	-	S	M	M	M	M	-	L	M	-	M
CO6	M	L	-	-	-	S	M	M	M	M	-	L	M	-	M

S- Strong; M-Medium; L-Low

Syllabus

Traditional and Modern Knowledge: Two Worlds of Knowledge - Phase of Explorers, Sir Arthur Cotton and Irrigation, Smallpox Vaccination, Late Nineteenth Century, Voelcker, Howard and Agriculture, Havell and Indian Art; Indians at the Encounter - Gaekwad of Baroda and Technical Education, Science Education and Modern Industries, Hakim Ajmal Khan and Ayurveda, R. N. Chopra and Indigenous Drugs, Gauhar Jaan and Indian Classical Music; Linking Science and the Rural - Tagore's Sriniketan Experiment, Marthandam, the YMCA Model, Gandhi's Thoughts on Development, Nehru's View of Growth; Post-Independence Era - Modernization and Traditional Knowledge, Social Roots of Traditional Knowledge Activism, Global Recognition for Traditional Knowledge. **Global Mechanisms of Protection and Sharing:** For Recognition and Protection - United Nations Educational, Scientific and Cultural Organization (UNESCO), World Health Organization (WHO), International Labour Organization (ILO), UN Working Group on Indigenous Populations, Evolution of Other Organizations; Norms of Sharing - United Nations Environment Programme (UNEP), World

Intellectual Property Organization (WIPO), World Trade Organization (WTO); IPR and Traditional Knowledge - Theoretical Background, Positive Protections of TK, Defensive Strategies, IPR Facilitation for TK. **Traditional Knowledge for Basic Needs:** Indian Midwifery Tradition—The Dai System, Surface Flow Irrigation Tanks, Housing - A Human Right, Changing Priorities—Niyamgiri. **Biodiversity and Genetic Resources:** Jeevani - The Wonder Herb of Kanis, A Holistic Approach - FRLHT, Basmati - In the New Millennium, AYUSH-Based Cosmetics. **Traditional Knowledge in Manufacturing and Industry:** Drug Discovery, A Sweetener of Bengal, The Sacred Ring of Payyanur, Channapatna Toys. **Traditional Cultural Expressions:** Banarasi Saree, Music, Built and Tangible Heritage, Modern Yoga, Sanskrit and Artificial Intelligence, Climate Change and Traditional Knowledge.

Assessment Pattern

Bloom's category	Continuous Assessment Tests		Seminar (Internal Exam)
	1	2	-
Remember	40	40	0
Understand	60	60	100
Apply	0	0	0
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

This course assessment is fully internal. There is no terminal examination.

Learning Resources:

1. Nirmal Sengupta "Traditional Knowledge in Modern India Preservation, Promotion, Ethical Access and Benefit Sharing Mechanisms" Springer, 2019.
2. Amit Jha," Traditional Knowledge System in India", Atlantic Publishers and Distributors Pvt Ltd, 2009.
3. Basanta Kumar Mohanta, Vipin Kumar Singh "Traditional Knowledge System and Technology in India", Pratibha Prakashan, 2012.
4. Kapil Kapoor, Michel Danino "Knowledge Traditions and Practices of India", Central Board of Secondary Education, 2012.
5. NPTEL video lecture on "Ayurvedic Inheritance of India", Video link: https://nptel.ac.in/courses/121/106/121106003/#.
6. Youtube video on "Introduction to Indian Knowledge Systems", Video link: https://www.youtube.com/watch?v=LZP1StpYEPM.
7. Youtube video on "12 Great achievements of Indian Civilization", Video link: https://www.youtube.com/watch?v=xmogKGCmclE.

Course Designers:

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CURRICULUM AND DETAILED SYLLABI

FOR

B. E. DEGREE PROGRAMME
(Electronics and Communication Engineering)

SIXTH SEMESTER

FOR THE STUDENTS ADMITTED IN THE

ACADEMIC YEAR 2022-23

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided Autonomous Institution Affiliated to Anna University)
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22EC610	ACCOUNTING AND FINANCE

Category	L	T	P	Credit
HSMC	4	0	0	4

Preamble

Engineering profession involves lots of decision making. The decisions may range from operation to non-operation. For taking decisions of these kinds, an engineer needs among other data about the organization routine operations and non-routine operations. Accounting is a science which provides all the data by recording, classifying, summarizing and interpreting the various transactions taking place in an organization and thereby helps an engineer in taking vital decisions in an effective manner. Integrating investment planning into the curriculum can empower students with the knowledge and skills they need to achieve financial independence and thrive in an ever-changing world.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO Number	Course Outcome Statement	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Prepare financial statements of accounting such as trial balance, trading and profit loss account.	TPS 3	70	60
CO2	Prepare cost sheet and depreciation values of fixed asset for business.	TPS 3	70	60
CO3	Estimate budgets for an organization based on function, time and flexibility.	TPS 3	70	60
CO4	Compute breakeven point and activity-based costing for business applications.	TPS 3	70	60
CO5	Compute working capital requirements and return on investment for long-term capital budget decisions.	TPS 3	70	60
CO6	Calculate the investment proportion for business and individual.	TPS 3	70	60

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	S	M	L	-	-	M	S	M	S	S	S	S	M	-	
CO2	S	M	L	-	-	-	M	M	S	S	S	M	M	-	
CO3	S	M	L	-	-	-	-	S	S	S	S	S	M	-	
CO4	S	M	L	-	M	M	L	S	S	S	S	M	M	-	
CO5	S	M	L	-	S	M	M	S	S	S	M	M	M	-	
CO6	S	M	L	-	-	M	M	S	S	M	M	S	M	-	

S- Strong; M-Medium; L-Low

Assessment Pattern:

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II * (%)					
TPS / Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	10	20	100			-						-	2	10
CO2	-	10	20				-						-	2	10
CO3	-		40				-						-	4	15
CO4	-						-	8	30	100			-	4	20
CO5	-						-	4	20				-	4	15
CO6	-						-	8	30				-	4	10
Total	-	**20**	**80**	**100**			**-**	**20**	**80**	**100**			**-**	**20**	**80**

Syllabus

Accounting- Introduction, definition, accounting principles-functions of accounting-Preparation of Financial statements and their analysis with the common size and comparative statements-Case studies.

Cost Accounting – Meaning and importance – Elements of cost – classification of cost – Cost Centre, Preparation of cost sheet and its applications. Depreciation – meaning and causes of depreciation, Methods to find out the depreciation-Case studies.

Budget and Budgetary control – Introduction – Meaning – objectives of budgetary control – Budget – Types of budgets and their preparation. **Marginal costing** – Introduction, Break even analysis – Managerial of breakeven analysis. Activity based costing-Case studies.

Capital Budgeting – Meaning and features, capital budgeting decisions, Methods of evaluating capital budgeting decisions by traditional and modern methods. Working capital management – concept, classification, estimation of working capital requirements-Case studies. **Investment Management:** Nature and Scope, Investment Avenues, Types of Financial Assets and Real Assets, Return and Risk- Systematic and Unsystematic Risk, Measurement of Risk, Measurement of Return, Capital Asset Pricing Model (CAPM).

Personal Investment: Investors life cycle, Personal Finance and Investment, Internal and International Diversification.

Text Books

1. M.C.Shukla,T.S.Grewal,—Advanced Accounts-Volume-I, 2010 Reprint, S. Chand & company Ltd.,2010.
2. Michael C. Ehrhardt and Eugene F. Brigham, —Financial Management: Theory and Practice -thirteenth edition‖ South-Western cengage learning, 2011
3. Preeti Singh, Investment Management, Himalay Publishing House, First Edition, 2016

Reference Books

1. P.S.Boopathi Manickam —Financial and Management Accounting‖ PSG publications 2009.
2. Prasanna Chandra, —Financial Management-Theory and practice‖ seventh Reprint,Tata McGraw-Hill publishing company Limited,2010.
3. Don R. Hansen and Maryanne M. Mowen —Cost Management: Accounting and Control, Fifth Edition‖ Thomson, 2006.
4. R.P.Rustagi, Investment Management-Theory and Practice, Sultan Chand & Sons, Eleventh Edition, 2021
5. https://nptel.ac.in/courses/110101003/

6. https://swayam.gov.in/nd1_noc19_mg38/preview Website: https://www.youtube.com/watch?v=P9JIBbZas3w

Course Contents and Lecture Schedule

Module No	Topic	No. of Lectures
1	**Accounting**	
1.1	Introduction, Definition, Functions of accounting	1
1.2	Accounting principles	1
1.3	Preparation of Financial statements	3
1.4	Common size statement analysis	1
1.5	Comparative statement analysis	1
1.6	Case studies	1
2	**Cost Accounting**	
2.1	Meaning, importance and Elements of cost	1
2.2	classification of cost and meaning of Cost centre,	1
2.3	Preparation of Cost sheet and its applications	3
2.4	Depreciation – meaning and causes of depreciation	1
2.5	Methods to find out the depreciation	2
2.6	Case studies	1
3	**Budget and Budgetary control**	
3.1	Introduction- Meaning -objectives of budgetary control –	2
3.2	Budget- Types of budgets and their preparation	4
3.3	Case studies	2
4	**Marginal costing**	
4.1	Introduction, Break even analysis	2
4.2	Managerial uses of breakeven analysis.	1
4.3	Activity Based Costing	2
4.4	Case studies	2
5	**Capital budgeting**	
5.1	Meaning and features, capital budgeting decisions	1
5.2	Methods of evaluating capital budgeting decisions by traditional and modern methods	4
5.3	Working capital management – concept, classification,	1
5.4	Estimation of working capital requirements.	1
5.5	Case studies	1
6	**Investment Management**	
6.1	Nature and Scope of Investment Management, Investment Avenues	1
6.2	Types of Financial Assets and Real Assets	1
6.3	Return and Risk- Systematic and Unsystematic Risk	2
6.4	Measurement of Risk, Measurement of Return, Capital Asset Pricing Model (CAPM)	2
7	**Personal Investment**	
7.1	Investors life cycle, Personal Finance and Investment	1
7.2	Internal and International Diversification	1
	Total	**48 hrs**

Course Designers:

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22EC620	IMAGE PROCESSING

Category	L	T	P	Credit	TE
PCC	2	0	2	3	Theory

Preamble

The purpose of this course is to provide the basic concepts and methodologies for Digital Image Processing in three different levels. At the lower level, the course introduces the terminology of image processing, image acquisition, digitization, formation, storage and the relationship between pixels. Further, it provides image enhancement by improving the contrast and noise removal in spatial domain and applications of transformations for enhancement and coding. In the middle-level, it addresses region-based segmentation, representation and description processes to extract meaningful information with geometrical operations. Morphological processing is introduced to clean up and cluster such regions for real world image processing applications.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO	Course Outcome	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Demonstrate the digital image acquisition, digitization, formation, storage, and the relationship between pixels.	TPS2	70	75
CO2	Enhance the visual perception of the digital imagery from contrast/brightness degradation and by removing noise in spatial domain.	TPS3	70	70
CO3	Apply image transformations such as Fourier and DCT for image enhancement and coding.	TPS3	70	70
CO4	Extract regions of interest from an image using region-based segmentation by region splitting, merging and watershed segmentation	TPS3	70	70
CO5	Represent the segmented boundary by chain code and shape numbers and describe it using shape number, Fourier, and Euler number with structural and geometric operations.	TPS3	70	70
CO6	Apply image processing algorithms to solve real-world image processing problems such as number plate detection, counting cars based on color, Cyst detection in MRI/CT, Non-destructive testing with IR, thermal images and Change detection.	TPS3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO2
CO1	M	L	-	-	M	-	-	L	L	L	-	-	L	-	L
CO2	S	S	M	L	M	M	-	L	M	M	-	L	M	S	L
CO3	S	S	M	L	M	L	L	L	M	M	-	L	M	S	L
CO4	S	S	M	L	M	L	-	L	M	M	-	L	M	M	L
CO5	S	S	M	L	M	M	L	L	M	M	-	L	M	S	L
CO6	S	S	M	L	S	M	M	L	M	M	-	L	S	S	M

Assessment Pattern

	Assessment - I			Assessment - II			Terminal Exam (%) (Theory)		
	CAT – I (%)			CAT – II (%)					
TPS / CO	1	2	3	1	2	3	1	2	3
CO1	-	20	-	-	-	-	-	10	-
CO2	-		40	-	-	-	-	-	20
CO3	-		40	-	-	-	-	-	15
CO4	-	-	-	-	10	20	-	-	15
CO5	-	-	-	-		30	-	-	20
CO6	-	-	-	-		40	-	-	20
Total	-	**20**	**80**	**-**	**10**	**90**	**-**	**10**	**90**

Syllabus

Theory:

Image acquisition and Fundamentals: Elements of Human Visual Perception-Image acquisition- Sensors-CCD, CMOS, Imaging modalities. Digital Image model**,** Image formats, Image Sampling and Quantization, Connectivity and Distance measures- Euclidean, city-block, chessboard, Color models and Color space conversion. **[5 hours**]

Image Enhancement: Point transformations, Image Negative, Contrast stretching, Log transformation- Gamma Correction, Histogram processing **[2 hours]**

Spatial Filtering- Noise models, Noise Removal, Smoothing- mean, median filters, Order statistics filter- Gray level thresholding- Binary image, Sharpening- sharpening**-** Point, line detection, Laplacian filter, unsharp masking, high-boost filter, and Sobel and Prewitt operators. **[4 hours]**

Spectral representation for enhancement and coding: Fourier, Discrete cosine Transform, Frequency domain filtering, JPEG compression. **[4 hours]**

Segmentation: Region based segmentation, Region growing, Region splitting and merging, Gray-scale Morphological operations. **[3 hours]**

Representation and Description: Boundary Representation, Chain codes, Signatures, Boundary descriptors, Regional Descriptors, Topological descriptors. **[2 hours]**

Real world Applications: Number plate detection, detecting cyst/tumour in MRI images, Non-destructive testing with Thermal images, Change detection between two satellite images. **[4 hours]**

Practical:

1. Image enhancement: Apply gray scale transformation to a poor contrast image.
2. Image enhancement: Apply spatial filters for different noisy images.
3. Image enhancement: Apply spatial filters to enhance the edges.
4. Perform DFT and DCT on images for noise removal and image compression.
5. Perform segmentation to obtain meaningful segments in images
6. Mini projects:

Text Book

- Rafael.C.Gonzalez, Richard.E. Woods and Steven L. Eddins, "Digital Image Processing using Matlab", 4th Edition, Gatesmark Publishing, 2018, ISBN 10: 1-292-22304-9.

Reference Books& web resources

- William K. Pratt, "Introduction to Digital Image Processing", CRC Press, 2013.
- Oge Marques, "Practical Image and Video Processing using MATLAB", Wiley-IEEE Press, 2011, ISBN: 978-0-470-04815-3.
- Al.Bovik, "The Essential Guide to Image Processing", Academic Press, 2009.
- Anil K.Jain, "Fundamentals of Digital Image Processing", Pearson Education 2003.
- NPTEL course Digital Image Processing: https://nptel.ac.in/courses/noc18_ee40/
- www.imageprocessingplace.com/
- http://www.mathworks.com/
- https://www.coursera.org/course/images

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures	CO
1	Image acquisition:		
1.1	Introduction to Image processing, it's need and applications – Elements of Human Visual Perception	2	1
1.2	Image acquisition- Sensors-CCD, CMOS, Imaging modalities: X-Ray, CT, MRI, Ultrasound	1	1
1.3	SAR	1	1
1.4	IR, Thermal		
1.5	Imaging Components of an Image processing system		
1.6	**Practical:** Functional Programming: Program that generates a test pattern image	2	1
2	Fundamentals: Digital Image model**,** Image formats	1	1
2.1	Image Sampling and Quantization		
2.2	Basic relationship between pixels, Connectivity- 4, 8 and m connectivity	1	1
2.3	Distance measures- Euclidean, city-block, chessboard		
	Color model-RGB, CMY, HSI, Color space conversion-RGB to HSV and YCbCr	1	1
2.4	**Practical:** HVS and color space: (RGB to HSV, YCbCr color space)	2	1
3.	**Image Enhancement:** Point transformations- gray level Transformations	1	2
3.1	Image Negative, Contrast stretching, Log transformation-Gamma correction	1	2
3.2	Histogram processing	1	2
3.3	**Practical:** Image enhancement: Point transformations: Image negative, log-transformation, contrast-stretching, histogram equalization	2	2
3.4	**Spatial Filtering**-Noise models – Salt and Pepper, Periodic	1	2
3.5	Mean-median filters-Order statistics filter		
3.6	**Practical**: **Image enhancement** - Spatial filtering – Edges-Laplacian filter, unsharp masking, high-boost filter, and Sobel and Roberts operators	1	2
3.7	Dithering**:** Gray-level thresholding- Binary image	1	2
3.8	**Practical: Dithering**: Threshold a gray-scale image to get binary, add noise to the original image and threshold, Compare and comment	2	2

3.9	**Edges-** Point, line detection, Laplacian filter, unsharp masking	1	2
3.10	High-boost filter, and Sobel and Roberts operators	1	2
4	**Spectral representation for enhancement and coding:**		
4.1	Fourier	2	3
4.2	Discrete cosine Transform	1	3
4.3	**Practical:** Spectral representation for enhancement and coding - DFT, DCT of simple images containing an edge or a box.	2	3
4.4	Spectrum-Frequency domain filtering –Periodic noise removal-	1	3
4.5	JPEG compression	2	3
4.6	**Practical:** Image enhancement: Filtering in the frequency domain: Perform LP of different size (spatial). Add periodic noise and remove using frequency filtering methods	2	3
5	**Segmentation:** Region based segmentation	1	4
5.1	Region growing– Region splitting and merging	1	4
5.2	Watershed Segmentation	1	4
5.3	**Practical: Segmentation:** Region growing, region splitting and merging, and watershed segmentation		
5.4	Gray-scale Morphological operations: Erosion, Dilation	1	4
5.5	Opening, closing, structuring element		
5.6	Geometric operations: Shrinking, Zooming and Rotation by Interpolations	2	4
5.7	**Practical: Morphological operations:** Erosion, Dilation, Opening, closing Selection of the structuring element, Increase the size of structuring element – Locating an object	2	4
6.	**Representation and Description:** Boundary representation	1	5
6.1	Chain codes–Signatures		
6.2	Boundary descriptors–Shape numbers-Fourier descriptors	1	5
6.3	Regional Descriptors-Topological descriptors-Euler number		
6.4	**Practical:** Geometric operations: Shrinking, Zooming and Rotation by Interpolations Comment on the quality of a thumbnail-size using different interpolation methods	2	4
7.	**Real world Applications:** Number plate detection	2	6
7.2	Detecting cyst/tumour in MRI sound images	1	6
7.3	Non-destructive testing with Thermal images	1	6
7.4	Change detection between two satellite images		
	Mini project:		6
	Theory	24	
	Practical	24	
	Total	48	

Course Designers:

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22EC630	OPTICAL AND WIRELESS COMMUNICATION

Category	L	T	P	Credit	TE
PCC	3	0	2	4	Theory

Preamble

The objective of the course on “Optical and Wireless Communications” is to present the techniques in the physical layer aspects of optical and wireless communications and determine the performance of wireless and optical systems in terms of capacity and probability of error.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Describe the working of optical fiber with different modes of signal propagation and optical transmitters.	TPS 2	70	60
CO2	Characterize the Optical and Wireless channels in terms of transmission parameters.	TPS 2	70	60
CO3	Determine the Receiver Performance analysis of Optical and Wireless communication systems.	TPS 3	70	60
CO4	Apply suitable Equalizers in Receiver structures for ISI free transmission in optical and wireless channels.	TPS 3	70	60
CO5	Determine the Capacity Performance of Optical and MIMO Wireless communication systems.	TPS 3	70	60
CO6	Describe multiplexing techniques in fibre optical communication system.	TPS 3	70	60

Mapping with Programme Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O2
CO1	M	L	-	-	-	-	-	-	-	-	-	-	L	-	L
CO2	M	L	L	-	-	-	-	-	-	-	-	-	L	-	L
CO3	S	M	L	-	-	-	-	-	-	-	-	-	M	-	L
CO4	S	M	L	-	-	-	-	-	-	-	-	-	M	-	L
CO5	S	M	L	-	-	-	-	-	-	-	-	-	M	-	L
CO6	S	M	L	-	-	-	-	-	-	-	-	-	M	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I			Assessment - II			Terminal Exam (%)		
	CAT – I (%)			CAT – II (%)			(Theory)		
TPS / CO	1	2	3	1	2	3	1	2	3
CO1	-	10	30	-			-	4	15
CO2	-	10	20	-			-	4	15
CO3	-	10	20	-			-	4	15
CO4	-			-	15	20	-	3	15
CO5	-			-	15	20	-	3	10
CO6					10	20		2	10
Total	-	**30**	**70**	**-**	**40**	**60**	**-**	**20**	**80**

Syllabus

Optical fiber Communication: Key elements of optical fiber system, System design consideration point –to –point links, **Optical Fibers:** Structures, optical fiber modes and configurations, Modal analysis, Step-index and graded index optical fibers, **Optical Transmitters:** Light Emitting Diode: structure, LED characteristics, Laser: rate equation, Laser characteristics.

Channel characteristics: Wireless link: Time and Frequency Coherence: Doppler Spread and Coherence Time, Delay Spread and Coherence Bandwidth, Power delay profile, Flat fading, frequency selective fading. **Optical fiber link**: Attenuation, Material absorption losses, Linear scattering losses, Nonlinear scattering losses, Fiber bend loss, Dispersion, Chromatic dispersion, Intermodal dispersion, polarization mode dispersion and Dispersion modified single mode fibers.

Receiver and BER analysis: Wireless link: Detection in a Rayleigh Fading Channel, Time Diversity: Repetition Coding, Spatial Diversity: Receive Diversity, Transmit Diversity: Space-Time Codes, MIMO, Frequency Diversity: Orthogonal Frequency Division Multiplexing**. Optical fiber link:** Fundamental receiver operation, PIN photo detector, characteristics; Avalanche photodiode, characteristics, Noise in Photo detector. Demodulation: Direct detection, coherent detection.

Channel Equalization: Wireless link: The channel model, Receiver front end, Eye diagrams, Maximum likelihood sequence estimation, Linear equalization, Decision feedback equalization**. Optical fiber link:** equalization, digital receiver performance, eye diagram**.**

Capacity analysis: Wireless link: Capacity in the presence of fading, Outage probability, MIMO channels, Receive Diversity, Transmit Diversity, Time and Frequency Diversity, Diversity multiplexing tradeoff. Multiplexing techniques in optical fiber link: optical time division multiplexing, subcarrier multiplexing, orthogonal frequency division multiplexing, Wavelength division multiplexing, Spatial division multiplexing.

Practical:

Experiment List:

- Find out the numerical aperture and v number estimation of the single mode fiber.
- Characterization of optical sources and detectors.
- Loss analysis in optical fiber link due to bending conditions.
- Analog and Digital fiber optic links
- WDM fiber optic link
- Simulation of Power Delay Profile in channel impulse response.
- Design and simulation of Equalizers.
- Simulation of BER performance of PSK in Rayleigh frequency flat, slow fading channels.
- Simulation of OFDM Systems
- Capacity analysis of wireless systems.

Text Book

- Gerd Keiser, “Optical fiber communications”, McGraw Hill Int., 5th edition, 2017.
- John Senior, “Optica fiber communication-principles and practices”, Prentice Hall of India, 3rd edition, 2013.
- Upamanyu Madhow, “Fundamentals of Digital Communication”, Cambridge University Press,2008.
- D. Tse and P. Viswanath,” Fundamentals of Wireless Communications”, Cambridge University Press, 2005.

Reference Books& web resources

- Rajiv Ramaswami, Kumar Sivarajan, Galen Sasaki, “Optical Networks: a practical perspective” Morgan kaufmann publishers, 3 rd edition, 2009.
- G.P. Agarwal, “Fiber optic communication system”, Wiley, 4th edition, 2010.
- J. Gower, “Optical communication system”, Prentice Hall of India, 2nd edition, 2001.
- Joseph C. Palais, “Fiber Optic Communication”, Pearson Education, 5th edition, 2011.
- NPTEL course on “Fiber Optic Communication Technology” by Prof. Deepa Venkatesh, Link: https://www.youtube.com/watch?v=ougKUUM3hJA
- NPTEL course on “Digital Communication using GNU radio” by Prof. Kumar Appaiah, Link: https://onlinecourses.nptel.ac.in/noc24_ee51/preview.
- Emil Björnson and Özlem Tugfe Demir, Introduction to Multiple Antenna Communications and Reconfigurable Surfaces, Now Publishers,2024
- A. J. Goldsmith, Wireless Communications, Cambridge University Press, 2005.
- A. Paulraj, R. Nabar and D Gore, —Introduction to Space-Time Wireless Communications, Cambridge University Press, 2003.

Course Contents and Lecture Schedule

Module No.	Topic	Lecture Hours
1	**Optical fiber Communication:**	
1.1	Key elements of optical fiber system, System design consideration point -to -point links	1
2	**Optical Fibers**	
2.1	Structures, optical fiber modes and configurations	1
2.2	Modal analysis, Step-index and graded index optical fibers	1
3	**Optical Transmitters**	
3.1	Light Emitting Diode: structure	1
3.2	LED characteristics, Laser: rate equation, Laser characteristics	1
4	**Channel characteristics:**	
4.1	**Wireless link:** Time and Frequency Coherence: Doppler Spread and Coherence Time,	1
4.2	Delay Spread and Coherence Bandwidth	1
4.3	Power delay profile	1
4.4	Flat fading, frequency selective fading	1
4.5	**Optical fiber link**: Attenuation, Material absorption losses,	1
4.6	Linear scattering losses, Nonlinear scattering losses	1
4.7	Fiber bend loss, Dispersion, Chromatic dispersion, Intermodal dispersion,	1
4.8	polarization mode dispersion and Dispersion modified single mode fibers	1
5	**Receiver and BER analysis:**	
5.1	**Optical fiber link:** Fundamental receiver operation, PIN photo detector, characteristics; Avalanche photodiode, characteristics,	2

5.2	Noise in Photo detector. Demodulation: Direct detection, coherent detection	2
5.3	**Wireless link:** Detection in a Rayleigh Fading Channel, Time Diversity: Repetition Coding, Spatial Diversity: Receive Diversity,	2
5.4	Transmit Diversity: Space-Time Codes, MIMO, Frequency Diversity: Orthogonal Frequency Division Multiplexing	2
6	**Channel Equalization:**	
	Wireless link: The channel model, Receiver front end, Eye diagrams, ,	2
6.1	Maximum likelihood sequence estimation, Linear equalization	2
6.2	Decision feedback equalization	2
6.3	**Optical fiber link:** equalization, digital receiver performance, eye diagram	1
7	**Capacity analysis: Wireless link**	
7.1	Capacity in the presence of fading, Outage probability	2
7.2	MIMO channels, Receive Diversity, Transmit Diversity	2
7.3	Time and Frequency Diversity, Diversity multiplexing tradeoff	1
7.4	Multiplexing techniques in optical fiber link: optical time division multiplexing	1
7.5	subcarrier multiplexing, orthogonal frequency division multiplexing	1
7.6	Wavelength division multiplexing, Spatial division multiplexing.	1
Theory		**36**
Practical		**24**
Total		**60**

Course Designers:

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DETAILED SYLLABI

FOR

ELECTIVE COURSES
(for the students admitted from the academic year 2022-23)

B. E. DEGREE PROGRAMME
(Electronics and Communication Engineering)

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided Autonomous Institution Affiliated to Anna University)
MADURAI – 625 015, TAMILNADU

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Passed in BoS meeting 18.11.2023 Approved in 66th Academic Council Meeting 16.12.2023

LIST OF ELECTIVE COURSES

Sl. No.	Course Code	Course Tile	Category
1.	22ECRA0	SIGNAL INTEGRITY FOR HIGH-SPEED SYSTEM DESIGN	PEES
2.	22ECPA0	ARTIFICIAL NEURAL NETWORKS FOR RF APPLICATIONS	PSE
3.	22ECPB0	MICRO STRUCTURES	PSE
4.	22ECPC0	ADVANCED ANTENNA TECHNOLOGY	PSE
5.	22ECPD0	COMPUTER VISION AND APPLICATIONS	PSE
6.	22ECRB0	MULTIMEDIA COMPRESSION TECHNIQUES	PEES
7.	22ECPE0	SATELLITE REMOTE SENSING	PSE
8.	22ECPF0	SATELLITE DATA ANALYSIS	PSE
9.	22ECRC0	ARRAY SIGNAL PROCESSING	PEES
10.	22ECRD0	STATISTICAL SIGNAL PROCESSING	PEES
11.	22ECPG0	SIGNAL PROCESSING WITH SMARTPHONE	PSE
12.	22ECPH0	SIGNAL PROCESSING AND MACHINE LEARNING FOR AUDIO AND SPEECH	PSE
13.	22ECPJ0	DIGITAL SYSTEM DESIGN USING FPGA	PSE
14.	22ECPK0	LOW POWER VLSI DESIGN	PSE
15.	22ECRE0	CAD FOR VLSI CIRCUITS	PEES
16.	22ECRF0	ASIC DESIGN	PEES
17.	22ECRG0	REAL TIME SYSTEMS	PEES
18.	22ECPL0	IOT SYSTEM AND APPLICATIONS	PSE
19.	22ECRH0	PARALLEL PROGRAMMING	PEES
20.	22ECPM0	ELECTRONIC MEASUREMENT AND INSTRUMENTS	PSE
21.	22ECPN0	FIBER OPTIC COMMUNICATION	PSE
22.	22ECPP0	5G WIRELESS NETWORKS	PSE
23.	22ECRJ0	AD-HOC NETWORKS AND APPLICATIONS	PEES
24.	22ECRK0	BLOCKCHAIN AND APPLICATIONS	PEES
25.	22ECPQ0	CRYPTOGRAPHY AND CYBERSECURITY	PSE

PSE - Programme Specific Elective

PEES - Programme Elective for Expanded Scope

22ECRA0	SIGNAL INTEGRITY FOR HIGH-SPEED SYSTEM DESIGN

Category	L	T	P	Credit
PEES	2	1	0	3

Preamble

Signal integrity refers to the quality of electrical signals as they travel through electronic systems, ensuring minimal distortion, noise, or loss, crucial for reliable communication and functionality in high-speed system design. The fundamentals of ideal transmission line structures, properties, parameters, reflection analysis at the source/load-end, performance metrics to ensure signal integrity is covered in module-1. The crosstalk, one of the major sources of noise coupling phenomenon in high density PCB systems and the different techniques to minimize the crosstalk noise is given in module-2. One of the signaling techniques that is commonly employed at higher data-rates, called Differential signaling, the source of common-mode noise generation and strategies to minimize the noise are covered in module-3. In module-4, the non-ideal return paths, the sources of switching noise generation and the methodologies to suppress the noise were presented. Finally, the high-speed measurement techniques to measure TDR, impedance, crosstalk noise and the usage of VNA for one-port and two-port measurements were discussed in module-5. A tutorial is given at the end of each module to gain insight in to the theoretical concepts.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Design and analyze transmission lines, ensuring efficient signal propagation and minimal signal degradation	TPS 3	70	60
CO2	Apply techniques to suppress crosstalk issues in electronic circuits, ensuring reliable device operation and signal integrity	TPS 3	70	60
CO3	Design and implement effective techniques to minimize common-mode noise and ensure robust data transmission	TPS 3	70	60
CO4	Apply practical strategies to mitigate switching noise and PDN noise impact on signal integrity and circuit performance	TPS 3	70	60
CO5	Use advanced tools and methods for accurate analysis and troubleshooting of high-speed electronic systems	TPS 3	70	60
CO6	Analyze the coupled noise in multiconductor transmission lines through PCB prototype fabrication and measurements using VNA	TPS 3	70	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	L	-	L	-	-	L	L	L	-	-	M	L	L
CO2	S	M	L	-	L	-	-	L	M	M	-	-	M	L	L
CO3	S	M	L	-	L	-	-	L	M	M	-	-	M	L	L

CO4	S	M	L	-	L	-	-	L	M	M	-	-	M	L	L
CO5	S	M	L	-	L	-	-	L	M	M	-	-	M	L	L
CO6	S	M	L	-	L	-	-	L	M	M	-	-	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						**Assessment - II**						**Terminal Exam** (%)		
	CAT – I (%)			**Assg. I *** (%)			**CAT – II** (%)			**Assg. II *** (%)					
TPS / Scale / CO	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1	-	10	20	100			-						-	-	10
CO2	-	10	20				-						-	4	10
CO3	-	10	30				-						-	4	15
CO4	-						-	10	20	100			-	4	15
CO5	-						-	10	30				-	4	15
CO6							-	10	20					4	15
Total	-	**30**	**70**	**100**			**-**	**30**	**70**	**100**			**-**	**20**	**80**

Syllabus

Introduction: Ideal Transmission Line Fundamentals, Transmission Line Structures, Transmission-Line Properties, Transmission Line Parameters, RLGC extraction, Transmission Line Reflections, Time-Domain Reflectometry (TDR), Eye-diagram, Jitter. ***Tutorial - 1:*** Transient simulation of interconnects and analyze response using TDR, EYE, Jitter, and RLGC extraction. **Crosstalk:** Mutual Inductance and Capacitance, Coupled Wave Equations, Coupled Line Analysis, Near-end crosstalk, Far-end crosstalk, Crosstalk Minimization: 3W rule, Dielectric overlay, Guard Trace – open-ended, terminated and vias stitched, Serpentine trace. ***Tutorial - 2:*** Coupled line simulation with guard trace – open-ended, short, termination and analyze NEXT, FEXT. **Differential Signaling:** Removal of Common-Mode Noise, Differential Crosstalk, Virtual Reference Plane, Propagation of Modal Voltages, Drawbacks of Differential Signaling - Mode Conversion, Fiber-Weave Effect. Common-mode suppression – Common-mode filters. ***Tutorial - 3:*** DGS based common mode filter design and analyze response using Differential and common-mode insertion loss, EYE and Jitter. **Channel Effects:** Nonideal Return Paths, Vias, Physics based Via modeling, Simultaneous Switching Noise, Power Delivery Network. Switching noise suppression: Split powerplane, Decoupling capacitors, High-impedance powerplane. High Speed Digital Interface - USB, PCIE, DDR, SDIO, eMMC. ***Tutorial - 4:*** Parallel plate resonance and suppression using high-impedance power plane. **High-Speed Measurement Techniques:** Time-Domain Reflectometry, Impedance Measurement, Crosstalk Noise, Propagation Velocity, Vector Network Analyzer, S-Parameters, One-Port Measurements (Z_O,L,C), Two-Port Measurements (Td, Attenuation, Crosstalk). ***Tutorial – 5:*** Coupled line fabrication and analyze NEXT, FEXT in frequency domain using VNA.

Text Book

- Stephen H. Hall, Howard L. Heck, "Advanced Signal Integrity for High-Speed Digital Designs", John Wiley & Sons, 2009.
- Stephen H. Hall, Garrett W. Hall, James A. McCall, "High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices", Wiley-IEEE Press, 2000.

Reference Books

- Peter J. Pupalaikis, "S-Parameters for Signal Integrity", Cambridge University Press, 2020.
- Eric Bogatin, "Signal and Power Integrity – Simplified", Pearson, Third Edition, 2018.
- Fabien Ndagijimana, "Signal Integrity: From High-Speed to Radiofrequency Applications", Wiley-ISTE, 2014.
- Stephen C. Thierauf, "Understanding Signal Integrity", Artech House, 2010.
- Huray, Paul G., "The Foundations of Signal Integrity", John Wiley & Sons, 2009.
- Howard W. Johnson, Martin Graham, "High-speed Digital Design: A Handbook of Black

Magic", Prentice Hall, 1993.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Introduction: (7)	
1	Ideal Transmission Line Fundamentals, Transmission Line Structures,	2
2	Transmission-Line Properties, Transmission Line Parameters, RLGC extraction,	2
3	Transmission Line Reflections, Time-Domain Reflectometry (TDR), Eye-diagram, Jitter.	2
4	***Tutorial - 1:*** Transient simulation of interconnects and analyze response using TDR, EYE, Jitter, and RLGC extraction.	1
	Crosstalk: (7)	
5	Mutual Inductance and Capacitance, Coupled Wave Equations, Coupled Line Analysis,	2
6	Near-end crosstalk, Far-end crosstalk, Crosstalk Minimization: 3W rule, Dielectric overlay,	2
7	Guard Trace – open-ended, terminated and vias stitched, Serpentine trace.	2
8	***Tutorial - 2:*** Coupled line simulation with guard trace – open-ended, short, termination and analyze NEXT, FEXT.	1
	Differential Signaling: (7)	
9	Removal of Common-Mode Noise, Differential Crosstalk, Virtual Reference Plane,	2
10	Propagation of Modal Voltages, Drawbacks of Differential Signaling - Mode Conversion,	2
11	Fiber-Weave Effect. Common-mode suppression – Common-mode filters.	2
12	***Tutorial - 3:*** DGS based common mode filter design and analyze response using Differential and common-mode insertion loss, EYE and Jitter	1
	Channel Effects: (7)	
13	Nonideal Return Paths, Vias, Physics based Via modeling, Simultaneous Switching Noise,	2
14	Power Delivery Network. Switching noise suppression: Split powerplane, Decoupling capacitors, High-impedance powerplane.	2
15	High Speed Digital Interface - USB, PCIE, DDR, SDIO, eMMC.	2
16	***Tutorial - 4:*** Parallel plate resonance and suppression using high-impedance power plane.	1
	High-Speed Measurement Techniques: (8)	
17	Time-Domain Reflectometry, Impedance Measurement, Crosstalk Noise,	2
18	Propagation Velocity, Vector Network Analyzer, S-Parameters,	2
19	One-Port Measurements (Z_O,L,C), Two-Port Measurements (Td, Attenuation, Crosstalk).	1
20	***Tutorial – 5:*** Coupled line fabrication and analyze NEXT, FEXT in frequency domain using VNA.	3
	TOTAL	**36**

Course Designers:

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- Dr.S.Kanthamani, skmece@tce.edu

22ECPA0	ARTIFICIAL NEURAL NETWORKS FOR RF APPLICATIONS

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

This course provides an in-depth exploration using Artificial Neural Network techniques for the design and modelling of RF and microwave components. It covers fundamental concepts of neural networks, data pre-processing, model evaluation and techniques. It also provides an insight to the implementation of neural network models for RF circuit design and optimization.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Understand the design and optimization process of RF and Microwave Components	TPS2	70	70
CO2	Discuss the basic concepts of neural networks	TPS3	70	70
CO3	Explore the different neural network training techniques	TPS3	70	70
CO4	Discuss the procedure for modeling RF and Microwave Components using neural networks	TPS3	70	70
CO5	Discuss the process for optimization of various RF Components	TPS3	70	70
CO6	Apply ANN technique in the design of RF and microwave circuits	TPS3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L	L	-	-	-	-	-	-	-	-	L	L	-	-
CO2	S	M	L	-	-	-	-	-	-	-	-	L	M	-	-
CO3	S	M	L	-	M	-	-	-	-	-	-	L	M	-	-
CO4	S	M	L	-	M	-	-	-	-	-	-	L	M	-	-
CO5	S	M	L	-	M	-	-	-	-	-	-	L	M	-	-
CO6	S	M	L	-	M	-	-	-	-	-	-	L	M	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam(%)		
	CAT – I(%)			Assg. I *(%)			CAT – II(%)			Assg. II *(%)					
TPS Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	20	-				-	-	-				-	10	-
CO2	-	20	-		100		-	-	-				-	10	-
CO3	-	20	40				-	-	-				-	10	-
CO4	-	-	-				-	20	10				-	10	10
CO5	-	-	-				-	10	20		100		-	-	20
CO6	-	-	-				-	10	30				-	-	30
Total	-	**60**	**40**		**100**		**-**	**40**	**60**		**100**		**-**	**40**	**60**

Syllabus

Introduction – RF and Microwave Design, Anatomy of Design Process, Conventional design procedures, CAD Approach and Optimization of RF circuits.

Introduction to Artificial Neural Networks: Highlights of neural network modelling approach –Multilayer perceptron (MLP) - Back Propagation – Radial Basis function networks (RBF), Clustering algorithms, Recurrent neural networks

Training of neural networks: Microwave neural modelling- Key issues in neural modelling- Neural network training- Back propagation algorithm and its variants- Training algorithms using Gradient Descent Techniques- Genetic algorithms- Comparison of different training Techniques**-** feed forward neural network training

Models for RF and Microwave Components – Modelling procedure, Selection of Model Input and Output parameters, Training Data Generation, Error Measures, Integration of EM-ML Models with circuit and network simulators, Passive component modelling using Neural Networks-Models for vias and multilayer interconnects-CPW transmission line, Bends, opens, short, spiral inductors, Patch antenna, high speed interconnects, active component modelling: Direct and Indirect Modelling Approach – Transistor DC model-Small and Large Signal Models

Design, Analysis and Optimization: Optimization of component structure- Circuit optimization using ANN models- Multilayer circuit design and optimization using ANNs-yield optimization of amplifiers, ANN models linked to design software, efficient use of EM simulators, Trends and challenges

Case Studies - Design and Optimization-Antenna, RF MEMS and Nano structures, FSS

Text Book

- K. C. Gupta, Q. J. Zhang. “Neural Networks for RF and Microwave Design”ArtechHouse, 2000.

Reference Books& web resources

- Zlatica Marinkovicet et al., “Artificial Neural Network based Design of RF MEMS Capacitive Shunt Switches”, The Applied Computational Electromagnetics Society Journal,31(7):756-764,2021.
- Percy, J.J., Kanthamani, S., Sethuraman, S. et al. Artificial Neural Network Approach to Model Sidewall Metallization of Silicon-based Bistable Lateral RF MEMS Switch for Redundancy Applications. Silicon 14, 9175–9185 (2022). https://doi.org/10.1007/s12633-022-02070-2
- El Misilmani, HM, Naous, T, Al Khatib, SK. A review on the design and optimization of antennas using machine learning algorithms and techniques. *Int J RF MicrowComput Aided Eng*. 30:e22356, 2020.
- https://nptel.ac.in/courses/106105152/- Introduction to machine learning by Prof. Sudeshna Sarkar, IIT Kharagpur

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Introduction to the Course, COs POs	1
1	**Introduction** – RF and Microwave Design **(2)**	
2	Anatomy of Design Process and Conventional design procedures	1
3	CAD Approach and Optimization of RF circuits	1
	Introduction to Artificial Neural Networks: **(5)**	
4	Highlights of neural network modelling approach	1
5	Multilayer perceptron (MLP)	1
6	Back Propagation	1
7	Radial Basis function networks (RBF)	1
8	Clustering algorithms, Recurrent neural networks	1
	Training of neural networks (6)	
9	Microwave neural modelling- Key issues in neural modelling	1
10	Neural network training- Back propagation algorithm and its variants	1
11	Training algorithms using Gradient Descent Techniques	1
12	Genetic algorithms, Comparison of different training Techniques	2
13	Feed forward neural network training	1
	Models for RF and Microwave Components (10)	
14	Modelling procedure, Selection of Model Input and Output parameters, Training Data Generation, Error Measures	1
15	Integration of EM-ML Models with circuit and network simulators, Passive component modelling using Neural Networks-Models for vias and multilayer interconnects-CPW transmission line, Bends, opens, short, spiral inductors, Patch antenna, high speed interconnects	3
16	Active component modelling: Direct and Indirect Modelling Approach – Transistor DC model-Small and Large Signal Models Design	2
17	Analysis and Optimization: Optimization of component structure	1
18	Circuit optimization using ANN models- Multilayer circuit design and optimization using ANNs	1
19	Yield optimization of amplifiers, ANN models linked to design software, efficient use of EM simulators, Trends and challenges	2
	Case Studies - Design and Optimization (12)	
20	Antenna	4
21	RF MEMS and Nano structures	4
22	FSS	4
	TOTAL	**36**

Course Designers:

- Dr.S.Kanthamani skmece@tce.edu

22ECPB0	MICRO STRUCTURES

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

Miniaturization of RF Transceiver have been identified as one of the most promising technologies for the 21st Century and has the potential to revolutionize both industrial and consumer products by combining silicon-based microelectronics with micromachining technology. This course starts with the glimpses of transmitter-receiver architecture and need for miniaturization followed by introduction and origin of MEMS, driving force for MEMS development, commercial applications, fabrication process and packaging techniques. The latter half of the course will be devoted to provide a thumb rule in designing, modeling various RF MEMS components such as switches, capacitors, phase shifters, and antennas. They are also exposed to the MEMS CAD tools available in the Design center. Special weight is given to design circuits and do simulation with Comsol, Intellisuite and Coventorware. By taking this course, students can make good preparations for their research in relevant areas

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Understanding of transmitter-receiver architecture, including its blocks, functionalities and the advantages of miniaturization and scaling	TPS2	70	70
CO2	Discuss the basic concepts of actuation mechanisms, packaging and micro-fabrication techniques to RF applications	TPS3	70	70
CO3	Design RF MEMS Switch Networks	TPS3	70	70
CO4	Design RF MEMS capacitors and inductors	TPS3	70	70
CO5	Design RF MEMS phase shifters for phased array antennas	TPS3	70	70
CO6	Apply the concept of micromachining to various micro structures	TPS3	70	70
CO7	Acquire skills in computer-aided design tools for modeling and simulating RF MEMS devices	TPS3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L	-	-	-	-	-	-	-	-	-	-	L	-	-
CO2	S	M	L	-	-	-	-	-	-	-	-	-	M	-	-
CO3	S	M	L	-	L	-	-	L	-	L	-	L	M	-	-
CO4	S	M	L	-	L	-	-	L	-	L	-	L	M	-	-
CO5	S	M	L	-	L	-	-	L	-	-	-	L	M	-	-
CO6	S	M	L	-	L	-	-	L	-	-	-	L	M	-	-
CO7	S	M	L	-	L	-	-	L	-	-	-	L	M	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I(%)			Assg. I *(%)			CAT – II(%)			Assg. II *(%)					
TPS / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	10	-				-	-	-				-	10	-
CO2	-	20	-		100		-	-	-				-	20	-
CO3	-	5	30				-	-	-				-	-	15
CO4	-	5	30				-	-	-				-	-	15
CO5	-	-	-				-	20	30		100		-	-	15
CO6	-	-	-				-	5	20				-	-	10
CO7	-	-	-					10	15				-	5	10
Total	-	**40**	**60**		**100**		**-**	**35**	**65**		**100**		**-**	**35**	**65**

Syllabus

Introduction: Transmitter Receiver Architecture– Blocks and Functionalities, Benefits of Miniaturization and Scaling

Overview of MEMS: Driving force for MEMS development, Applications in wireless communication, space and defence, RF MEMS in industry and academia, Commercial packages.

Actuation Mechanisms in MEMS: Electrostatic, Thermal and Magnetic

Micro fabrication Techniques: MEMS Materials, Material Properties, Bulk micromachining, surface micromachining, Wet etching and dry etching, Thin-film depositions (LPCVD, Sputtering, Evaporation), other techniques (LIGA, Electroplating).Conventional IC fabrication processes.

Packaging of RF MEMS: Role of MEMS packaging, Types of MEMS Packages, Reliability issues of MEMS packaging.

RF MEMS Components: Case study 1: RF MEMS in Switching Networks: Series switches, Capacitive shunt switches, Electromagnetic modeling and Current research. Examples of switches for various applications

Case Study 2: Tunable Capacitors and Inductors: Effect of inductor layout, reduction of stray capacitance of planar inductor, Approaches for improving quality factor, Polymer-based inductors, MEMS gap tuning, area tuning and dielectric tuning capacitors.

Case Study 3: RF MEMS in Phased Arrays: Types of phase shifters and their limitations, Switched delay line phase shifters, Distributed phase shifters, Micromachined antennas, Micromachining techniques to improve antenna performance, Reconfigurable antennas.

Case Study 4: Fabrication flow of cantilever and bridge type structures.

Computer-aided design of MEMS: Usage of Intellisuite, Coventorware**,** and Comsol CAD tools.

Text Book

- Jacopo Iannacci. “RF-MEMS Technology for High-Performance Passives (2nd Edition): 5G applications and prospects for 6G”, IOP Publishing Ltd 2022

Reference Books & web resources

- Vijay K Varadhan, K.J.Vinoy, “RF MEMS and their Applications”, John Wiley & Sons,1998
- G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Aatre. “Micro and Smart Systems”,Wiley India Pvt. Limited, 2010
- K.J.Vinoy,K.N.Bhat, V.K.Aatre “Micro and Smart Systems”, John Wiley & Sons,2010.
- http://care.iitd.ac.in/People/Faculty/bspanwar/teaching.html
- http://nptel.ac.in/courses/’MEMS and Microsystems’
- http://www.mecheng.iisc.ernet.in/~suresh/memscourse/pcontent.html

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Introduction to the Course, COs POs	1
1	**Introduction:** transmitter receiver architecture **(2)**	
2	Blocks and Functionalities	1
3	Benefits of Miniaturization and Scaling	1
	Overview of MEMS (2)	
4	Driving force for MEMS development, Application in wireless communications, space and defence applications	1
5	RF MEMS in industry and academia, Introduction to Commercial packages	1
	Actuation Mechanisms in MEMS (2)	
6	Electrostatic Thermal and Magnetic	2
	Micro Fabrication Techniques (3)	
7	MEMS Materials, Material Properties	1
8	Bulk and surface micromachining	0.5
9	Wet and dry etching	0.5
10	Thin-film depositions (LPCVD, Sputtering, Evaporation), other techniques (LIGA, Electroplating), Conventional IC fabrication Processes	1
	Packaging of RF MEMS (1)	
11	Role of MEMS packaging ,Types of MEMS Packages	0.5
12	Reliability issues of MEMS packaging.	0.5
	RF MEMS Components: Case study 1: RF MEMS Switch (3)	
13	RF MEMS in Switching network : Series , Capacitive shunt switches	1
14	Electromagnetic modelling	1
15	Current research, Examples of switches for various applications	1
	Case Study 2:Tunable Capacitors And Inductors (2)	
16	Example of tunable capacitors and inductors and their applications in circuits, Effect of inductor layout	0.5
17	Reduction of stray capacitance of planar inductor	0.5
18	Approaches for improving quality factor	0.5
19	MEMS gap tuning, Area tuning and dielectric tuning capacitors	0.5
	Case Study 3: RF MEMS In Phased Array (6)	
20	Types of phase shifters and their limitations	1
21	MEMS phase shifters: Switched delay line phase shifters, Distributed phase shifters	2
22	Micromachined antennas, Microstrip antennas	1
23	Micromachining techniques to improve antenna performance	1
24	Reconfigurable antennas	1
25	**Case study 4: Fabrication flow of cantilever and bridge type structures**	2
	Computer aided design of MEMS (12)	
26	Overview of Commercial packages	2
27	Usage of Intellisuite, Coventorware and Comsol CAD tools	9
28	Future trends in MEMS device design	1
	TOTAL	**36**

Course Designers:

- Dr.S.Kanthamani skmece@tce.edu

22ECPC0	ADVANCED ANTENNA TECHNOLOGY

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

Advanced antenna technology revolutionizes telecommunications, offering transformative improvements in wireless communication. Innovations like smart antennas and Massive MIMO enhance signal strength, reduce interference, and boost coverage. These technologies, coupled with advanced materials, result in compact, high-performance antennas resilient to environmental factors. As the demand for faster and more reliable communication grows, advanced antenna technology plays a crucial role in shaping the future of connectivity. This course presents various types of antenna geometry suitable for the above-mentioned wireless applications, the issues in respect of their design and development.

Prerequisite

NIL

Course Outcomes

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	To understand the principle of various antenna technology suitable for advanced wireless communication	TPS3	70	60
CO2	To design miniaturized antennas such as metamaterials and EBG based structures and techniques for enabling advanced control of electromagnetic properties	TPS3	70	60
CO3	To design and develop antennas for navigation system covering GPS, GNSS and IRNSS	TPS3	70	60
CO4	To design and analyse antenna arrays and algorithms for smart antenna system	TPS3	70	60
CO5	To design and analyze antennas for 5G and future wireless communication systems.	TPS3	70	60
CO6	To study and investigate various applications of millimeter wave antennas and Radar for applications	TPS3	70	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	L	-	L	-	-	L	M	M	-	-	L	L	L
CO2	S	M	L	-	L	-	-	L	M	M	-	-	L	L	L
CO3	S	M	L	-	L	-	-	L	M	M	-	-	L	L	L
CO4	S	M	L	-	L	-	-	L	M	M	-	-	L	L	L
CO5	S	M	L	-	L	-	-	L	M	M	-	-	L	L	L
CO6	S	M	L	-	-	-	-	L	M	M	-	-	L	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II *(%)					
TPS Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	10	20	100			-						-	4	10
CO2	-	10	30				-						-	4	10
CO3	-	10	20				-						-	4	15
CO4	-						-	10	20	100			-	-	15
CO5	-						-	10	30				-	4	15
CO6	-						-	10	20				-	4	15
Total	-	30	70	100			-	30	70	100			-	20	80

Syllabus

Introduction: Review of antenna arrays and planar antenna design. Trends in recent wireless applications and antenna technology such as Smart antenna, Miniaturized antennas, Navigation system, Millimeterwave Radars, 5G and beyond, Design requirements and specifications [6 hours]

Miniaturized antennas - Metamaterial, EBG structures: Concept of Metamaterials, Classification, Principle of EBG structure and Compact EBG designs, Antenna Miniaturization, Multi-band applications. [6 hours]

Antennas for Navigation system: Circularly polarized antennas for GPS, Single-and dual feed Microstrip, Spiral and Helix antennas for GNSS, Low profile antenans for IRNSS application [6 hours]

Smart Antenna: Antenna arrays, Types of arrays, Buttler matrices, Active and passive arrays. Beamforming, Concept of angle of arrival estimation, Fixed weight beamforming and adaptive beamforming. [6 hours]

Antenna for 5G & Beyond: 5G Massive MIMO Systems, Microstrip antennas for future 5G mobile handsets, Substrate Integrated waveguide antennas, Reconfigurable and metasurface antenna [6 hours]

Millimeter wave antennas for Automotive Radar: Millimeter wave technology, characteristics and applications, Transceiver architecture, frequency allocation and FMCW technique, mm wave Radar integrated sensor antenna, and Radome. Radar Equation and Link Budget. [6 hours]

Reference Books & web resources

- Amit K. Singh, Mahesh P. Abegaonkar, Shiban Kishen Koul, "Metamaterials for Antenna Applications", CRC Press, 2021.
- Fan Yang, Yahya Rahmat Samii, “Electromagnetic Band Gap Structures in Antenna Engineering”, Cambridge University Press, 2009.
- Xiaodong Chen, Clive G. Parini, Brian Collins, Yuan Yao, Masood Ur Rehman, "Antennas for Global Navigation Satellite Systems", John Wiley & Sons Ltd., 2012.
- Frank Gross, “Smart antennas for wireless communications”, McGraw-Hill, 2006.
- S. Chandran, “Adaptive antenna arrays, trends and applications”, Springer, 2009.
- Xiang, W.Zheng, K. Shen, X.S, “5G Mobile Communications”, Springer, 2016.
- Ericsson Handbook on “ Massive MIMO” 2023, Edition 2
- Robert W. Heath, Robert C. Daniel, James N. T.S. Rappaport, Murdock, “Millimeter Wave Wireless Communications”, PH, 2014.
- Wonbin Hong, Chow-Yen Desmond Sim, "Microwave and Millimeter-wave Antenna Design for 5G Smartphone Applications", Wiley-IEEE Press, 2022.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Introduction (6)	1
1	Review of antenna arrays and planar antenna design.	2
2	Trends in recent wireless applications and antenna technology	2
5	Design requirements and specifications	1
	Miniaturized antennas - Metamaterial, EBG structures (6)	
6	Concept of Metamaterials, Classification,	2
7	Principle of EBG structure and Compact EBG designs,	2
8	Antenna Miniaturization,	1
9	Multi-band applications.	1
	Antennas for Navigation system (6)	
11	Circularly polarized antennas for GPS,	2
12	Single-and dual feed Microstrip	1
13	Spiral and Helix antennas for GNSS	2
14	Low profile antenans for IRNSS application	1
	Smart Antenna (6)	
16	Antenna arrays, Types of arrays,	1
17	Buttler matrices, Active and passive arrays	1
18	Beamforming, Concept of angle of arrival estimation	2
	Fixed weight beamforming and adaptive beamforming	2
	Antenna for 5G & Beyond (6)	
19	5G Massive MIMO Systems	2
20	Microstrip antennas for future 5G mobile handsets,	2
21	Substrate Integrated waveguide antennas,	1
	Reconfigurable and metasurface antenna	1
	Millimeter wave antennas for Automotive Radar (6)	
22	Millimeter wave technology, characteristics and applications,	2
23	Transceiver architecture, frequency allocation and FMCW technique	1
24	mm wave Radar integrated sensor antenna, and Radome.	2
	Radar Equation and Link Budget.	1
	TOTAL	**36**

Course Designers:

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22ECPD0	COMPUTER VISION AND APPLICATIONS

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

This course focuses on how computers treat vision to understand the human visual world. It deals with the construction of explicit meaningful descriptions of physical objects or other observable phenomena from images and how they are visualized by a computer and its applications. It focuses theoretical and algorithmic basis by which valuable information about the world can be automatically extracted and visualized from a single image or a set of images. Since images are two-dimensional projections of the three-dimensional world, knowledge about the objects in the scene and projection are required for the low-level vision process. In mid-level, it describes how the feature points such as interest points corner points are detected, matched and the alignment of matched feature points. The higher-level vision encompasses object recognition and categorization, which includes various classifiers. Recent developments in deep learning have revolutionized the field of computer vision, bringing new innovations closer to deployment that benefit end users. The course will cover traditional computer vision topics before introducing deep learning methods. In this course, students will learn both basic concepts as well as the latest advances in these fields, so the students can apply these methods in real-world applications after learning the basics.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Understand the concepts of image formation, camera parameters, 3D-2D transformations, and perspective projection to solve computer vision problems.	TPS 2	70	60
CO2	Extract meaningful information from images, including the identification of key interest points, gradients, corners, and textures for computer vision applications.	TPS 3	70	60
CO3	Demonstrate supervised and unsupervised classifiers and the architecture of a multilayer perceptron by employing the backpropagation algorithm to train the neural network.	TPS 3	70	60
CO4	Illustrate the concept of convolution, pooling, activation functions, batch normalization, data augmentation and hyperparameters tuning to train CNN architectures for specific computer vision tasks.	TPS 3	70	60
CO5	Illustrate the concept of transfer learning, and pre-trained models such as AlexNet, VGGNet, and ResNet to train and develop network models for specific computer vision tasks.	TPS 3	70	60
CO6	Develop deep learning algorithms for image stitching, object detection using single-stage and two-stage detectors, MRI reconstruction and anomaly detection.	TPS 3	70	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L	-	-	-	-	-	-	L	-	-	M	L	L	L
CO2	S	M	L	-	M	-	-	-	M	-	-	M	M	M	M
CO3	S	M	L	-	M	-	-	-	M	-	-	M	M	M	M
CO4	S	M	L	-	L	-	-	-	M	L	-	M	M	L	L
CO5	S	M	L	-	M	-	-	-	M	-	-	M	M	L	M
CO6	S	M	L	-	M	M	-	M	M	M	-	M	M	L	M

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II *(%)					
TPS Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	30	0	100			-						-	10	
CO2	-	5	30				-						-		15
CO3	-	5	30				-						-	10	15
CO4	-						-	10	20	100			-	-	15
CO5	-						-	5	30				-	-	15
CO6	-						-	5	30				-	-	20
Total	-	**40**	**60**	**100**			-	**20**	**80**	**100**			-	**20**	**80**

Syllabus

Low Level Vision: Introduction to computer vision and its applications – Image formation – camera intrinsic and extrinsic parameters – 3D-2D Transformations – Euler Angle – Rotation matrices – Translation – Perspective Projection [4 hours]

Middle Level Vision: Feature detectors and descriptors – Interest points, Harris corner detection – Scale Invariant Feature Transform (SIFT), Histogram of Oriented Gradients (HOG) – Local Binary Pattern (LBP) – Feature matching algorithms – RANSAC Euclidean distance metric – Performance measures – Error rates [8 hours]

High Level Vision: Classifiers**:** Supervised, K-nearest neighbour, SVM, Unsupervised – Deep learning – Multilayer perceptron – Back propagation – Higher-level representations, image features – Convolution and pooling– CNN Architecture-Batch Normalization –Transfer Learning – Alexnet – VGGnet – Resnet [8 hours]

Training Neural Networks: Activation functions – Data processing – Weight Initialization – Hyperparameter tuning – Data augmentation. [6 hours]

Computer vision applications: Image stitching using feature alignment – Object detection – Two stage detectors – RCNN – Faster RCNN - Single stage detector YOLO— Semantic Segmentation – Deep Generative model – GAN – MRI reconstruction – Anomaly Detection [10 hours]

Text Book

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

Reference Books

- R Szeliski, “Computer vision: algorithms and applications”, Springer Science & Business Media, 2010.
- David A. Forsyth, Jean Ponce, “Computer Vision – A Modern Approach”, Prentice Hall, 2003, ISBN: 0130851981.
- Richard Hartley and Andrew Zisserman, “Multiple View Geometry in Computer Vision”, Second Edition, Cambridge University Press, March 2004.
- Al Bovik, “Handbook of Image & Video Processing”, Academic Press, 2000, ISBN: 0121197905.

- Prince, S.J.D, “Computer Vision: Models, Learning, and Inference”, Cambridge University Press, 2012.
- Ragav VenRagav Venkatesan and Baoxin Li, “Convolutional Neural Networks in
  - Visual Computing A Concise Guide”, CRC Press, Taylor and Francis Group, LCCN
  - 2017029154| ISBN 9781498770392 (hardback : alk. paper), 2017.
- http://www.ius.cs.cmu.edu/demos/facedemo.html
- https://nptel.ac.in/courses/106105216/Course on Computer Vision by Jayanta Mukhopadhyay.
- https://nptel.ac.in/courses/106106224/Course on Deep learning for Computer Vision by Vineet N Balasubramanian
- https://www.coursera.org/courses?query=computer%20vision.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
1.	Introduction to the Course and course outcomes **Computer Vision and Applications**	1
2.	**Image formation:** camera intrinsic and extrinsic parameters	1
3.	3D-2D Transformations	1
4.	Euler Angle, Rotation matrices	1
5.	Translation	1
6.	Perspective Projection, Pinhole cameras	1
7.	**Middle Level Vision:** Feature detectors and descriptors	1
8.	Interest points, Harris corner detection	1
9.	Scale Invariant Feature Transform (SIFT)	1
10.	Histogram of Oriented Gradients (HOG)	1
11.	Local Binary Pattern (LBP)	1
12.	Feature matching algorithms, RANSAC Euclidean distance metric	1
13.	Performance measures, Error rates	1
14.	**High Level Vision:** Classifiers**:** Supervised, K-nearest neighbour	1
15.	SVM	1
16.	Unsupervised, Deep learning: Multilayer perceptron, Back propagation	2
17.	Higher-level representations, image features, Convolution and pooling, CNN Architecture, Batch Normalization	2
18.	Transfer Learning	1
19.	Alexnet–	2
20.	VGGnet–Resnet	2
21.	**Training Neural Networks:** Activation functions	1
22.	Data processing – Weight Initialization –Hyperparameter tuning	2
23.	Data augmentation	1
24.	**Computer vision applications:** Image stitching using feature alignment	1
25.	Object detection: Two stage detectors: RCNN, Faster RCNN	2
26.	Single stage detector: YOLO, Semantic Segmentation,	2
27.	Deep Generative model, GAN – MRI Reconstruction	2
28.	Anomaly Detection	1
	TOTAL	**36**

Course Designers:

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22ECRB0	MULTIMEDIA COMPRESSION TECHNIQUES

Category	L	T	P	Credit
PEES	3	0	0	3

Preamble

This course aims at understanding characteristics of various multimedia data and apply a suitable coding/compression technique to efficiently represent the data.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Characterize Multimedia data and its Compression with performance measures	TPS3	70	60
CO2	Determine the performance of lossless compression techniques such as variable-length coding, Arithmetic and Dictionary-based coding	TPS3	70	60
CO3	Determine the performance of lossy compression techniques such as scalar and vector quantization and transform coding	TPS3	70	60
CO4	Illustrate the performance of Image compression standards such as JPEG 2000 and JBIG	TPS3	70	60
CO5	Illustrate the performance of video compression schemes such as H.261 and MPEG	TPS3	70	60
CO6	Illustrate the performance of Audio compression techniques such as G.726, Vocoder, MPEG Audio , Surround sound and Silence Compression	TPS3	70	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	L	-	-	-	-	-	-	-	-	-	M	-	-
CO2	S	M	L	-	-	-	-	-	-	-	-	-	M	-	-
CO3	S	M	L	-	-	-	-	-	-	-	-	-	M	-	-
CO4	S	M	L	-	-	-	-	-	-	-	-	-	M	-	-
CO5	S	M	L	-	-	-	-	-	-	-	-	-	M	-	-
CO6	S	M	L	-	-	-	-	-	-	-	-	-	M	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II *(%)					
TPS / Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	10	10	100			-			100			-	6	-
CO2	-	10	30				-						-	4	16
CO3	-	10	30				-						-	4	16
CO4	-						-	5	20				-	2	16
CO5	-						-	5	30				-	2	16
CO6	-						-	10	30				-	2	16
Total	-	**30**	**70**	**100**			**-**	**20**	**80**	**100**			**-**	**20**	**80**

Syllabus

Multimedia Data Representation: Special features of Multimedia – Graphics and Image Data Representations –Fundamental Concepts in Video and Digital Audio – Storage requirements for multimedia applications -Need for Compression. (4 hours)

Multimedia Data Compression: Lossless Compression Techniques: Run length coding- Variable Length Coding: Huffman Coding- Non binary Huffman coding- Extended Huffman- Adaptive Huffman, Arithmetic Coding, Dictionary Based Coding- LZ7 Algorithms (6 hours)

Lossy Compression Techniques: Distortion Measures-The Rate-Distortion Theory- Quantization- Scalar and Vector Quantization, Differential Encoding- Transform Coding- Discrete Cosine Transform, Karhunen–Loève Transform, Wavelet Based Coding- Sub band coding - Embedded Zero tree of Wavelet Coding (EZW) -Set Partitioning in Hierarchical Trees (SPIHT) coders; (8 Hours)

Image Compression Standards: JPEG 2000, JBIG, HEIF (High Efficiency Image File Format); (5 hours)

Video Compression Standards: Video Compression Based on Motion Compensation- MPEG-4, H.264, H.265 (HEVC (High Efficiency Video Coding)), MP4-Container, MOV. (6 Hours)

Audio Compression Standards: Speech compression techniques – LPC and CELP- Application to speech coding – G.722 - Application to audio coding – MPEG audio (MP3)- **AAC**–M4A Surround sound - Dolby Digital- Silence Compression. (7 Hours)

Text Books

1. Li, Ze-Nian, Mark S. Drew, and Jiangchuan Liu, “Fundamentals of multimedia” Springer, 2021.
2. Khalid Sayood, “Introduction to Data Compression” Fifth Edition, Morgan Kauffmann Publishers, Inc, Newnes, 2020.

Reference Books

1. David Salomon, “Data Compression: The Complete Reference”, Fourth Edition Springer Science & Business Media, 2007.
2. David Salomon, “A Guide to Data Compression Methods”, Fourth Edition Springer Science & Business Media, 2013.
3. Mark Nelson, Jean Louf Goilly, “The Data Compression Book”, BPB Publications, 1995.
4. Yun-Qing Shi, Huifang Sun, “Image and Video Compression for Multimedia Engineering - Fundamentals, Algorithms, and Standards, Second Edition”, CRC Press, 2017.
5. https://archive.nptel.ac.in/course.html: Multimedia processing, Prof. Somnath Sengupta, IIT Kharagpur
6. https://nptel.ac.in/courses/117101053: Information Theory and Coding, IIT Bombay, Prof. S.N. Merchant

Course Contents and Lecture Schedule

Module No.	Topic	Lecture Hour
1.	**Multimedia- Data Representation**	
1.1	What is Multimedia- Special features of Multimedia	1
1.2	Graphics and Image Data Representations –Fundamental Concepts in Video and Digital Audio	1
1.3	Storage requirements for multimedia applications	1
1.4	Need for Compression, Measures of Performance	1
2.	**Multimedia Data Compression**	
2.1	**Lossless Compression Techniques**	
2.1.1	Lossless Compression overview - Coding Redundancy-Run length Coding	1
2.1.2	Variable Length Coding: Huffman Coding and its variations- Baseline, Non-Binary, Extended	1
2.1.3	Adaptive Huffman	2
2.1.4	Arithmetic coding	1
2.1.5	Dictionary Based Coding –Diagrams, LZ77, LZ78, LZW	1
2.2	**Lossy Compression Techniques**	
2.2.1	Distortion Measures, Rate Distortion Theory, differential encoding	1
2.2.2	Scalar and Vector Quantization	2
2.2.3	DCT, KL Transform coding	2
2.2.4	Wavelet Based Coding	
2.2.4.1	Sub band coding	1
2.2.4.2	Embedded Zero tree of Wavelet coding	1
2.2.4.3	Set Partitioning in Hierarchical Trees (SPIHT)	1
3	**Image Compression Standards**	
3.1	JPEG 2000	2
3.2	Bi-level Image Compression Standards: JBIG	1
3.3	HEIF (High Efficiency Image File Format)	2
4	**Video Compression Standards**	
4.1	Video Compression Based on Motion Compensation	1
4.2	MPEG-4	1
4.3	H.264,H.265	2
4.4	MP4-Container, MOV	2
5.	**Audio Compression Standards**	
5.1	Speech compression: Vocoder	1
5.2	LPC, CELP, G.722	1
5.3	Application to audio coding – MPEG audio (MP3)	1
5.4	MPEG (AAC), M4A	2
5.5	Surround Sound- Dolby Digital and DTS X	1
5.6	Silence Compression	1

Course Designers:

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- Dr.R.A.AlaguRaja alaguraja@tce.edu

22ECPE0	SATELLITE REMOTE SENSING

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

In this course the students will learn about the concepts and principles of various processes of remote sensing, data acquisition systems and sensors, different types of remote sensing satellites, data and their characteristics and satellite image processing operations using open source software. They will also apply the satellite data for various societal developments applications.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Explain the concepts of Electromagnetic energy, spectrum and spectral signature curves, Satellite orbits and platforms	TPS2	70	70
CO2	Interpret Multispectral, Thermal and Hyperspectral Images	TPS3	70	70
CO3	Interpret SAR (Microwave) and LIDAR Images	TPS3	70	70
CO4	Interpret the concepts of satellite and sensor parameters and characteristics of different platforms	TPS3	70	70
CO5	Apply open source Image processing packages to process satellite images	TPS3	70	70
CO6	Choose appropriate satellite data and apply the concepts for different applications	TPS3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO1 2	PSO 1	PS O 2	PS O 3
CO1	M	L	-	-	-	-	-	M	M	L	-	-	L	L	L
CO2	S	M	L	-	M	M	-	M	M	L	-	-	M	L	L
CO3	S	M	L	L	M	M	-	M	M	L	-	-	M	-	L
CO4	S	M	L	L	-	-	-	M	M	L	-	-	M	-	L
CO5	S	M	L	-	-	-	-	M	M	L	-	-	M	-	L
CO6	S	M	L	L	L	M	-	M	M	L	-	M	M	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam(%)		
	CAT – I(%)			Assg. I *(%)			CAT – II(%)			Assg. II *(%)					
TPS Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	10	20	100			-						-	5	10
CO2	-	15	20				-						-	5	10
CO3	-	15	20				-						-	5	10
CO4	-						-	10	10	100			-	5	10
CO5	-						-	15	25				-	5	15
CO6	-						-	15	25				-	5	15
Total	-	**40**	**60**	**100**			**-**	**40**	**60**	**100**			**-**	**30**	**70**

Syllabus

Fundamentals: Remote Sensing Process- Satellite orbits and platforms -Image Resolution Types-Image Resolution Types-False Color Images and Band Combinations-Radiometric and Geometric Errors **[5 Hours]**

Types: Multi Spectral Sensing –Along Track & Across Track scanning-Thermal Remote Sensing – Radiation Principles, Interpretations- Hyperspectral Sensing– Dimensionality Reduction, Analysis Techniques- Microwave Sensing–Side looking Radar Systems, Synthetic Aperture Radar (SAR), Radar Image Characteristics, Radar Image Interprétation- LIDAR Remote Sensing– Data Characteristics, Point Cloud Processing. **[8 Hours]**

Sensors &Platforms: Multi Spectral: Landsat, SPOT, and IRS Programmes- Thermal: AVHRR, ASTER, ATLAS, MODIS- Hyper Spectral: Hyperion, HySIS, Enmap, PROBA, Microwave: RISAT, RADARSAT, TerraSAR, TanDEM- LIDAR: ICESat2, CALIPSO- High Resolution Satellites: GeoEye, IKONOS, QuickBird- Remote Sensing Data Providers. **[7 Hours]**

Processing using Open Source Packages: Interpretation of MSS and Thermal Data- Statistics Computation and Band math operations on MSS Data- Preprocessing- Destriping, Masking, Georeferencing of MSS Data- Supervised & Unsupervised Classification of MSS Data- Adaptive & Texture Filters for Speckle Removal from Radar Data- Visualization and Analysis of various bands of Hyperspectral Data **[7 Hours]**

Applications: Land Use Land Cover Change Detection and Urban Sprawl Monitoring (MSS)- Mineral exploration & Agricultural Crop Detection (HS)- Temperature Mapping, Forest Fire Detection (TRS)- Snow Cover Studies (SAR)- 3D Reconstruction (LIDAR) **[9 Hours]**

Text Book

- T.M. Lillesand and R.W. Kiefer “Remote Sensing and Image Interpretation (7th Edition)”, John Wiley,2015.

Reference Books

- R.A. Schowengerdt “Remote Sensing – Models and Methods for Image Processing”, Academic Press, 2006
- John R. Jensen, “Introductory Digital Image Processing | A Remote Sensing Perspective”, 4th Edition, Pearson Education, 2017.
- J.R. Jensen “Remote Sensing of the Environment – An Earth Resources Perspective”, 2nd Edition, Pearson Education, 2013

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Fundamentals**	
1.1	Remote Sensing Process	1
1.2	Satellite orbits and platforms	1
1.3	Spectral Reflectance Curve, Image Resolution Types	1
1.4	False Color Images and Band Combinations	1
1.5	Radiometric and Geometric Errors	1
2	**Types**	
2.1	Multi Spectral Sensing – Along Track &Across Track scanning	1
2.2	Thermal Remote Sensing – Radiation Principles, Interpretations	2
2.3	Hyperspectral Sensing– Dimensionality Reduction, Analysis Techniques	2
2.4	Microwave Sensing–Side looking Radar Systems, Synthetic Aperture Radar (SAR), Radar Image Characteristics, Radar Image Interpretation,	2
2.5	LIDAR Remote Sensing– Data Characteristics, Point Cloud Processing	1
3	**Sensors &Platforms**	
3.1	Multi Spectral: Landsat, SPOT, and IRS Programmes	1
3.2	Thermal: AVHRR, ASTER, ATLAS, MODIS	1
3.3	Hyper Spectral: Hyperion, HySIS, Enmap, PROBA,	1
3.4	Microwave: RISAT, RADARSAT, TerraSAR, TanDEM	1
3.5	LIDAR: ICESat2, CALIPSO	1
3.6	High Resolution Satellites: GeoEye, IKONOS, QuickBird	1
3.7	Remote Sensing Data Providers	1
4	**Processing using Open Source Packages**	
4.1	Interpretation of MSS and Thermal Data	
4.2	Statistics Computation and Band math operations on MSS Data	1
4.3	Preprocessing- Destriping, Masking, Georeferencing of MSS Data	1
4.4	Supervised & Unsupervised Classification of MSS Data	2
4.5	Adaptive & Texture Filters for Speckle Removal from Radar Data	2
4.6	Visualization and Analysis of various bands of Hyperspectral Data	1
5	**Applications**	
5.1	Land Use Land Cover Change Detection and Urban Sprawl Monitoring (MSS)	2
5.2	Mineral exploration & Agricultural Crop Detection (HS)	2
5.3	Temperature Mapping, Forest Fire Detection (TRS)	2
5.4	Snow Cover Studies (SAR)	2
5.5	3D Reconstruction (LIDAR)	1
	Total Periods	**36**

Course Designer(s):

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22ECPF0	SATELLITE DATA ANALYSIS

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

This course deals with the qualitative and quantitative techniques applied on analyzing satellite data and related applications. The students will learn the computation of different parameters from satellite data, data transformation techniques, advanced feature extraction algorithms, popular machine learning classifiers and finally data fusion algorithms.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Describe the Satellite data characteristics and their resolutions	TPS2	70	60
CO2	Compute different statistics and quality parameters of satellite data for analysis	TPS3	70	60
CO3	Apply various data transformation techniques on satellite images for different perspective of analysis	TPS3	70	60
CO4	Apply advanced feature extraction algorithms on satellite data for texture feature extraction and analysis	TPS3	70	60
CO5	Learn the types of supervised and unsupervised machine learning classifiers for satellite data analysis	TPS3	70	60
CO6	Perform data fusion algorithms on satellite images	TPS3	70	60

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	M	L	-	-	-	-	-	M	M	L	-	-	L	L	L
CO2	S	M	-	-	M	-	-	M	M	L	-	-	M	L	L
CO3	S	M	L	L	M	M	-	M	M	L	-	-	M	-	L
CO4	S	M	L	L	-	-	-	M	M	L	-	-	M	-	L
CO5	S	M	L	-	-	-	-	M	M	L	-	-	M	-	L
CO6	S	M	L	L	L	M	-	M	M	L	-	M	M	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II *(%)					
TPS / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	10	-	100			-						-	5	-
CO2	-	10	35				-						-	5	10
CO3	-	10	35				-						-	5	10
CO4	-						-	10	25	100			-	5	15
CO5	-						-	10	25				-	5	20
CO6	-						-	10	20				-	5	15
Total	-	30	70	100			-	30	70	100			-	30	70

Syllabus

Satellite Data: Satellite Image Characteristics- Spatial, Spectral, Radiometric and Multi-Temporal Resolutions- Geometric and Radiometric Correction- Image Rectification. [5 Hrs]

Image Statistics: Univariate Statistics- Multivariate Statistics - Image quality statistics. [5 Hrs]

Data Transformation: Multispectral Ratios -Vegetation indices, Water related indices- Principal Components, Tasseled-Cap Components- Wavelet Transform. [6 Hrs]

Feature Extraction: Gray Level Co-occurrence Matrix (GLCM)- Local Binary Pattern (LBP)- Scale Invariant Feature Transform (SIFT)- Histogram Oriented Gradient (HoG)- Wavelet Features- Morphological Features. [8 Hrs]

Learning Methods: Unsupervised learning: Clustering, EM Algorithm- Supervised learning: SVM Classifier- Decision tree learning- Random Forest Classier- Ada Boost Classifier- Texture Based Classification- Accuracy Assessment. [9 Hrs]

Data Fusion: Brovey Method- IHS Fusion- Wavelet Fusion. [3 Hrs]

Learning Resources

- Robert A. Schowengerdt, Remote Sensing Models & Methods for Image Processing, 3rdEdition, 2007.
- Shunlin Liang, Advanced Remote Sensing: Terrestrial Information Extraction and Applications, First edition, 2019
- John R. Jensen, — Introductory Digital Image Processing, A Remote Sensing Perspective, Pearson Education Series, Fourth Edition, 2021.
- Shai Shalev-Shwartz, Shai Ben-David, Understanding Machine Learning From Theory to Algorithms ,Cambridge University press, 2014.
- Ethem Alpaydin —Introduction to Machine Learning, second edition, The MIT Press, 2010.

Course Contents and Lecture Schedule

Module No.	Topic	Lecture Hours
1	**Satellite Data**	
1.1	Satellite Image Characteristics- Spatial, Spectral, Radiometric and Multi-Temporal Resolutions	3
1.2	Geometric and Radiometric Correction	1
1.3	Image Rectification	1
2	**Image Statistics**	
2.1	Univariate Statistics	2
2.2	Multivariate Statistics	2
2.3	Image quality statistics	1

Module No.	Topic	Lecture Hours
3	**Data Transformation**	
3.1	Multispectral Ratios	1
3.2	Vegetation indices	1
3.3	Water related indices	1
3.4	Principal Components	1
3.5	Tasseled-Cap Components	1
3.6	Wavelet Transform	1
4	**Feature Extraction**	
4.1	Gray Level Co-occurrence Matrix (GLCM)	1
4.2	Local Binary Pattern (LBP)	1
4.3	Scale Invariant Feature Transform (SIFT)	1
4.4	Histogram Oriented Gradient (HoG)	2
4.5	Wavelet Features	2
4.6	Morphological Features	1
5	**Learning Methods** - - -	
5.1	Unsupervised learning : Clustering , EM Algorithm	2
5.2	Supervised learning : SVM Classifier- Decision tree learning- Random Forest Classier- Ada Boost Classifier	4
5.3	Texture Based Classification	2
5.4	Accuracy Assessment	1
6	**Data Fusion**	
6.1	Brovey Method	1
6.2	IHS Fusion	1
6.3	Wavelet Fusion	1
	Total Periods	**36**

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22ECRC0	ARRAY SIGNAL PROCESSING

Category	L	T	P	Credit
PEES	2	1	0	3

Preamble

The objective of this course is to assemble in a coherent way a variety of theoretical and practical approaches to sensor array processing problems.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Describe the properties of spatiotemporal propagating signals and noise.	TPS 3	70	60
CO2	Represent signal modeling and apply optimal filters, spectral estimation techniques for the specific problem.	TPS 3	70	60
CO3	Apply spatiotemporal filtering to separate signals according to their directions of propagation and their frequency content.	TPS 3	70	60
CO4	Determine the characteristics of apertures and find the array geometry that determines the performance characteristics of arrays.	TPS 3	70	60
CO5	Apply Optimum beamforming techniques adjust the array pattern to optimize the characteristics of received signal.	TPS 3	70	60
CO6	Apply Array geometries in higher dimensions based on characteristics of the observations.	TPS 3	70	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	L	-	-	-	-	-	-	M	-	-	M	M	-
CO2	S	M	L	-	-	-	-	-	-	M	-	-	M	M	-
CO3	S	M	L	-	-	-	-	-	-	M	-	-	M	M	-
CO4	S	M	L	-	-	-	-	-	-	M	-	-	M	M	-
CO5	S	M	L	-	-	-	-	-	-	M	-	-	M	M	-
CO6	S	M	L	-	-	-	-	-	-	M	-	-	M	M	-

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II *(%)					
TPS Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	5	15	15	100			-			100			-	4	10
CO2	5	15	15				-						-	4	10
CO3	5	15	10				-						-	4	15
CO4	-	-	-	-			5	10	15				-	-	15

CO5	-	-	-	-	5	15	15		-	4	15
CO6	-	-	-	-	5	15	15		-	4	15
Total	**15**	**45**	**40**	**100**	**15**	**40**	**45**	**100**	**-**	**20**	**80**

Syllabus

Representation of space - time signals: Coordinate systems; propagating waves; wave number-frequency space; arrays and apertures; space-time random processes and their characterization; noise assumptions. **[5 Hours]**

Signal modeling and optimal filters: Auto-regressive (AR), Moving average (MA), ARMA models; Autocorrelation and power spectral density of random processes; linear minimum mean square and linear least squares error estimator; solution of normal equations; optimum filters; matched filters. Power spectrum estimation: Nonparametric methods: Estimation of autocorrelation function and PSD using periodogram; BlackmanTukey and Welch-Bartlett methods; Parametric methods: Model and model order selection; PSD estimation using rational spectral models; MUSIC; ESPRIT. **[12 Hours]**

Arrays and spatial filters: Frequency-wavenumber response and beam patterns, uniform linear arrays, uniform weighted linear arrays, array steering, array performance measures: directivity, array gain, linear apertures. **[5 Hours]**

Synthesis of linear arrays and apertures: Spectral weighting, array polynomials, pattern sampling in wavenumber space, minimum beamwidth for specified sidelobe levels, broadband arrays. **[5 Hours]**

Optimum beamforming: MVDR beamformers, MMSE beamformers, Eigenvector beamformers. Adaptive beamforming: Least mean squares algorithms, Recursive least squares; Generalized sidelobe canceler. **[5 Hours]**

Array geometries in higher dimensions: Rectangular arrays; Circular arrays; Spherical arrays; Cylindrical arrays **[4 Hours]**

Text Book

- Harry L Van Trees, “Optimum Array Processing”,John Wiley & Sons,2004.

Reference Books

- S. Theodoridis and R. Chellapa, Academic Press Library in Signal Processing, Vol. 3: Statistical and Array Signal Processing, Academic Press, 2013.
- S. Haykin and K. J. Ray Liu, Handbook on Array Processing and Sensor Networks, WileyIEEE Press, 2010.
- Don H.Johnson, Dan E.Judgeon, “Array signal processing:concepts and techniques”,First edition, Prentice hall signal processing series,1993.
- Prabhakar S. Naidu, Sensor Array Signal Processing,CRC Press,2000.
- Pillai, S. Unnikrishna, Array Signal Processing, Springer,1989.
- Vijay K. Madisetti, The Digital Signal Processing Handbook: Wireless, Networking, Radar, Sensor Array Processing, and Nonlinear Signal Processing, CRC Press, 2nd Edn., 2010.
- P. Stoica and R. L. Moses, “Spectral Analysis of Signals,” Prentice Hall, 2005.
- Sophocles J. Orfanidis, “Optimum Signal Processing An Introduction,” McGraw-Hill Publishing Company,2007.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Introduction to the Course, COs POs	
1	**Representation of space - time signals (5)**	
2	Coordinate systems; propagating waves;	1
3	wave number-frequency space;	1
4	arrays and apertures;	1

5	space-time random processes and their characterization; noise assumptions.	2
	Signal modeling and optimal filters (12)	
6	Auto-regressive (AR), Moving average (MA)	1
7	ARMA models	1
8	Autocorrelation and power spectral density of random processes	1
9	linear minimum mean square and linear least squares error estimator; solution of normal equations	1
10	optimum filters; matched filters	1
11	Nonparametric methods: Estimation of autocorrelation function and PSD using periodogram	2
12	Power spectrum estimation: BlackmanTukey and Welch-Bartlett methods	2
13	Parametric methods: Model and model order selection	1
14	PSD estimation using rational spectral models; MUSIC; ESPRIT	2
	Arrays and spatial filters (5)	
15	Frequency-wavenumber response and beam patterns,	2
16	uniform linear arrays, uniform weighted linear arrays,	1
17	array steering	1
18	array performance measures: directivity, array gain, linear apertures.	1
	Synthesis of linear arrays and apertures (5)	
19	Spectral weighting	2
20	array polynomials, pattern sampling in wavenumber space	1
21	minimum beamwidth for specified sidelobe levels	1
22	broadband arrays	1
	Optimum beamforming (5)	
23	MVDR beamformers	1
24	MMSE beamformers	1
25	Eigenvector beamformers	1
26	Adaptive beamforming: Least mean squares algorithms, Recursive least squares;	1
27	Generalized sidelobe canceler.	1
	Array geometries in higher dimensions (4)	
28	Rectangular arrays	1
29	Circular arrays	1
30	Spherical arrays	1
31	Cylindrical arrays	1
	TOTAL	**36**

Course Designers:

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22ECRD0	STATISTICAL SIGNAL PROCESSING

Category	L	T	P	Credit
PEES	2	1	0	3

Preamble

The objective of this course is to present the theory and applications of statistical signal processing methods. In this course, the key topics namely statistical estimation theory and detection theory are discussed in detail. The topics have been chosen based on the grounds of theoretical value and practical importance.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Describe the properties of commonly used probability density functions.	TPS2	70	60
CO2	Design an unbiased and consistent estimator that meets the CRLB	TPS3	70	60
CO3	Design Least square and Maximum likelihood estimators for parameter estimation for the given problem	TPS3	70	60
CO4	Design Bayesian estimator both for scalar and linear vector parameters estimation	TPS3	70	60
CO5	Design an optimal detector that detects the signals in noise through hypothesis testing	TPS3	70	60
CO6	Design an optimal detector to determine unknown parameters in deterministic signals	TPS3	70	60
CO7	Design an optimal detector to determine unknown parameters of random signals	TPS3	70	60

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	M	L	-	-	-	-	-	-	-	M	-	-	L	M	-
CO2	S	M	L	-	-	-	-	-	-	M	-	-	M	M	-
CO3	S	M	L	-	-	-	-	-	-	M	-	-	M	M	-
CO4	S	M	L	-	-	-	-	-	-	M	-	-	M	M	-
CO5	S	M	L	-	-	-	-	-	-	M	-	-	M	M	-
CO6	S	M	L	-	-	-	-	-	-	M	-	-	M	M	-
CO7	S	M	L	-	-	-	-	-	-	M	-	-	M	M	-

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II *(%)					
TPS Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	05	05	-	100			-						2	-	-
CO2	05	05	30				-						2	-	10
CO3	05	05	40				-						2	2	10
CO4	-	-	-	-			05	-	15	100			2	2	15
CO5	-	-	-	-			-	05	15				2	2	15
CO6	-	-	-	-			05	05	20				-	2	15
CO7	-	-	-	-			05	05	20				-	2	15
Total	15	15	70	100			15	15	70	100			10	10	80

Syllabus

Basics: Estimation in Signal Processing, The mathematical estimation problem. Detection theory in signal processing, The mathematical detection problem, Hierarchy of detection problem, Role of asymptotics, Fundamental probability density functions [3 Hours]

Minimum variance unbiased estimator and CRLB: Unbiased estimators, Minimum variance criterion, Cramer-Rao Lower Bound (CLRB) for signals in White Gaussian noise, Vector parameter CRLB for Transformations. Signal Processing example. [5 Hours]

Least Square (LS) and Maximum Likelihood Estimators (MLE): Linear least square, Geometrical interpretation, Finding MLE, Properties of MLE, MLE for Transformed parameters, extension to a vector parameter, Signal Processing example. [5 Hours]

Linear Bayesian Estimators: Linear Minimum Mean Square Error (MMSE) Estimator, Vector LMMSE estimator, sequential LMMSE estimator, Signal Processing Example. [5 Hours]

Hypothesis Testing: Binary hypothesis testing, Bayes risk, multiple hypothesis testing, minimum bayes risk detector, Composite hypothesis testing. [8 Hours]

Detection of Deterministic signals: Detection of deterministic signals with unknown parameters-amplitude, arrival time, Sinusoidal detection, Generalized Likelihood Ratio Test (GLRT) for linear model, Energy Detector [5 Hours]

Detection of Random signals: Detection of Random signals with unknown covariance, Detection for large data records, Weak signal detection, Detection of periodic random signals [5 Hours]

Text Books

- Steven M. Kay, “Fundamentals of Statistical Signal Processing, Vol I - Estimation Theory”, Prentice Hall, 1993.
- Steven M. Kay, “Fundamentals of Statistical Signal Processing, Vol II - Detection Theory”, Prentice Hall, 1998.

Reference Books

- Umberto Spagnolini, Politecnico di Milano, “Statistical Signal Processing in Engineering”, John Wiley & Sons Ltd, 2018.
- Dimitris G. Manolakis, Vinay K. Ingle and Stephen M. Kogon, “Statistical and Adaptive Signal Processing”, Artech House, 2005.
- John G.Proakis and Dimitris G.Manolakis, “Digital Signal Processing Principles, Algorithms and Applications”, Prentice-Hall of India, Fourth Edition, 2006.
- Sophocles J. Orfanidis, “Optimum Signal Processing”, McGraw-Hill Publishing Company, 2007.
- Prof. Prabin Kumar Bora, IIT Guwahati, “Statistical Signal Processing”, NPTEL Video Lectures: https://nptel.ac.in/courses/108/103/108103158/

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Introduction to the Course, COs POs	
	Basics (3)	
1.	Estimation in Signal Processing, The mathematical estimation problem, Detection theory in signal processing, The mathematical detection problem	1
2.	Hierarchy of detection problem, Role of asymptotics	1
3.	Fundamental probability density functions	1
	Minimum variance unbiased estimator and CRLB (5)	
4.	Unbiased estimators, Minimum variance criterion	1
5.	Cramer-Rao Lower Bound (CLRB) for signals in White Gaussian noise	1
6.	Vector parameter CRLB for Transformations	2
7.	Signal Processing example.	1
	Least Square (LS) and Maximum Likelihood Estimators (MLE) (5)	
8.	Linear least square estimator, Geometrical interpretation	1
9.	Finding MLE, Properties of MLE	1
10.	MLE for Transformed parameters	1
11.	Extension to a vector parameter,	1
12.	Signal Processing example	1
	Linear Bayesian Estimators (5)	
13.	Linear Minimum Mean Square Error (MMSE) Estimator	1
14.	Vector LMMSE estimator	1
15.	Sequential LMMSE estimator	2
16.	Signal Processing Example	1
	Hypothesis Testing (8)	
17.	Binary hypothesis testing, Bayes risk	2
18.	Multiple hypothesis testing	2
19.	Minimum bayes risk detector	1
20.	Composite hypothesis testing	3
	Detection of Deterministic signals (5)	
21.	Detection of deterministic signals with unknown amplitude	1
22.	Detection of deterministic signals with unknown arrival time	1
23.	Sinusoidal detection	1
24.	Generalized Likelihood Ratio Test (GLRT) for linear model	1
25.	Energy Detector	1
	Detection of Random signals (5)	
26.	Detection of Random signals with unknown covariance	2
27.	Detection for large data records	1
28.	Weak signal detection	1
29.	Detection of periodic random signals	1
	TOTAL	**36**

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22ECPG0	SIGNAL PROCESSING WITH SMARTPHONE

Category	L	T	P	Credit	TE
PSE	2	0	2	3	Practical

Preamble

This course is offered as a follow-up to the courses “Signals and Systems” and “Discrete Time Signal Processing". The purpose of this courses is to enable students to bridge the gap between signal processing theory and implementation aspects. Smartphones have become powerful processing platforms led to the development of this course toward enabling students to use their own smartphones as implementation platforms for running signal processing algorithms.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Describe the smartphone implementation tools for Android operating system	TPS 2	70	70
CO2	Perform signal sampling and frame based processing in smartphone	TPS 3	70	70
CO3	Determine the effects of quantization of fixed point and floating point arithmetic for implementing FIR and IIR filter in smartphone	TPS 3	70	70
CO4	Perform adaptive filtering and frequency domain filtering in smartphone	TPS 3	70	70
CO5	Perform code optimization by exploiting hardware features	TPS 3	70	70
CO6	Transform MATLAB code for signal processing algorithm to smartphone	TPS 3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	M	L	-	-	L	-	-	-	L	L	-	L	L	-	-
CO2	S	M	L	-	L	-	-		L	L	-	L	M	-	-
CO3	S	M	L	-	S	-	-		S	M	-	L	M	L	M
CO4	S	M	L	-	S	-	-		S	M	-	L	M	L	M
CO5	S	M	L	-	S	-	-		S	M	-	L	M	L	M
CO6	S	M	L	-	S	-	-		S	M	-	L	M	L	M

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I			Assessment - II			Terminal Exam (%)		
	CAT – I (%)			CAT – II (%)					
TPS / CO	1	2	3	1	2	3	1	2	3
CO1	-	10	-	-	-	-	Practical Exam		
CO2	-	10	30	-	-	-			
CO3	-	10	40	-	-	-			
CO4	-			-	20	30			
CO5	-			-	10	30			
CO6	-			-	-	10			
Total	-	**30**	**70**	**-**	**30**	**70**	**100**		

Syllabus

Basics: Smartphone implementation tools, smartphone implementation shells, Overview of ARM processor architecture, Android/iOS Software development tools. [2 Hours]

Sampling and Frame based processing: Sampling and Quantization, Android /iPhone audio signal sampling [4 Hours]

Fixed-Point and Floating Point representation for real time filtering: Q-format number representation, floating point number representation, overflow and scaling, Functional approximation [6 Hours]

Real Time Filtering: FIR/IIR filter implementation, circular buffering, frame processing, finite word length effect. [6 Hours]

Adaptive Signal Processing: Implementation of frequency domain adaptive filtering algorithm. [6 Hours]

Theory: 24 Hours

Practical:

1. Getting familiar with Android Software tools
2. Android Audio Signal Sampling
3. Fixed Point operations
4. Floating Point operations
5. Real time FIR filtering, Quantization effects and overflow
6. IIR filtering and Adaptive filtering
7. Frequency domain transforms – DFT and FFT
8. Code Optimization
9. MATLAB coder implementation

Practical:24 Hours
Total: 48 Hours

Text Book

- Nasser Kehtarnavaz, Abhishek Sehgal, Shane Parris, and Arian Azaran, “Smartphone-Based Real-Time Digital Signal Processing”, 3rd Edition, A Publication in the Morgan & Claypool Publishers series Synthesis Lectures on Signal Processing, 2020.

Reference Books& web resources

- Nasser Kehtarnavaz, Fatemeh Saki, Adrian Druan and Arian Azarang, “Anywhere-Anytime Signals and Systems Laboratory: From MATLAB to Smartphones”, 3rd Edition, A Publication in the Morgan & Claypool Publishers series Synthesis Lectures on Signal Processing, 2020.
- Sen M.Kuo, Bob H.Lee and Wenshun Tian, “Real-Time Digital Signal Processing, Fundamentals, Implementations and Applications”, 3rd Edition, Wiley.
  https://onlinecourses.nptel.ac.in/noc22_ee99/preview

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Introduction to the Course, COs POs	
1	**Basics:** Smartphone implementation tools, smartphone implementation shells	1
2	Overview of ARM processor architecture, Android/iOS Software development tools.	1
	Sampling and Frame based processing	
3	Sampling and Quantization	2
4	Android /iPhone audio signal sampling	2
	Fixed-Point and Floating Point representation for real time filtering	
5	Q-format number representation	2
6	Floating point number representation	2
7	overflow and scaling	1
8	Functional approximation	1
	Real Time Filtering	
10	FIR/IIR filter implementation	2
11	Circular buffering	1
12	Frame processing	1
13	Finite word length effect	2
	Adaptive Signal Processing	
14	Implementation of frequency domain adaptive filtering algorithm	6
	TOTAL	**24**

Course Designers:

1. Dr.S.J.Thiruvengadam - sjtece@tce.edu
2. Dr.M.N.Suresh - mnsece@tce.edu
3. Dr.P.G.S.Velmurugan - pgsvels@tce.edu

22ECPH0	SIGNAL PROCESSING AND MACHINE LEARNING FOR AUDIO AND SPEECH	Category	L	T	P	Credit
		PSE	3	0	0	3

Preamble

This course aims to provide students with a foundational understanding of signal processing concepts and tools essential for the application of machine learning to discrete signals. Students will gain insights into techniques for capturing, processing, manipulating, learning, and classifying signals. The course will delve into diverse mathematical methods integral to machine learning, empowering students to craft and optimize their own models effectively. Emphasizing mathematical principles, the course includes coding-based assignments tailored for applications in audio and speech processing.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Apply mathematical tools and techniques on discrete signals for machine learning applications	TPS 3	70	70
CO2	Apply signal processing tools on speech and audio data	TPS3	70	70
CO3	Apply the theory of machine learning relevant to Signal Processing applications	TPS 3	70	70
CO4	Apply multi-class discriminant and support vector machine for Multi-class classification, Multi-label classification and regression analysis.	TPS 3	70	70
CO5	Apply probability models and Expectation Maximization algorithm for processing, manipulating, learning and classifying signals.	TPS 3	70	70
CO6	Apply Neural Networks and Deep Learning algorithms for audio classification	TPS 3	70	70
CO7	Apply Neural Networks and Deep Learning algorithms for speech recognition	TPS 3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	L	-	L	-	-	-	M	-	-	L	M	L	L
CO2	S	M	L	-	L	-	-	-	M	-	-	L	M	L	L
CO3	S	M	L	-	L	-	-	-	M	-	-	L	M	L	L
CO4	S	M	L	-	L	-	-	-	M	-	-	L	M	L	L
CO5	S	M	L	-	L	-	-	-	M	-	-	L	M	L	L
CO6	S	M	L	-	L	-	-	-	M	-	-	L	M	L	L
CO7	S	M	L	-	L	-	-	-	M	-	-	L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II *(%)					
TPS Scale / CO	2	3	4	2	3	4	2	3	4	2	3	4	2	3	4
CO1	-	10	30	100			-						-	4	15
CO2	-	10	20				-						-	4	10
CO3	-	10	20				-						-	4	15
CO4	-	-	-	-			-	10	20	100			-	2	10
CO5	-	-	-	-			-	10	20				-	2	10
CO6	-	-	-	-			-	5	20				-	2	10
CO7								5	10					2	10
Total	**-**	**30**	**70**	**100**			**-**	**30**	**70**	**100**			**-**	**20**	**80**

Syllabus

Basics for Signal Processing and Machine Learning (ML) Systems: Mathematical foundations for ML: Linear Algebra and convex optimization, Linear Gaussian systems and signal processing, Human speech production, perception mechanism, Cepstrum, Mel-Frequency Cepstral Coefficients (MFCCs), Wavelets, Short Time Fourier Transform, Time Series Analysis, [12 Hours]

Classification Problem: Statistical decision theory – Bayes Classifiers, detecting a constant signal in Gaussian noise, detecting change in variance, detecting known signal and detecting correlated signal. Linear and quadratic discriminant analysis. Multi-class discriminant analysis, Support Vector Machine in classification and regression. [6 Hours]

Probability Models and Expectation Maximization algorithm: Expectation Maximization (EM) algorithm, Gaussian Mixture Models [6 Hours]

ML for Audio Classification: Long Short Term Memory (LSTMs) and Convolutional Neural Networks (CNNs) [6 Hours]

ML for Speech Recognition: Hidden Markov Models, Finite State Transducers and Dynamic Programming [6 Hours]

Total: 36 Hours

Text Book

- C.M. Bishop, Pattern Recognition and Machine Learning, 2nd Edition, Springer, 2011.
- I. Goodfellow, Y, Bengio, A. Courville, Deep Learning, MIT Press, 2016.
- D. Yu and L. Deng, Automatic Speech Recognition: A Deep Learning Approach, Springer, 2016.
- Paolo Prandoni and MartinVetterli, Signal Processing for Communications, CRC-Taylor and Francis Group, 2008.
- Mohammed J.Zaki and Wagner Meira. J.R, Data Mining and Machine learning, fundamental concepts and algorithm, 2nd Edition, Cambridge University Press, 2020.
- Max A. Little, Machine Learning for Signal Processing: Data Science, Algorithms, and Computational Statistics, 1st Edition, Oxford University Press, 2019.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Introduction to the Course, COs POs	
	Basics for Signal Processing and Machine Learning (ML) Systems	
1	Mathematical foundations for ML: Linear Algebra	1
2	Linear Algebra and convex optimization,	2

3	Linear Gaussian systems and signal processing	2
4	Human speech production	1
5	perception mechanism	1
6	Cepstrum	1
7	Mel-Frequency Cepstral Coefficients (MFCCs)	1
8	Wavelets	1
9	Short Time Fourier Transform	1
10	Time Series Analysis	1
	Classification Problem	
11	Statistical decision theory	1
12	detecting a constant signal in Gaussian noise	1
13	Bayes Classifiers	1
14	detecting change in variance, detecting known signal and detecting correlated signal	1
15	Linear and quadratic discriminant analysis. Multi-class discriminant analysis	1
16	Support Vector Machine in classification and regression	1
	Probability Models and Expectation Maximization algorithm	
17	Expectation Maximization algorithm	3
18	Gaussian Mixture Model	3
	ML for Audio Classification	
19	Long Short Term Memory (LSTMs)	3
20	Convolutional Neural Networks (CNNs)	3
	ML for Speech Recognition	
21	Hidden Markov Models	3
22	Finite State Transducers and Dynamic Programming	3
	TOTAL	**36**

Course Designers:

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22ECPJ0	DIGITAL SYSTEM DESIGN USING FPGA

Category	L	T	P	Credit	TE
PSE	2	0	2	3	Theory

Preamble

Digital System Design using FPGA aims to analyze the different architecture and organization of Field Programmable Gate Arrays. Initially the different elements like Programmable logic cell, interconnect and Input/Output cells of the FPGA are explored and analyzed. The subject focuses on the procedure for the design and implementation of sequential digital circuits and their mapping with the fixed platform of FPGA. It also deals with the implementation of algorithms that is used to interface the FPGA with the external world for applications. Finally, the learner is exposed with some reference case studies for FPGA implementation of combinational, sequential digital circuits and interfaces for practical applications.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Describe the architecture, programming technologies of standard logic families and Programmable Logic Devices.	TPS3	70	70
CO2	Use the logic and dedicated blocks to implement combinational and sequential logics.	TPS3	70	70
CO3	Examine the Input / Output cells of FPGA for interfacing with external peripherals.	TPS3	70	70
CO4	Illustrate the routing process in interconnect architectures of different vendors of FPGA	TPS3	70	70
CO5	Verify the functionality of the digital logic functions using the IDE tool.	TPS3	70	70
CO6	Demonstrate the functioning of a digital system in a FPGA hardware platform	TPS3	70	70

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	S	M	L	L	S	-	-	-	L	L	-	-	M	L	L
CO2	S	M	L	L	S	-	-	-	L	L	-	-	M	L	L
CO3	S	M	L	L	S	-	-	-	L	L	-	-	M	L	L
CO4	S	M	L	L	S	-	-	-	L	L	-	L	M	L	L
CO5	S	M	L	L	S	-	-	-	L	L	-	L	M	L	L
CO6	S	M	L	L	S	-	-	-	L	L	-	-	M	L	L

S-Strong; M-Medium; L-Low

Assessment Pattern

	Assessment-I CAT–I(%)			Assessment-II CAT–II(%)			Terminal Exam (Theory) (%)		
TPS / CO	1	2	3	1	2	3	1	2	3
CO1	-	10	20	-			-	04	20
CO2	-	10	30	-			-	04	20
CO3	-	20	10	-			-	04	10
CO4	-			-	05	30	-	04	10
CO5	-			-	10	20	-	02	10
CO6	-			-	05	30	-	02	10
Total	-	**40**	**60**	**-**	**20**	**80**	**-**	**20**	**80**

Psychomotor Skill	Practical
Perception	-
Set	-
Guided Response	-
Mechanism	100
Complex Overt Responses	-
Adaptation	-
Origination	-

Syllabus

Digital Design process: Standard IC: Logic families (TTL, ECL, CMOS), Design flow:PLD, CPLD, FPGA and ASIC, Architectures: Programmable Logic Devices, FPGA, Programming technologies: SRAM, DRAM, EPROM, EEPROM FLASH and Anti-fuses. **[8]**

Programmable Logic cells: Xilinx and Altera logic blocks, Dedicated blocks, Logic synthesis for combinational circuits, sequential circuits - Synchronous and Asynchronous Sequential Circuit -Finite State Machine design, Design examples. **[8]**

Programmable I/O cells: AC, DC inputs and outputs, Clock inputs and power inputs Xilinx I/O cells and Altera I/O cells. **[4]**

Programmable interconnects: Switch matrix, Xilinx and Altera interconnect architectures**.[4]**

Practical: **[24 hours]**

1. Simulation and Implementation of Basic gates and flip flops using Altera platform.
2. Simulation and implementation of Arithmetic circuits using Altera platform.
3. Simulation and Implementation of BCD to Seven segment display
4. Design and Implementation of Synchronous Mod counters
5. Design and Simulation of Sequence Detectors using FSM Approaches.
6. Interfacing LCD and PS2 keyboard with cyclone II FPGA using Altera DE1 board.
7. Interfacing matrix, PS2 keyboard with cyclone II FPGA using Altera DE1 board.
8. Controlling the speed of DC motor using Altera DE1 board.
9. Stepper motor angle control using Altera DE1 board.

Text Book

- M. Morris Mano and Michael D. Ciletti, “Digital Design: with an Introduction to the Verilog HDL”, 5th Edition, Prentice Hall 2012.
- M.J.S.Smith, "Application Specific Integrated Circuits", Pearson, 2003.
- Samir Palnitkar, “Verilog HDL: A guide to digital design and synthesis” Pearson Education India, 2010.

Reference Books

- Jan M. Rabey, Anantha Chandrakasan and Borivoje Nikolic ” Digital integrated circuits: A Design Perspective (2nd Edition) “, Pearson 2009.
- Stephen D. Brown, and Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design, 2nd Edition," McGraw Hill, June, 2007.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
1.	**Digital Design process**	
2.	Standard IC: Logic families (TTL, ECL, CMOS IC datasheets)	3
3.	Design flow: PLD, CPLD, FPGA and ASIC	1
4.	Architectures: Programmable Logic Devices, FPGA	2
5.	Programming technologies: SRAM, DRAM, EPROM, EEPROM FLASH and Anti-fuses	2
6.	**Programmable Logic cells**	
7.	Xilinx and Altera logic blocks (with reference datasheet)	2
8.	Dedicated blocks	1
9.	Logic synthesis for combinational circuits	1
10.	sequential circuits - Synchronous and Asynchronous Sequential Circuit	2
11.	Finite State Machine design	2
12.	Design examples	
13.	**Programmable I/O cells**	
14.	AC, DC inputs and outputs	1
15.	Clock inputs and power inputs	1
16.	Xilinx I/O cells and Altera I/O cells (from datasheet)	2
17.	**Programmable interconnects**	
18.	Switch matrix	2
19.	Xilinx and Altera interconnect architectures	2

Course Designers:

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22ECPK0	LOW POWER VLSI DESIGN

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

Increased levels of integration (increased functionality) and higher throughput under tight power budgets has led to the need for changes in the traditional way of designing circuits and systems. Portable communication and computation have driven the need for low-power electronics. Recent progress has been made in creating tools for estimating power dissipation in CMOS circuits. The research approach is to use accurate and efficient power estimation techniques to drive the design of new low-power systems. Software tools for testing integrated circuits, rapid fault simulation, and failure analysis are also being developed. This course discusses design techniques, estimation and optimization of power at various levels of design abstraction for designing energy-efficient digital systems used in battery operated devices

Prerequisite

NIL

Course Outcomes

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Demonstrate various sources of power dissipation in CMOS Digital logic Circuits.	TPS3	70	70
CO2	Use techniques to design circuits for leakage power reduction.	TPS3	70	70
CO3	Estimate the switching power in CMOS digital circuits using probabilistic and statistical techniques.	TPS3	70	70
CO4	Optimize the given Digital logic and arithmetic circuits for reduced power consumption.	TPS3	70	70
CO5	Apply circuit design techniques to the different elements of Memory to reduce power consumption.	TPS3	70	70
CO6	Modify the conventional digital logic circuits into adiabatic logic circuits using the energy recovery techniques.	TPS3	70	70

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	S	M	L	-	L	-	-	-	M	-	-	L	M	L	L
CO2	S	M	L	-	L	-	-	-	M	-	-	L	M	L	L
CO3	S	M	L	-	L	-	-	-	M	-	-	L	M	L	L
CO4	S	M	L	-	L	-	-	-	M	-	-	L	M	L	L
CO5	S	M	L	-	L	-	-	-	M	-	-	L	M	L	L
CO6	S	M	L	-	L	-	-	-	M	-	-	L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II *(%)					
TPS / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	10	10	100			-						-	4	15
CO2	-	10	20				-						-	4	15
CO3	-	10	40				-						-	4	15
CO4	-						-	5	20	100			-	2	15
CO5	-						-	5	30				-	2	10
CO6	-						-	10	30				-	4	10
Total	-	**30**	**70**	**100**			**-**	**20**	**80**	**100**			**-**	**20**	**80**

Syllabus

Power Dissipation in CMOS: Sources of power dissipation, Hierarchy of limits of power, Physics of power dissipation in MOSFET devices, leakage mechanism, leakage current in deep submicrometer transistors, low power VLSI design limits and issues, Circuit techniques for leakage power reduction. [10 hours]

Power Estimation: Signal Probability calculation, Probabilistic Techniques for signal activity estimation, Statistical Techniques, Estimation of Glitching power, Circuit level power estimation. [7 hours]

Power Optimization: Algorithm level, Logical level and Circuit level power optimization techniques, Techniques for reducing power consumption in digital circuits: supply voltage scaling, multiple supply voltages and minimizing switched capacitance. [7 hours]

Low Power Static RAM Architectures: Organization of a static RAM, MOS Static RAM Memory cell, Banked organization of SRAMs, Reducing voltage swings on bit lines, Reducing power in write driver circuits, Reducing power in sense amplifier circuits, method for achieving low core voltages from a single supply. [6 hours]

Adiabatic Logic Circuits: Energy recovery circuit design, Adiabatic charging, Adiabatic amplification, Adiabatic logic circuits, Pulsed power supply, Stepwise charging circuits, Partially adiabatic circuits – 2N-2N2P logic, Efficient charge recovery logic, Positive feedback logic. [6 hours]

Text Book

- Kaushik Roy and Sharat Prasad, “Low Power CMOS VLSI Circuit Design”, Wiley India, Reprint 2009.
- A.P. Chandrakasan and R.W. Broadersen, “Low Power Digital CMOS Design”, Kluwer,2012.

Reference Books& web resources

- P. Rashinkar, Paterson and L. Singh, “Low Power Design Methodologies”, Kluwer Academic, 2002
- Gary Yeap, “Practical Low Power Digital VLSI Design”, Kluwer, 1998.Abdellatif Bellaouar, Mohamed. I. Elmasry, “Low Power Digital VLSI designs” Kluwer, 1995.
- Jan Rabaey, “Low Power Design Essentials”, Springer Publications, 2009.
- Dimitrios Soudris, Chirstian Pignet, Costas Goutis, “Designing CMOS Circuits for Low Power”, Kluwer,2002.
- J.B. Kuo and J.H Lou, “Low voltage CMOS VLSI Circuits”, Wiley, 1999.
- Wang, B. H. Calhoun and A. P. Chandrakasan, “Sub-threshold Design for Ultra Low-Power Systems”, Springer, 2006.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Power Dissipation in CMOS**	
1.1	Sources of power dissipation	1
1.2	Hierarchy of limits of power	1
1.3	Physics of power dissipation in MOSFET devices	2
1.4	Leakage mechanism, leakage current in deep submicrometer transistors	2
1.5	Low power VLSI design limits and issues	1
1.6	Circuit techniques for leakage power reduction	3
2	**Power Estimation**	
2.1	Signal Probability calculation	2
2.2	Probabilistic Techniques for signal activity estimation	2
2.3	Statistical Techniques	1
2.4	Estimation of Glitching power	1
2.5	Circuit level power estimation.	1
3.	**Power Optimization**	
3.1	Algorithm level	1
3.2	Logical level and Circuit level power optimization techniques	2
3.3	Techniques for reducing power consumption in digital circuits: supply voltage scaling	2
3.4	multiple supply voltages and minimizing switched capacitance	2
4	**Low Power Static Ram Architecture**	
4.1	Organization of a static RAM	1
4.2	MOS Static RAM Memory cell	1
4.3	Banked organization of SRAMs	1
4.4	Reducing voltage swings on bit lines	1
4.5	Reducing power in write driver circuits	1
4.6	Reducing power in sense amplifier circuits, method for achieving low core voltages from a single supply.	1
5	**Adiabatic Logic Circuits**	
5.1	Energy recovery circuit design	1
5.2	Adiabatic charging	1
5.3	Adiabatic amplification, Adiabatic logic circuits	1
5.4	Pulsed power supply, Stepwise charging circuits	1
5.5	Partially adiabatic circuits – 2N-2N2P logic	1
5.6	Efficient charge recovery logic, Positive feedback logic	1
	Total Number of Hours	**36**

Course Designers:

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22ECRE0	CAD VLSI

Category	L	T	P	Credit
PEES	3	0	0	3

Preamble

The semiconductor industry has advanced tremendously over the last ten years with features sizes being downscaled from micrometer to nanometer regime today. Due to the increasing high complexity of modern VLSI chip design, Computer Aided Design (CAD) tools play an important role in delivering high system performance. This course introduces the techniques of modelling digital systems at various abstraction levels and exploring the various algorithms in VLSI physical design, which serve as a basis for the research and development of new Computer Aided Design (CAD) tools.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Demonstrate the knowledge of computational and optimization algorithms and tools applicable to solving CAD related problems	TPS3	70	70
CO2	Represent mechanism for Boolean functions that has application in logic synthesis and Verification	TPS3	70	70
CO3	Partition or divide the system into smaller portions based on the performance such as area, wire length and cost matrices.	TPS3	70	70
CO4	Determine the approximate location of each module in a chip area.	TPS3	70	70
CO5	Use Optimization algorithms in placement to determine the best position for each module on the chip.	TPS3	70	70
CO6	Analyse the Optimizations algorithms in VLSI Global and Detailed Routing process based on their wire length and area constraints.	TPS3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	L	-	L	-	-	L	L	L	-	L	M	-	L
CO2	S	M	L	-	L	-	-	L	L	L	-	L	M	-	L
CO3	S	M	L	-	L	-	-	L	L	L	-	L	M	-	L
CO4	S	M	L	-	L	-	-	L	L	L	-	L	M	-	L
CO5	S	M	L	-	L	-	-	L	L	L	-	L	M	-	L
CO6	S	M	L	-	L	-	-	L	L	L	-	L	M	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II *(%)					
TPS Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	10	10	100			-						-	4	10
CO2	-	10	20				-						-	4	10
CO3	-	10	40				-						-	4	15
CO4	-						-	5	20	100			-	2	15
CO5	-						-	5	30				-	2	15
CO6	-						-	10	30				-	4	15
Total	-	**30**	**70**	**100**			**-**	**20**	**80**	**100**			**-**	**20**	**80**

Syllabus

VLSI Design Automation: VLSI Design Cycle, New trends in VLSI Design cycle, Physical Design cycle, Design styles, Different Packaging Styles, Design Abstraction Levels, Evolution of CAD Tools, Importance of Design Automation.

Data Structures and Basic Algorithms: Terminology, Complexity Issues and NP-hardness, Data Structures for the representation of Graphs, Graph algorithms for Physical design, Integer Linear Programming

Logic Synthesis: Combinational Logic Synthesis, Binary Decision Diagrams, Reduced Ordered BDD principles, ROBDD Manipulation, Variable Ordering, Two Level Logic Synthesis**.**

System Partitioning: Terminology, Optimization Goals, Partitioning Algorithms: Kernighan-Lin Algorithm, Ratio Cut Algorithm, Fiduccia Mattheyess Algorithm, Clustering.

Chip Planning: Terminology, Optimization Goals in Floorplanning, Floorplan Representations: Floorplan to a Constraint-Graph Pair, Floorplan Sizing, Cluster Growth, Simulated Annealing, Integrated Floorplanning Algorithms**.**

Placement: Circuit Representation: bipatite Model Clique Model, Wire length Estimation; Global Placement Algorithms: Min-cut Placement, Analytic Placement, and Simulated Annealing Algorithms.

Routing: Fundamentals: Maze Running, Line Searching, Steiner Trees, and Global Routing: Sequential Approaches, Hierarchical approaches, Integer Linear Programming, Detailed routing: Channel Routing, switchbox Routing.

Clock and Power Routing: Clock Routing, Clocking Schemes, Design Considerations for the Clocking System, Problem Formulation, Clock Routing Algorithms: H-tree Based Algorithm, Power and Ground Routing.

Learning Resources

- Andrew B. Kahng, Jens Lienig, Igor L. Markov, Jin Hu, VLSI Physical Design: From Graph Partitioning to Timing Closure, Springer Dordrecht, 2011.
- Naveed Sherwani, Algorithms for VLSI physical design Automation, Kluwer Academic Publishers, 2010.
- S.H. Gerez, Algorithms for VLSI Design Automation, Wiley-India, Reprint 2008
- Sung Kyu Lim, “Practice Problems in VLSI physical design Automation”, Springer, 2008
- Charles J . Alpert, Dinesh P. Mehta, Sachin S. Sapatnekar, “Hand book of algorithms of Physical design Automation “, CRC press, 2009.
- Sadiq M .Sait, Habib Youssef, “VLSI Physical design automation theory and Practice”, World Scientific Publishing, 1999
- M. Sarrafzadeh and C.K. Wong, An Introduction to VLSI Physical Design, McGraw Hill, 1996
- D.D Gajski et al., High Level Synthesis: Introduction to Chip and System Design, Kluwer Academic Publishers, 1992

- https://www.coursera.org/learn/vlsi-cad-logic
- https://nptel.ac.in/courses/106/106/106106088/

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
1.	**Introduction to the Course, COs POs**	1
2.	**VLSI Design Automation:** VLSI Design Cycle, New trends in VLSI Design cycle,	1
3.	Design styles, Different Packaging Styles	1
4.	Design Abstraction Levels,	1
5.	Physical Design cycle Evolution of CAD Tools, Importance of Design Automation.	1
6.	**Data Structures and Basic Algorithms:** Terminology	1
7.	Complexity Issues and NP-hardness	1
8.	Data Structures for the representation of Graphs,	1
9.	Graph algorithms for Physical design, Integer Linear Programming	1
10	**Logic Synthesis:** Combinational Logic Synthesis	1
11	Binary Decision Diagrams,	1
12	Reduced Ordered BDD principles, ROBDD Manipulation,	2
13	Variable Ordering, Two Level Logic Synthesis.	1
14	**System Partitioning:** Terminology, Optimization Goals	1
15	Kernighan-Lin Algorithm, Ratio Cut Algorithm	2
16	Fiduccia Mattheyess Algorithm	1
17	Clustering.	1
18	**Chip Planning**: Terminology, Optimization Goals in Floorplanning,	0.5
19	Floorplan Representations: Floorplan to a Constraint-Graph Pair	0.5
20	Floorplanning Algorithms: Floorplan Sizing, Cluster Growth,	2
21	Simulated Annealing, Integrated Floorplanning Algorithms.	2
22	**Placement:** Circuit Representation: bipatite Model Clique Model	0.5
23	Wire length Estimation	0.5
24	Global Placement Algorithms: Min-cut Placement,	2
25	Analytic Placement, and Simulated Annealing Algorithms	2
26	**Routing:** Fundamentals: Maze Running	1
27	Line Searching, Steiner Trees	1
28	Sequential Approaches, Hierarchical approaches	1
29	Integer Linear Programming,	1
30	Detailed routing: Channel Routing, switchbox Routing,	1
31	**Clock and Power Routing:** Clock Routing, Clocking Schemes	1
32	Design Considerations for the Clocking System, Problem Formulation,	1
33	Clock Routing Algorithms: H-tree Based Algorithm, Power and Ground Routing	1
		36

Course Designers:

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22ECRF0	ASIC DESIGN

Category	L	T	P	Credit
PEES	3	0	0	3

Preamble

The course aims at ASIC physical design flow, including partitioning, floor-planning, placement, routing and testing.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Describe the ASIC Design flow, Programmable ASICs, ASIC types and Library design	TPS2	70	70
CO2	Use algorithms to partition the ASIC to meet the given objectives	TPS3	70	70
CO3	Use floorplanning algorithms to place the logic cells inside the flexible blocks of an ASIC	TPS3	70	70
CO4	Use placement algorithms - Min-cut Placement, Eigen value Placement, Iterative Placement Improvement, Timing Driven Placement algorithms	TPS3	70	70
CO5	Use global and detailed routing algorithms to route the channels in ASIC and apply techniques for circuit extraction	TPS3	70	70
CO6	Use techniques to test ASIC- Boundary Scan Test, BIST.	TPS3	70	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	M	L	-	-	-	-	-	L	L	L	-	L	L	-	L
CO2	S	M	L	-	-	-	-	L	L	L	-	L	M	-	L
CO3	S	M	L	-	-	-	-	L	L	L	-	L	M	-	L
CO4	S	M	L	-	-	-	-	L	L	L	-	L	M	-	L
CO5	S	M	L	-	-	-	-	L	L	L	-	L	M	-	L
CO6	S	M	L	-	-	-	-	L	L	L	-	L	M	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II *(%)					
TPS Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	5	15				-	-	-		-		-	4	10
CO2	-	10	30	50			-	-	-		-		-	4	10
CO3	-	10	30	50			-	-	-		-		-	2	15
CO4	-	-	-	-			-	10	20	100			-	2	15
CO5	-	-	-	-			-	10	25				-	4	15
CO6	-	-	-	-			-	10	25				-	4	15
Total	-	**25**	**75**	**100**			**-**	**30**	**70**	**100**			**-**	**20**	**80**

Syllabus

ASIC Types and Library Design: ASIC Design Flow, Types of ASIC - Full Custom, Semi Custom – Standard Cell Based ASIC and Gate Array ASIC - Programmable ASICs-Library cell design - Library architecture. **System Partitioning**: Measurement of Partitioning, Partitioning Algorithms - Constructive Partitioning, Iterative Partitioning Improvement Algorithms - Kernighan-Lin Algorithm, Ratio-Cut Algorithm, FPGA Partitioning. **Floorplanning and Placement:** Floor Planning Measurement and tools, I/O, Power and Clock planning, Measurement of Placement, Placement Algorithms – Min-cut Placement, Eigen value Placement, Iterative Placement Improvement, Timing Driven Placement algorithms. **Routing and Circuit Extraction:** Global Routing Measurement – Measurement of Interconnect Delay using Elmore's constant, Global routing for CBIC and GA, Detailed Routing Measurement - Measurement of Channel Density, Detailed routing Algorithms – Lee Maze and High tower Algorithms, Circuit extraction process, Layout Design Rules, Technology related issues. **ASIC TESTING:** The importance of Testing-Boundary Scan Test- Faults-Faults Models- Physical and Logical Faults- IDDQ Test - Fault Simulation - Automatic Test-Pattern Generation, Design for Testability- Built-in-Self-Test.

Text Book

- Michael John Sebastian Smith, - Applications Specific Integrated Circuits, Pearson Education, 2013.

Reference Books& web resources

- H.Gerez, —Algorithms for VLSI Design Automation, John Wiley, 1999.
- Andrew B.Khang, Lienig, Markov and Hu, VLSI Physical Design: From Graph Partitioning to Timing Closure —, Springer, 2011.
- J..M.Rabaey, A. Chandrakasan, and B.Nikolic, Digital Integrated Circuit Design Perspective (2/e), PHI 2003.
- Hoi-Jun Yoo, Kangmin Leeand Jun Kyong Kim, —Low-Power NoC for High-Performance SoC Design, CRC Press, 2008.
- S.Pasricha and N.Dutt, On-Chip Communication Architectures System on Chip Interconnect, Elsveir‖, 2008.
- Wayne Wolf, —Modern VLSI design - Addison Wesley, 1998.
- Prof. Santosh Biswas, IIT Guwahati, NPTEL Video Lecture on —Optimization Techniquesfor Digital VLSI Design, weblink:
- https://nptel.ac.in/courses/108/103/108103108/www.asic-design.com.
- Prof. Santosh Biswas, IIT Guwahati, NPTEL Video Lecture on —Design Verification and Test of Digital VLSI Circuits, weblink: https://nptel.ac.in/courses/106/103/106103116/
- Website: www.asic-world.com

Course Contents and Lecture Schedule

No.	Topic	No. of Hours
1	**ASIC Types and Library Design**	
1.1	ASIC Design Flow	1
1.2	Types of ASIC - Full Custom, Semi Custom	1
1.3	Standard Cell Based ASIC and Gate Array ASIC	2
1.4	Programmable ASICs, Library cell design	1
1.5	Library architecture	1
2	**System Partitioning**	
2.1	Measurement of Partitioning	1
2.2	Partitioning Algorithms - Constructive Partitioning	1
2.3	Iterative Partitioning Improvement Algorithms- Kernighan-Lin algorithm	2
2.4	Ratio-Cut Algorithm	1
2.5	FPGA Partitioning	1
3	**Floorplanning and Placement**	
3.1	Floor Planning Measurement and tools	2
3.2	I/O, Power and clock planning	1
3.3	Measurement of Placement	1
3.4	Placement Algorithms – Min-cut Placement	2
3.5	Eigen value Placement, Iterative Placement Improvement	1
3.6	Timing Driven Placement algorithms	1
4	**Routing and Circuit Extraction**	
5	**ASIC TESTING**	
5.1	The importance of Testing, Boundary Scan Test	1
5.2	Faults, Faults Models	1
5.3	Physical and Logical Faults	1
5.4	IDDQTest, Fault Simulation,	2
5.6	Automatic Test-Pattern Generation	2
5.7	Design for Testability, Built-in-Self-Test.	2
	Total	36

Course Designers:

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22ECRG0	REAL TIME SYSTEMS

Category	L	T	P	Credit
PEES	3	0	0	3

Preamble

The course on Real Time Systems is designed as a theory that aims to provide students with an understanding of operating system and real time systems principles. This subject dives into the core principles and practical applications of the embedded systems in real-time environments. The course covers Hard and Soft Real-Time systems, task scheduling, inter process communication and other resources managements. The final stretch of the course is covered with practical examples that showcase Free RTOS in action, and its API use cases.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Describe the real time systems parameters	TPS 3	70	60
CO2	Distinguish between conventional operating system and a real time operating system	TPS 3	70	60
CO3	Describe and exemplify the RTOS kernel functions	TPS 3	70	60
CO4	Develop pseudo codes for multitasking scheduler	TPS 3	70	60
CO5	Develop a model for a real time embedded system methods and protocol for validation and testing	TPS 3	70	60
CO6	Develop the codes using free RTOS APIs	TPS 3	70	60

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	S	M	L	L	L	-	-	L	M	M	-	-	M	L	L
CO2	S	M	L	L	L	-	-	L	M	M	-	-	M	L	L
CO3	S	M	L	L	-	-	-	L	M	M	-	-	M	-	L
CO4	S	M	L	L	-	-	-	L	M	M	-	L	M	-	L
CO5	S	M	L	L	-	-	-	L	M	M	-	L	M	-	L
CO6	S	M	L	L	-	-	-	L	M	M	-	-	M	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						**Assessment - II**						**Terminal Exam**(%)		
	CAT – I(%)			**Assg. I ***(%)			**CAT – II**(%)			**Assg. II ***(%)					
TPS / CO	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1	-	10	20				-						-	4	10
CO2	-	10	20		100		-						-	4	10
CO3	-	10	30				-						-	4	15
CO4	-						-	10	20				-	-	15
CO5	-						-	10	30		100		-	4	15
CO6	-						-	10	20				-	4	15
Total	-	**30**	**70**		**100**		-	**30**	**70**		**100**		-	**20**	**80**

Syllabus

Real-Time Systems: Embedded Systems and Real-Time System characteristics, Structure, Response, Concurrency, Predictability, Safety and Reliability, Hard and Soft Real-Time Embedded Systems.

Functions of Operating Systems: Process Management, Memory Management, Interrupts Management, Multitasking, File System Management, I/O Management.

Real-Time Operating Systems: Characteristics of RTOS Kernels, Priority Scheduling Intertask Communication and Resource Sharing, Real-Time Signals, Semaphores, Message Passing, Shared Memory, Memory Locking, RTOS principles for System Bus Sharing and RTOS Examples POSIX.

Task Management: Tasks and Specification, Task control Block, Task Assignment and Scheduling, Clock-Driven Scheduling, Round-Robin Approach, Scheduling Algorithms: Rate monotonic, Priority-Driven, Bin-Packing, First-Fit, First-Fit Decreasing, Rate-Monotonic First-Fit (RMFF) and EDF

System modeling and Testing: Introduction to FSM, UML and Petri Nets.

Validation and testing: Program Validation and Testing

FreeRTOS: Datatypes and coding formats, task management APIs, IPC-Queue management, Timer management, Interrupts management and resource sharing APIs

Text Book

- Jiacun Wang, Real-Time Embedded Systems, "Wiley publication 1st edition 2017
- Richard Barry "Mastering the FreeRTOS Real Time Kernel A Hands-On Tutorial Guide

Reference Books

- Philip A.Laplante, "Real time systems analysis and Design-IEEE Computer Society Press PHI-2000
- Allan.V.Shaw, Real Time systems and software", John Wiley & Sons 2000.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Introduction to the Course, COs POs	1
1	**Real-Time Systems (2)**	
2	Embedded Systems and Real-Time Embedded System characteristics,.	1
3	structure, response, concurrency, predictability, safety and reliability	1
	Functions of Operating Systems (6)	
4	Process Management, and Memory Management,	1
5	Interrupts Management,	1
6	Multitasking, File System Management, I/O Management	1
	Real-Time Operating Systems (10)	
7	Characteristics of RTOS Kernels, Scheduling	2
8	Priority Types Scheduling	2
9	Inter Task/Process Communication and Resource Sharing,	2
10	Real-Time Signals, Semaphores, Message Passing, Shared Memory, Memory Locking	2
11	RTOS principles for System Bus Sharing and RTOS Examples POSIX	2
	Task Management: **(10)**	
12	Tasks and its Specification, TCB	2
13	Task Assignment and Scheduling,	2
14	Clock-Driven Scheduling, Round-Robin Approach, S	2
15	cheduling Algorithms : Priority-Driven,	2

16	Bin-Packing, First-Fit, First-Fit Decreasing, Rate-Monotonic First-Fit (RMFF) and EDF	2
17	**System modeling and Testing (2)**	
18	Introduction to FSM, UML and Petri Nets	1
19	**Validation and testing:** Program Validation and Testing	1
	FreeRTOS (6)	
20	Datatypes and coding formats	1
21	Task management APIs	1
22	IPC and program	1
23	Timer management	1
24	Interrupts management	1
25	resource sharing APIs	1
	TOTAL	**36**

Course Designers:

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22ECPL0	IOT SYSTEM AND APPLICATIONS

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

This course is designed to provide a comprehensive understanding and practical mastery of Internet of Things (IoT) systems and their diverse applications. Through a structured curriculum, students will delve into the intricacies of IoT, ranging from its foundational characteristics, physical design, and protocols to the logical design and enabling technologies. The course aims to empower students with the necessary skills to design, implement, and optimize IoT systems.

Prerequisite

NIL

Course Outcomes

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Understand the characteristics, physical design, protocols, logical design, and enabling technologies of IoT systems	TPS2	70	60
CO2	Use IoT design methodology - NETCONF-YANG, enabling the development of specifications, models, and integration strategies for devices and applications.	TPS3	70	60
CO3	Demonstrate proficiency in using Python packages, cloud platforms, web application frameworks, and working with basic building blocks of IoT devices and open-source hardware.	TPS3	70	60
CO4	Apply IoT Edge fundamentals, sensor integration with open-source hardware, and wireless protocol implementation for effective IoT communication.	TPS3	70	60
CO5	Apply the knowledge of cloud storage models, communication APIs, and key IoT platforms, including WAMP, Xively, Django, and AWS, for practical integration in IoT scenarios.	TPS3	70	60
CO6	Understand the Internet of Medical Things (IoMT) and apply Internet of Everything (IoE) concepts through case studies, gaining the ability to implement real-time applications in diverse contexts.	TPS3	70	60

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	M	L	L	L	-	-	-	L	M	M	M	-	L	L	L
CO2	S	M	L	L	-	-	-	L	M	M	M	-	M	L	L
CO3	S	M	L	L	-	-	-	L	M	M	M	L	M	-	L
CO4	S	M	L	L	L	-	-	L	M	M	M	L	M	-	L
CO5	S	M	L	L	L	-	L	L	M	M	M	L	M	-	L
CO6	S	M	L	L	L	-	L	L	M	M	M	L	M	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam(%)		
	CAT – I(%)			Assg. I *(%)			CAT – II(%)			Assg. II *(%)					
TPS / Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	25		100			-						-	15	
CO2	-		25				-						-		15
CO3	-		50				-						-		20
CO4	-						-	10	20	100			-		10
CO5	-						-	10	30				-		20
CO6	-						-	10	20				-	5	15
Total	-	25	75	100			-	30	70	100			-	20	80

Syllabus

Foundations of IoT Systems: Characteristics of IoT systems, Physical design and protocols Logical design, enabling technologies, and IoT levels, Domain-specific IoT: Medical IoT vs M2M. [4]

IoT Design Methodology and Specifications: Design methodology with NETCONF-YANG IoT design specifications, models, and level specifications, Device and component integration, and application development. [4]

Logical Design and Physical Devices in IoT: Python packages for IoT**,** Cloud platforms for IoT (AWS, Google Cloud, IBM Cloud)**,** Python web application frameworks**,** Basic building blocks of IoT devices, open source hardware (NodeMCU, Raspberry Pi-4, Intel Galileo Gen - 2). [10]

IoT Edge: Introduction, sensor interface with Open Source Hardware, Wireless protocols for Internet of Things. [4]

IoT Physical Servers & Cloud Offerings: Introduction to cloud storage models and communication APIs,WAMP - AutoBahn for IoT, Xively Cloud for IoT, Python web application framework- Django, Designing a RESTful Web API, Amazon web services for IoT. [8]

IoECase Studies: smart lighting, home security, weather reporting BOT, smart irrigation**,** IoE in Retail Environments, Industry 4.0 Implementation. [4]

Internet of Medical Things (IoMT): Overview, Emerging Technologies, Benefits, Challenges and Case Studies. [2]

Text Book

- ArshdeepBahga, Vijay Madisetti, —Internet of Things – A hands-on approach, Universities Press, 2015.

Reference Books& web resources

- Adrian McEwen, Hakim Cassimally —Designing the Internet of Things, Wiley Publishing,2015
- Peter Waher —Learning Internet of Things‖, Packt Publishing, UK, 2015.
- Miguel de Sousa‖, Internet of Things with Intel Galileo‖ ‖, Packt Publishing, UK, 2015.
- Marco Schwartz, —Internet of Things with the Arduino Yun‖, Packt Publishing, 2014.
- SahshanuRazdan&Sachin Sharma (2022) Internet of Medical Things (IoMT): Overview, Emerging Technologies, and Case Studies, IETE Technical Review, 39:4, 775-788, DOI: 10.1080/02564602.2021.1927863
- https://www.cse.wustl.edu/~jain/cse574-16/
- https://www.techtarget.com/iotagenda/definition/IoMT-Internet-of-Medical-Things

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Foundations of IoT Systems	
1	Characteristics of IoT systems, Physical design and protocols	1
2	Logical design, enabling technologies	1
3	IoT levels	1
4	Domain-specific IoT: Medical IoT vs M2M	1
	IoT Design Methodology and Specifications	
5	Design methodology with NETCONF-YANG	1
6	IoT design specifications, models, and level specifications,	1
7	Device and component integration	1
8	Application development.	1
	Logical Design and Physical Devices in IoT	
9	Python packages for IoT	2
10	Cloud platforms for IoT (AWS, Google Cloud, IBM Cloud)	2
11	Python web application frameworks	2
12	Basic building blocks of IoT devices	2
13	Open-source hardware (NodeMCU, Raspberry Pi-4, Intel Galileo Gen -2).	2
	IoT Edge	
16	Introduction, sensor interface with Open Source Hardware	2
17	Wireless protocols for Internet of Things.	2
	IoT Physical Servers & Cloud Offerings	
18	Introduction to cloud storage models and communication APIs	2
19	WAMP - AutoBahn for IoT	1
20	Xively Cloud for IoT	1
21	Python web application framework- Django	2
22	Designing a RESTful Web API	1
23	Amazon web services for IoT	1
	IoECase Studies	
24	Smart lighting, home security, weather reporting BOT,	2
25	Smart irrigation**,** IoE in Retail Environments, Industry 4.0 Implementation.	2
	Internet of Medical Things (IoMT)	
26	Overview, Emerging Technologies, Benefits, Challenges	1
27	Case Studies	1
	TOTAL	**36**

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22ECRH0	PARALLEL PROGRAMMING

Category	L	T	P	Credit
PEES	3	0	0	3

Preamble

The goal of this course is to make the students understand the need for multi-core processors, their architecture and various parallel programming paradigms.

Prerequisite

NIL

Course Outcomes

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Understand the need for multicore architecture	TPS2	70	70
CO2	Use the concepts of Parallel program design	TPS3	70	70
CO3	Apply parallel programming concepts in Distributed Memory and shared Memory	TPS3	70	70
CO4	Develop parallel programs for distributed address space	TPS3	70	70
CO5	Develop parallel programs using shared memory paradigms	TPS3	70	70
CO6	Implement parallel programs for Tree Search	TPS3	70	70

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	M	L	L	L		-	-	L	M	M	-	-	L	L	L
CO2	S	M	L	L	L	-	-	L	M	M	-	-	M	L	L
CO3	S	M	L	L	-	-	-	L	M	M	-	-	M	-	L
CO4	S	M	L	L	-	-	-	L	M	M	-	L	M	-	L
CO5	S	M	L	L	-	-	-	L	M	M	-	L	M	-	L
CO6	S	M	L	L	-	-	-	L	M	M	-	-	M	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						**Assessment - II**						**Terminal Exam** (%)		
	CAT – I(%)			**Assg. I ***(%)			**CAT – II**(%)			**Assg. II ***(%)					
TPS Scale / CO	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1	-	10	20	100			-	-	-	-	-	-	-	10	-
CO2	-	10	20				-	-	-	-	-	-	-	6	12
CO3	-	10	30				-	-	-	-	-	-	-	6	12
CO4	-	-	-	-	-	-	-	10	20	100			-	4	14
CO5	-	-	-	-	-	-	-	10	30				-	4	14
CO6	-	-	-	-	-	-	-	10	20				-	4	14
Total	-	**30**	**70**	100			**-**	**30**	**70**	**100**			**-**	**34**	**66**

Syllabus

Parallel Hardware: Need for high speed computing device, solving problems in parallel, Von Neumann architecture, Modifications to the von Neumann Model Parallel Hardware – SIMD and MIMD systems – Interconnection networks - Cache coherence - Shared Memory versus Distributed Memory Architectures, ARM-Neon-SIMD Architecture, Nividia GPU Architecture..

[8 hours]

Parallel Software: Caveats, Coordinating the processes/threads, Shared-memory, Distributed-memory, Programming hybrid systems, Input and Output, Performance, Parallel Program Design

[8 hours]

Distributed Memory Programming With MPI: MPI program execution – MPI constructs – libraries – MPI send and receive – Point-to-point and Collective communication – MPI derived datatypes – Performance evaluation

[7 hours]

Shared Memory Programming With OpenMP: OpenMP Execution Model – Memory Model – OpenMP Directives – Work-sharing Constructs - Library functions – Handling Data and Functional Parallelism – Handling Loops - Performance Considerations.

[8 hours]

Parallel Program Development: Case studies - n-Body solvers – Tree Search – OpenMP and MPI implementations and comparison.

[5 hours]

Text Book

- Peter S. Pacheco, —An Introduction to Parallel Programming, Morgan-Kauffman/Elsevier, 2011.

Reference Books& web resources

- Darryl Gove, —Multicore Application Programming for Windows, Linux, and Oracle Solaris, Pearson, 2011
- Michael J Quinn, —Parallel programming in C with MPI and OpenMP, Tata McGraw Hill,2003.
- V. Rajaraman, C. Siva Ram Murthy M., Parallel Computers - Architecture and Programming, PHI, 2016.
- Victor Alessandrini, Shared Memory Application Programming, 1st Edition, Concepts and Strategies in Multicore Application Programming, Morgan Kaufmann, 2015.
- Yan Solihin, Fundamentals of Parallel Multicore Architecture, CRC Press, 2015.
- https://nptel.ac.in/courses/106102163 by Dr. Yogish Sabharwal, IIT Delhi

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
1.	**Introduction**	1
2.	**Parallel Hardware:** Need for high speed computing device, solving problems in parallel	
3.	Von Neumann architecture, Modifications to the von Neumann Model	1
4.	Parallel Hardware – SIMD	1
5.	MIMD systems	1
6.	Interconnection networks	1
7.	Cache coherence	
8.	Shared Memory versus Distributed Memory Architectures	1

9.	ARM-Neon-SIMD Architecture	1
10.	Nividia GPU Architecture	1
	Parallel Software	
11.	Caveats	1
12.	Coordinating the processes/threads	1
13.	Shared-memory	1
14.	Distributed-memory	1
15.	Programming hybrid systems	1
16.	Input and Output	1
17.	Performance	1
18.	Parallel Program Design	1
	Distributed Memory Programming With MPI	
19.	MPI program execution	1
20.	MPI constructs	1
21.	Libraries	1
22.	MPI send and receive	1
23.	Point-to-point and Collective communication	1
24.	MPI derived datatypes	1
25.	Performance evaluation	1
	Shared Memory Programming With OpenMP	
26.	OpenMP Execution Model	2
27.	Memory Model	1
28.	OpenMP Directives-Work-sharing Constructs	1
29.	Library functions	1
30.	Handling Data and Functional Parallelism	1
31.	Handling Loops	1
32.	Performance Considerations	1
	Parallel Program Development	
33.	Case studies: n-Body solvers, Tree Search	2
34.	OpenMP and MPI implementations and comparison	3
	Total	**36**

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22ECPM0	ELECTRONIC MEASUREMENT AND INSTRUMENTS

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

This course deals with the computation of errors in different types of electrical measurements, analog measurement concepts, DC bridges, AC bridges, Digital measurement concepts and the functionality of signal generators and oscilloscope.

Prerequisite

NIL

Course Outcomes

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Compute errors in different types of electrical measurements	TPS3	70	70
CO2	Use analog measurement concepts	TPS3	70	70
CO3	Determine resistance using DC bridges.	TPS3	70	70
CO4	Determine capacitance and inductance using AC bridges.	TPS3	70	70
CO5	Use Digital Measurement Concepts	TPS3	70	70
CO6	Understand the functionality of Signal generators and oscilloscope	TPS2	70	70

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	S	M	L	-	L	-	-	-	M	-	-	L	M	L	L
CO2	S	M	L	-	L	-	-	-	M	-	-	L	M	L	L
CO3	S	M	L	-	L	-	-	-	M	-	-	L	M	L	L
CO4	S	M	L	-	L	-	-	-	M	-	-	L	M	L	L
CO5	S	M	L	-	L	-	-	-	M	-	-	L	M	L	L
CO6	M	L	-	-	L	-	-	-	M	-	-	L	L	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						**Assessment - II**						**Terminal Exam** (%)		
	CAT – I (%)			**Assg. I *** (%)			**CAT – II** (%)			**Assg. II *** (%)					
TPS / CO	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1	-	10	10	100			-			100			-	4	14
CO2	-	10	20				-						-	4	14
CO3	-	10	40				-						-	4	14
CO4	-						-	10	20	100			-	4	14
CO5	-						-	10	30				-	4	14
CO6	-						-	30	-				-	10	-
Total	-	**30**	**70**	**100**			**-**	**50**	**50**	**100**			**-**	**30**	**70**

Syllabus

Measurements and Measurement Error: Significance of measurements, methods of measurements, instruments and measurement systems, Functions of instruments and measurement systems, Calibration, Gross errors and systematic errors, Absolute and relative errors, basic concepts of accuracy, Precision, Repeatability, Tolerance, range/Span, Linearity, Sensitivity, threshold, Resolution and Significant figures. [8 Hours]

Analog Meters: PMMC Meter, Characteristics of Moving Coil Meter Movement, Moving Coil Galvanometer, Torque Equation of Galvanometer, D.C. Ammeter, Properties of shunt resistor, Multi-range Ammeter, DC Voltmeter, Multi-range Voltmeter, Sensitivity, Loading Effect, Ohmmeter, Series Ohmmeter, Shunt Type Ohmmeter. [8 Hours]

Bridges: Measurement of Resistance, Ammeter-Voltmeter Method, Kelvin Bridge, Double Kelvin Bridge, Substitution Method, Wheatstone Bridge, Measurement Errors in Wheatstone Bridge, A.C. Bridges, Condition for Bridge Balance, Maxwell Inductance Bridge, Maxwell Inductance Capacitance Bridge, Hay Bridge, Anderson Bridge, Owen Bridge, De Sauty Bridge, Schering Bridge, Wien Bridge. [8 Hours]

Digital Meters: Digital Voltmeter Systems, Types of Digital Voltmeter, Ramp-Type DVM, Dual-Slope Integrating Type DVM, Successive-approximation DVM, Digital Multimeter, Specification of Digital Multimeter, Digital frequency meter System, High Frequency Measurement. [6 Hours]

Signal generators and oscilloscope: Signal Generators, Audio Generators, Function Generators, Pulse Generators, Spectrum Analyser, Logic Analyser, Frequency Synthesizer, Oscilloscopes: Analog, Digital CRO and DSO. [6 Hours]

Text Book

- Reza Langari Alan S. Morris, 'Measurement and Instrumentation Theory and Application' Elsevier, 3rd Edition, 2020.

Reference book & web resources

- *Albert D.Helfrick and William D.Cooper* ""Modern Electronic Instrumentation and Measurement Techniques" Pearson, 2016.
- Ernest O. Doebelin, Measurement Systems-Application and Design, TMH,2007.
- R.S. Sedha, "Electronic Measurements and Instrumentation" S. Chand & Company, 2013.
- H. S. Kalsi, "Electronic Instrumentation", Tata McGraw Hills, 2004
- Sawhney A K, 'A course in Electrical and Electronic Measurements and Instrumentation' Dhanpat Rai & Co, 2021.
- David A Bell "Electronic Instrumentation and Measurements", Pearson Education, 2013.
- NPTEL course on Electrical Measurement and Electronic Instruments, Prof. Avishek chatterjee, IIT Kharagpur.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Measurements and Measurement Error**	
1.1	Significance of measurements, methods of measurements	1
1.2	instruments and measurement systems, Functions of instruments and measurement systems	1
1.3	Calibration, Gross errors and systematic errors	1
1.4	Absolute and relative errors, basic concepts of accuracy	1
1.5	Precision, Repeatability	1
1.6	Tolerance, range/Span	1
1.7	Linearity, Sensitivity	1

1.8	Threshold, Resolution and Significant figures	1
2	**Analog Meters**	
2.1	PMMC Meter, Characteristics of Moving Coil Meter Movement	1
2.2	Moving Coil Galvanometer, Torque Equation of Galvanometer	1
2.3	D.C. Ammeter, Properties of shunt resistor	1
2.4	Multi-range Ammeter, DC Voltmeter	1
2.5	Multi-range Voltmeter, Sensitivity	1
2.6	Loading Effect, Ohmmeter	1
2.7	Series Ohmmeter, Shunt Type Ohmmeter.	2
3.	**Bridges**	
3.1	Measurement of Resistance, Ammeter-Voltmeter Method	1
3.2	Kelvin Bridge, Double Kelvin Bridge	1
3.3	Substitution Method, Wheatstone Bridge	1
3.4	Measurement Errors in Wheatstone Bridge, A.C. Bridges	1
3.5	Condition for Bridge Balance, Maxwell Inductance Bridge	1
3.6	Maxwell Inductance Capacitance Bridge, Hay Bridge	1
3.7	Anderson Bridge, Owen Bridge	1
3.8	De Sauty Bridge, Schering Bridge, Wien Bridge	1
4	**Digital Meters**	
4.1	Digital Voltmeter Systems, Types of Digital Voltmeter	1
4.2	Ramp-Type DVM	1
4.3	Dual-Slope Integrating Type DVM	1
4.4	Successive-approximation DVM	1
4.5	Digital Multimeter, Specification of Digital Multimeter	1
4.6	Digital frequency meter System, High Frequency Measurement.	1
5	**Signal generators and oscilloscope**	
5.1	Signal Generators, Audio Generators	1
5.2	Function Generators, Pulse Generators	1
5.3	Spectrum Analyser	1
5.4	Logic Analyser, Frequency Synthesizer	1
5.5	Oscilloscopes: Analog	1
5.6	Digital CRO and DSO	1
	Total Number of Hours	**36**

Course Designers:

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22ECPN0	FIBER OPTIC COMMUNICATION

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

The objective of this course is to provide a comprehensive understanding of optical communication systems and networks. This course provides coverage of basic optical technology including physical aspects of light propagation, fiber optic components and its characteristics and modulation/demodulation techniques and link design. It also covers enabling technologies for optical network including SONET/SDH, WDM network, integrated optics and photonics, future optical systems and Networks

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Determine the transmission characteristics of optical fiber and their measurement procedures.	TPS 3	70	60
CO2	Demonstrate the characteristics of optical sources and modulation techniques.	TPS 3	70	60
CO3	Analyze various coupling losses.	TPS 4	70	60
CO4	Demonstrate the characteristics of optical detectors and demodulation techniques	TPS 3	70	60
CO5	Demonstrate the characteristics of SONET/SDH, WDM network and network components.	TPS 3	70	60
CO6	Design and analyze the performance of optical communication links.	TPS 3	70	60

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	L	L	L	-	-	L	M	M	-	-	M	L	L
CO2	S	M	L	L	L	-	-	L	M	M	-	-	M	L	L
CO3	S	S	M	L	-	-	-	L	M	M	-	-	S	-	L
CO4	S	M	L	L	-	-	-	L	M	M	-	-	M	-	L
CO5	S	M	L	L	-	L	-	L	M	M	-	L	M	-	L
CO6	S	M	L	L	-	L	-	L	M	M	-	L	M	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II *(%)					
TPS / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	10	30	100			-						-	4	20
CO2	-	10	20				-						-	4	10
CO3	-	10	20				-						-	4	10
CO4	-						-	10	20	100			-	4	15
CO5	-						-	10	20				-	4	10
CO6	-						-	10	30				-	-	15
Total	-	30	70	100			-	30	70	100			-	20	80

Syllabus

Introduction: Motivation and evolution of fiber optic system, Role of fiber optics in telecom, Key elements of optical fiber system: **Optical Fibers:** Structures, optical fiber modes and configurations, Modal analysis, Step-index and graded index optical fibers, Multi-core fibers, Ring core fiber, photonic crystal fiber, Fiber fabrication. Transmission characteristics of optical fiber: Attenuation, Dispersion. Test and Measurements: Basic test equipment, Optical power measurement and Optical time domain reflectometer. **Optical Transmitters:** Light Emitting Diode: structure, LED characteristics: output power, quantum efficiency, modulation bandwidth. Laser: laser diode mode, threshold condition, rate equation, Laser characteristics: quantum efficiency, resonant frequency. Modulation: Direct modulation, sub carrier modulation; Multiplexing strategies: Optical TDM, subcarrier multiplexing, OFDM, SDM. **Optical Power Launching and Coupling:** Lensing schemes for coupling improvement, Fiber-to-fiber joints, Splicing techniques, Fiber connectors. **Optical Receivers:** PIN photo detector, characteristics; Avalanche photodiode, characteristics, Noise in Photo detector. Demodulation: Direct detection, coherent detection. **Optical communication system and Networks:** System design consideration point –to –point links, Link power budget, Rise time budget. Optical network: Optical layer, SONET/SDH, high speed light wave link. WDM concepts and Components: Coupler, Isolator, Multiplexers, switches, cross connects. Optical amplifiers: EDFA. **Integrated optics and photonics:** Technologies, integrated optical devices: Beam splitters, directional couplers, Modulators, Polarization converters and photonic integrated circuits.

Text Book

- Gerd Kaiser, “Optical fiber communications”, MCGraw Hill Int., 5th edition, 2017.
- John Senior, “Optica fiber communication-principles and practices”, Prentice Hall of India, 3rd edition, 2013.

Reference Books

- Rajiv Ramaswami, Kumar Sivarajan, Galen Sasaki, “Optical Networks: a practical perspective” Morgan Kaufmann Publishers, 3rd edition, 2009.
- G.P. Agarwal, “Fiber optic communication system”, Wiley, 4th edition, 2010.
- J.Gower, “Optical communication system”, Prentice Hall of India, 2nd edition, 2001.
- Joseph C. Palais, “Fiber Optic Communication”, Pearson Education, 5th edition, 2011.
- Biswanath Mukherjee, “Optical WDM Network”, Springer, 1st edition.
- H Nishihara, M Haruna and T Suhara, Optical Integrated Circuits; McGraw-Hill Book Company, New York, 1989.
- C. R. Pollock and M Lipson, Integrated photonics, Kluwer Pub, 2003.
- José Capmany and Daniel Pérez, Photonic Integrated Circuits, Oxford University Press, 2020.
- NPTEL course on “Introduction to photonics” by Dr. Balaji Srinivasan.Link: https://nptel.ac.in/courses/108106135/
- NPTEL course on “Fiber Optic Communication Technology” by Prof. Deepa Venkitesh.

Link: https://www.youtube.com/watch?v=ougKUUM3hJA

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Introduction to the Course, COs POs	1
1	**Overview of Optical Fiber Communication (9)**	
2	Motivation and evolution of fiber optic system, Elements of optical fiber transmission link, optics in telecom	1
3	Fiber Types: Step index, Graded index, Single mode, multimode,	1
4	optical fiber modes and configurations	2
5	Multi-core fibers, Ring core fiber, photonic crystal fiber, Fiber fabrication.	1
6	Transmission characteristics of optical fiber: Attenuation, Dispersion.	2
7	Test and Measurements: Basic test equipment, Optical power measurement and Optical time domain reflectometer.	1
	Optical Transmitters (6)	
8	Light Emitting Diode: structure, Characteristics: Quantum efficiency, output power, modulation bandwidth	2
9	Laser: Structure, laser diode mode and threshold condition, rate equation, quantum efficiency and resonant frequency	2
10	Direct modulation, sub carrier modulation/multiplexing OTDM, Optical OFDM, SDM	2
	Optical Power Launching and Coupling (5)	
11	Lensing schemes for coupling improvement,	2
12	Fiber-to-fiber joints, Splicing techniques	2
13	Fiber connectors	1
	Optical Receivers (6)	
14	PIN photo detector and Avalanche photodiode: characteristics	2
15	Noise in Photo detector.	2
16	Demodulation: Direct detection, coherent detection	2
	Optical communication system and Networks (10)	
17	System design consideration point –to –point links, Link power budget, rise time budget.	2
18	Optical network: Optical layer, SONET/SDH, high speed light wave link.	2
19	WDM concepts and Components: Coupler, Isolator, Multiplexers, switches, cross connects. Optical amplifiers: EDFA	3
20	Integrated optics and photonics: Technologies, integrated optical devices: Beam splitters, directional couplers, Modulators, Polarization converters and photonic integrated circuits.	3
	TOTAL	**36**

Course Designers:

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22ECPP0	5G WIRELESS NETWORKS

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

The objective of this course is to introduce the students with a comprehensive understanding of current and 5G Wireless Networks that includes 5G Fundamentals with its architecture, small cells, 5G Internets with Internet of Thing. This course also includes cloud network and security challenges in 5G network

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

Course Outcomes

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Apply the access technologies for realizing the capabilities of TDMA, CDMA, GSM and LTE architecture of cellular networks	TPS 3	70	70
CO2	Illustrate the role of 5G and service-based architecture in the core and radio networks	TPS 2	70	75
CO3	Use the distributed mobility management functions for the next generation mobile networks	TPS 3	70	70
CO4	Describe the next generation application protocols such as 5GNAS, NGAP, PFCP, EAP and SCTP	TPS 3	70	70
CO5	use Cloud, Fog and Edge computing techniques for 5G enabled IoT	TPS 3	70	70
CO6	Use the privacy-preserving techniques and Blockchain technology for the IoT systems	TPS 3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	L	-	-	-	-	L	M	M	-	-	M	-	L
CO2	M	L	-	-	-	-	-	L	M	M	-	-	L	-	L
CO3	S	M	L	-	-	-	-	L	M	M	-	-	M	-	L
CO4	S	M	L	-	-	-	-	L	M	M	-	-	M	-	L
CO5	S	M	L	-	-	-	-	L	M	M	-	-	M	-	L
CO6	S	M	L	-	-	-	-	L	M	M	-	-	M	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam(%)		
	CAT – I(%)			Assg. I *(%)			CAT – II(%)			Assg. II *(%)					
TPS / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	10	30	100			-						-	5	15
CO2	-	20	-				-						-	5	-
CO3	-	10	30				-						-	5	15
CO4	-						-	10	20	100			-	5	15
CO5	-						-	10	30				-	5	15
CO6	-						-	10	20				-	5	10
Total	-	40	60	100			-	30	70	100			-	30	70

Syllabus

Generation of Cellular Network: Principles of Cellular Networks, First- Generation Analog, Second- Generation TDMA Second- Generation CDMA Third- Generation Systems Fourth Generation Systems and LTE- LTE Architecture, Evolved Packet Core LTE Resource Management, LTE Channel Structure and Protocols **5G Architecture overview:** Overview, 5G—A new era of connectivity, The road to 5G network deployments, Core requirements, New use cases, New technologies, Two perspectives on 5G Core, Service-based architecture (SBA), The core of the core, Connecting the core network to mobile devices and radio networks, Mobility and data connectivity, 5GC interworking with EPC, Voice services, Messaging services **Management of 5G Networks:** PDU Session concepts, Session types, User plane handling, Mechanisms to provide efficient user plane connectivity, Edge computing, Session authentication and authorization, Local Area Data Network. **5G Protocols:** Protocols, 5G non-access stratum (5G NAS), NG application protocol (NGAP), Hypertext transfer protocol (HTTP), Transport layer security (TLS), Packet forwarding control protocol (PFCP), GPRS tunneling protocol for the User Plane (GTP-U), Extensible Authentication Protocol (EAP), IP security (IPSec), Stream Control Transmission Protocol (SCTP), Generic routing encapsulation. **5G Enabled Internet of Things:** 5G cloud, Mobile and Edge computing for IoT, Emerging challenges and requirements for IoT in 5G, Network function virtualization based IoT in 5G network, 5G small cells. **Privacy and Security Issues:** Privacy and security issues in 5G Enabled IoT, Privacy-preserving Techniques for the 5G Enabled Location Based Services, Block chain Technology for the 5G Enabled IoT Systems-Principles, Applications and Challenges.

Text Book

- Stefan Rommer, Peter Hedman, Magnus Olsson, Lars Frid, Shabnam Sultana, Catherine Mulligan, “5G Core Networks”, Academic Press, 2020

Reference Books

- Cory Beard, William Stallings, **“**Wireless Communication Networks and Systems”, Pearson, 2014.
- Stefan Rommer, Peter Hedman, Magnus Olsson, Lars Frid, Shabnam Sultana, Catherine Mulligan, “5G Core Networks”, Academic Press, 2020
- Yulei Wu, Haojun Huang, Cheng-Xiang Wang, Yi Pan(edited),”5G Enabled Internet of Things”, CRC Press, 2019.
- Saad Z. Asif, “5G Mobile Communications Concepts and Technologies”, CRC Press, 2019.
- Jonathan Rodriguez, Fundamental of 5G Mobile Network, Wiley, 2015.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Introduction to the Course, COs POs	1
	Generation of Cellular Network: (6)	
1	Principles of Cellular Networks, First- Generation Analog, Second-Generation TDMA and CDMA	1
2	Third- Generation Systems Fourth Generation Systems and LTE	1
3	LTE Architecture	1
4	Evolved Packet Core LTE	1
5	Resource Management	1
6	LTE Channel Structure and Protocols	1
	5G Architecture overview: (7)	
7	Overview, 5G—A new era of connectivity, The road to 5G network deployments	1
8	Core requirements, new use cases, new technologies, Two perspectives on 5G Core	1
9	Service-based architecture (SBA), The core of the core,	1
10	Connecting the core network to mobile devices and radio networks, Mobility and data connectivity	2
11	5GC interworking with EPC	1
12	Voice services, Messaging services	1
	Management of 5G Networks: (6)	
13	PDU Session concepts, Session types, User plane handling	2
14	Mechanisms to provide efficient user plane connectivity	2
15	Edge computing, Session authentication and authorization, Local Area Data Network	2
	5G Protocols: (6)	
16	5G non-access stratum (5G NAS), NG application protocol (NGAP), Hypertext transfer protocol (HTTP)	2
17	Transport layer security (TLS), Packet forwarding control protocol (PFCP), GPRS tunneling protocol for the User Plane (GTP-U)	2
18	Extensible Authentication Protocol (EAP), IP security (IPSec)	1
19	Stream Control Transmission Protocol (SCTP), Generic routing encapsulation	1
	5G Enabled Internet of Things: (6)	
20	5G cloud, Mobile and Edge computing for IoT	2
21	Emerging challenges and requirements for IoT in 5G	2
22	Network function virtualization based IoT in 5G network, 5G small cells	2
23	**Privacy and Security Issues: (5)**	
24	Privacy and security issues in 5G Enabled IoT	1
25	Privacy-preserving Techniques for the 5G Enabled Location Based Services	2
26	Block chain Technology for the 5G Enabled IoT Systems-Principles, Applications and Challenges	2
	TOTAL	**36**

Course Designers:

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22ECRJ0	AD-HOC NETWORKS AND APPLICATIONS

Category	L	T	P	Credit
PEES	3	0	0	3

Preamble

The objective of this course is to introduce students with fundamental concepts, design issues and solutions to the issues, architectures and protocols and the state-of-the-art research developments in ad hoc and sensor networks. This course also includes VANET enabled safety applications and Intelligent Transport Systems.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

Course Outcomes

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Identify the necessity of Ad Hoc and Sensor networks	TPS 2	70	75
CO2	Use various MAC protocols for Adhoc Network	TPS 3	70	70
CO3	Use various routing protocols for Adhoc Network	TPS 3	70	70
CO4	Use appropriate network protocol to provide solutions for transport layer issues	TPS 3	70	70
CO5	Apply appropriate protocols for sensor network based applications	TPS 3	70	70
CO6	Use VANET to disseminate information for intelligent transport systems	TPS 3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L	L	L	-	-	-	L	M	M	-	-	L	-	L
CO2	S	M	L	L	-	-	-	L	M	M	-	-	M	-	L
CO3	S	M	L	L	-	-	-	L	M	M	-	-	M	-	L
CO4	S	M	L	L	L	-	-	L	M	M	-	-	M	L	L
CO5	S	M	L	L	L	-	-	L	M	M	-	-	M	L	L
CO6	S	M	L	L	L	-	-	L	M	M	-	-	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam(%)		
	CAT – I(%)			Assg. I *(%)			CAT – II(%)			Assg. II *(%)					
TPS / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	10	20	100			-			100			-	5	-
CO2	-	10	20				-						-	5	15
CO3	-	10	30				-						-	5	15
CO4	-						-	10	20				-	5	15
CO5	-						-	10	30				-	5	15
CO6	-						-	10	20				-	5	10
Total	-	30	70	100			-	30	70	100			-	30	70

Syllabus

Ad-hoc Mac: Design Issues in Ad-Hoc Networks - MAC Protocols – Issues, Classifications of MAC protocols: Contention Based Protocols, Contention Based Protocols with reservation mechanisms, Contention Based Protocols with Scheduling Mechanism – MAC protocol with Directional Antenna - Multi channel MAC & Power control MAC protocol. **Ad-Hoc Routing and Transport layer protocols:** Issues – Classifications of routing protocols: Table Driven Protocols, On-Demand Routing Protocols, Hybrid Routing Protocols – Hierarchical and Power aware Routing Protocols – Ad Hoc Transport Layer Issues, TCP Over Ad Hoc – Feedback based, TCP with explicit link, TCP-Bus, Ad Hoc TCP, and Split TCP.
Wireless Sensor Networks: Introduction **–** Design Issues and challenges – Energy consumption – Clustering of sensors, MAC and Routing mechanisms of WSN **Applications and Case studies in WSN:** Target detection – Habitat Monitoring – Environment disaster Monitoring. **VANET**- Introduction to VANET and its Applications-VANET enabled Active Safety Applications -Infrastructure-to-vehicle applications Vehicle-to-vehicle applications, Pedestrian-to-vehicle applications **Information Dissemination in VANETs –**Intelligent Transport Systems (ITS) Introduction Obtaining Local Measurements Information Transport Protocols for information transport Improving network connectivity Geographical Data Aggregation

Text Book

- C.Siva Ram Murthy and B.S. Manoj, “Ad Hoc Wireless Networks – Architectures and Protocols”, Pearson Education, 2008.

Reference Books

- Feng Zhao and Leonidas Guibas, “Wireless Sensor Networks”, Morgan Kaufman Publishers, 2010.
- Hannes Hartenstein Kenneth P Laberteaux, “VANET: Vehicular Applications and Inter-Networking Technologies”, Wiley 2010.
- Jun Zheng and Abbas Jamalipour,“Wireless Sensor Network A Networking Perspective”, A John Wiley & Sons, Inc., Publication,2009.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Introduction to the Course, COs POs	1
1	**Ad-hoc Mac: (9)**	
2	Design Issues in Ad-Hoc Networks - MAC Protocols – Issues	1
3	Classifications of MAC protocols: Contention Based Protocols, Contention Based Protocols with reservation mechanisms	3
4	Contention Based Protocols with Scheduling Mechanism	2
5	MAC protocol with Directional Antenna - Multi channel MAC & Power control MAC protocol	3
	Ad-Hoc Routing and Transport layer protocols: (9)	
6	Issues – Classifications of routing protocols:	1
7	Table Driven Protocols, On-Demand Routing Protocols	2
8	Hybrid Routing Protocols – Hierarchical and Power aware Routing Protocols	2
9	Ad Hoc Transport Layer Issues, TCP Over Ad Hoc, Feedback based,	2
10	TCP with explicit link, TCP-Bus, Ad Hoc TCP, and Split TCP	2
	Wireless Sensor Networks: (8)	
11	Design Issues and challenges	1
12	Energy consumption	1
13	Clustering of sensors,	1
14	MAC and Routing mechanisms of WSN	2
15	Applications and Case studies in WSN: Target detection – Habitat Monitoring – Environment disaster Monitoring.	3

	VANET: (5)	
16	Introduction to VANET and its Applications	1
17	VANET enabled Active Safety Applications	1
18	Infrastructure-to-vehicle applications Vehicle-to-vehicle applications, Pedestrian-to-vehicle applications	3
	Information Dissemination in VANETs: (5)	
19	Intelligent Transport Systems (ITS) Introduction, Obtaining Local Measurements	2
20	Information Transport Protocols for information transport	1
21	Improving network connectivity Geographical Data Aggregation	2
	TOTAL	**36**

Course Designers:

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22ECRK0	BLOCKCHAIN AND APPLICATIONS

Category	L	T	P	Credit
PEES	3	0	0	3

Preamble

Blockchain is an emerging technology platform for developing decentralized applications and data storage. This course includes the fundamental design and architectural primitives of Blockchain along with consensus mechanisms, crypto currencies, and smart contracts. The applications of Blockchain have now spread from crypto-currencies to various other domains, including business process management, IoT, trustworthy e-governance and so on.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

Course Outcomes

G30 CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Determine the role of Hash functions and digital signature as blockchain primitives	TPS 3	70	70
CO2	Describe the operations of Bitcoin and Ethereum	TPS 2	70	75
CO3	Apply the distributed consensus mechanisms of proof of work and proof of stake	TPS 3	70	70
CO4	Use the scripting language to write smart contracts and blockchain platforms to develop hyperledgers	TPS 3	70	70
CO5	Use Geth - Mist/ Metamask and hyper Ledger to develop the blockchain framework	TPS 3	70	70
CO6	Build the Blockchain use cases in finance, industry, IoT and e-governance.	TPS 3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	L	-	-	-	-	L	M	M	-	-	M	-	L
CO2	M	L	-	-	-	-	-	L	M	M	-	-	L	-	L
CO3	S	M	L	-	-	-	-	L	M	M	-	-	M	-	L
CO4	S	M	L	-	-	-	-	L	M	M	-	-	M	-	L
CO5	S	M	L	-	-	-	-	L	M	M	-	-	M	-	L
CO6	S	M	L	-	-	-	-	L	M	M	-	-	M	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam(%)		
	CAT – I(%)			Assg. I *(%)			CAT – II(%)			Assg. II *(%)					
TPS / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	10	30	100			-						-	5	15
CO2	-	20	-				-						-	5	-
CO3	-	10	30				-						-	5	15
CO4	-						-	10	20	100			-	5	15
CO5	-						-	10	30				-	5	15
CO6	-						-	10	20				-	5	10
Total	-	**40**	**60**	**100**			**-**	**30**	**70**	**100**			**-**	**30**	**70**

Syllabus

Cryptography and Blockchain: Blockchain Mechanism – Centralization Vs Decentralization – P2P Systems - Transactions and Blocks - Consensus - Cryptographic Hash functions - SHA 256 - Proof of membership - Digital Signatures - Public Key Cryptosystems - encryption schemes and elliptic curve cryptography, Types of Blockchains.**Bitcoin:** Bitcoin transactions - Bitcoin script - Wallet - Ledger - Bitcoin Blocks - Bitcoin Network - Mining - Proof -of- Work Consensus - Cryptocurrency. **Ethereum**: The Ethereum Network – Components of Ethereum Ecosystem – Ethereum Programming Languages: Runtime Byte Code, Blocks and Blockchain- EVM - Smart Contract -Solidity. **Blockchain Development Frameworks:** Ethereum Development framework - Geth - Mist/Metamask-Web3 -HyperLedger as a Protocol - Reference Architecture - Hyperledger Fabric. **Applications and Emerging Trends:** Distributed applications - Blockchain interoperability - Non-Fungible Tokens (NFTs)- Scalability -Alt coins- Case studies - Finance, Industry – supply chain management, e-governance, Land Registration, Internet of Things, Medical Record Management System, and Domain Name Service.

Text Book

- Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained”, Second Edition, Packt Publishing, 2018

Reference Books

- S.Shukla, M.Dhawan, S.Sharma, S. Venkatesan, “Blockchain Technology: Cryptocurrency and Applications”, Oxford University Press, 2019.
- M.Antonopoulos, “Mastering Bitcoin”, Second Edition, O’Reilly Publishers .2017.
- Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction. Princeton University Press ,2016.
- D. Drescher, ‘Blockchain Basics’ First Edition, Apress, 2017.
- Ambadas Tulajadas Choudhari, “Blockchain for Enterprise Application Developers”, Wiley Publication, 2016
- Anshul Kaushik, “Block Chain & Crypto Currencies”, Khanna Publication, 2018
- NPTEL Course on Blockchain architecture design and use cases: https://nptel.ac.in/courses/106/105/106105184/
- NPTEL Course on Introduction to Blockchain technology and applications: https://nptel.ac.in/courses/106/104/106104220/#
- Virtual Lab: http://vlabs.iitb.ac.in/vlabs-dev/labs/blockchain/

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Introduction to the Course, COs POs	1
	Cryptography and Blockchain: (8)	
1	Blockchain Mechanism	1
2	Centralization Vs Decentralization, P2P Systems	1
3	Transactions and Blocks - Consensus	2
4	Cryptographic Hash functions - SHA 256 - Proof of membership - Digital Signatures	2
5	Public Key Cryptosystems - encryption schemes	1
6	Elliptic curve cryptography, Types of Blockchains	1
	Bitcoin: (7)	
7	Bitcoin transactions	1
8	Bitcoin script - Wallet - Ledger	2
9	Bitcoin Blocks - Bitcoin Network - Mining	2
10	Proof -of- Work Consensus - Cryptocurrency	2
	Ethereum: (7)	
11	The Ethereum Network – Components of Ethereum Ecosystem	1
12	Ethereum Programming Languages: Runtime Byte Code	2
13	Blocks and Blockchain- EVM	2
14	Smart Contract -Solidity	2
	Blockchain Development Frameworks: **(7)**	
15	Ethereum Development framework	1
16	Geth - Mist/Metamask	2
17	Web3 -HyperLedger as a Protocol - Reference Architecture -	2
18	Hyperledger Fabric	2
	Applications and Emerging Trends: **(7)**	
19	Distributed applications - Blockchain interoperability	2
20	Non-Fungible Tokens (NFTs)- Scalability Alt coins	1
21	Case studies - Finance, Industry – supply chain management, e-governance, Land Registration	2
22	Internet of Things, Medical Record Management System, and Domain Name Service	2
	TOTAL	**36**

Course Designers:

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22ECPQ0	CRYPTOGRAPHY AND CYBERSECURITY

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

The objectives of this course are to provide in-depth understanding of the underlying concepts of cryptographic techniques along with their network security applications. This course also includes various cybersecurity attacks and countermeasures.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

Course Outcomes

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Identify the threats and security attacks in the networks and corresponding services and mechanism	TPS 2	70	75
CO2	Use conventional encryption technique, classical encryption technique and modern encryption technique	TPS 3	70	70
CO3	Use Asymmetric encryption algorithm and Diffie-Hellman algorithm, Elliptic Curve Cryptography	TPS 3	70	70
CO4	Identify threats and services of cyber security	TPS 3	70	70
CO5	Use security tools and counter measures to overcome the cyber attacks	TPS 3	70	70
CO6	Relate various system security attacks along with their countermeasures	TPS 3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L	L	-	-	-	-	L	M	M	-	-	L	-	L
CO2	S	M	L	L	-	-	-	L	M	M	-	-	M	-	L
CO3	S	M	L	L	-	-	-	L	M	M	-	-	M	-	L
CO4	S	M	L	L	-	-	-	L	M	M	-	-	M	L	L
CO5	S	M	L	L	-	-	-	L	M	M	-	-	M	L	L
CO6	S	M	L	L	-	-	-	L	M	M	-	-	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam(%)		
	CAT – I(%)			Assg. I *(%)			CAT – II(%)			Assg. II *(%)					
TPS / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	20	-	100			-						-	5	-
CO2	-	10	30				-						-	5	15
CO3	-	10	30				-						-	5	15
CO4	-						-	10	20	100			-	5	15
CO5	-						-	10	30				-	5	15
CO6	-						-	10	20				-	5	10
Total	-	**40**	**60**	**100**			**-**	**30**	**70**	**100**			**-**	**30**	**70**

Syllabus

Conventional Encryption: Introduction Conventional Encryption model Data Encryption Standard block cipher Encryption algorithms confidentiality Key distribution. **Public Key Encryption and Hashing**: Principles of Public key cryptosystems Number Theory-discrete Logarithms RSA algorithm Diffie-Hellman Key Exchange, Elliptic curve cryptography Message authentication and Hash function Hash MAC algorithms Digital signatures. **System Security**: Intruders Intrusion detection-password management -Viruses and related threats-Worms Firewall design Trusted systems Antivirus techniques digital immune systems. Case study-Secure Electronic Transaction **Cyber Security** – History of Internet – Impact of Internet – CIA Triad; Reason for Cyber Crime – Need for Cyber Security – History of Cyber Crime; Cybercriminals – Classification of Cybercrimes – A Global Perspective on Cyber Crimes; Cyber Laws – The Indian IT Act – Cybercrime and Punishment. **Attacks and Countermeasures** OSWAP; Malicious Attack Threats and Vulnerabilities: Scope of Cyber-Attacks – Security Breach – Types of Malicious Attacks – Malicious Software – Common Attack Vectors – Social engineering Attack – Wireless Network Attack – Web Application Attack – Attack Tools – Countermeasures

Text Book

- William Stallings, “Cryptography and network security”, 4th Edition, PHI, 2012

Reference Books

- W.R. Cheswick, S.M. Bellovin and A.D. Rubin, “Firewalls and Internet Security”, Addison Welseyy, 2003.
- Anand Shinde, “Introduction to Cyber Security Guide to the World of Cyber Security”, Notion Press, 2021.
- Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd., 2011
- R. C. Mishra, “Cyber Crime Impact in the New Millennium”, Author Press. 2010
- NPTEL course on Cryptography and network security: https://nptel.ac.in/courses/106105031/

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Introduction to the Course, COs POs	1
1	**Conventional Encryption**: **(6)**	
2	Introduction Conventional Encryption model	1
3	Data Encryption Standard	2
4	block cipher Encryption algorithms and confidentiality	2
5	Key distribution	1
	Encryption and Hashing: (10)	
6	Principles of Public key cryptosystems Number Theory-discrete	1

	Logarithms	
7	RSA algorithm	2
8	Diffie-Hellman Key Exchange,	2
9	Elliptic curve cryptography	2
10	Message authentication and Hash function and Hash MAC algorithms	2
11	Digital signatures	1
	System Security: (7)	
12	Intruders Intrusion detection-password management	1
13	Viruses related threats and Worms	1
14	Firewall design	2
15	Trusted systems Antivirus techniques digital immune systems.	2
16	Case study-Secure Electronic Transaction	1
	Cyber Security: (6)	
17	History of Internet – Impact of Internet – CIA Triad; Reason for Cyber Crime – Need for Cyber Security – History of Cyber Crime;.	2
18	Cybercriminals – Classification of Cybercrimes – A Global Perspective on Cyber Crimes;	2
19	Cyber Laws – The Indian IT Act – Cybercrime and Punishment	2
	Attacks and Countermeasures: **(7)**	
20	OSWAP; Malicious Attack Threats and Vulnerabilities: Scope of Cyber-Attacks – Security Breach	2
21	Types of Malicious Attacks – Malicious Software – Common Attack Vectors	1
22	Social engineering Attack – Wireless Network Attack – Web Application Attack	2
23	Attack Tools – Countermeasures	
	TOTAL	**36**

Course Designers:

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22ECPR0	CONTROL SYSTEMS

Category	L	T	P	Credit
PSE	2	1	0	3

Preamble

Control Systems plays vital role in the advance of engineering and science. Automatic control has become an important and integral part of modern manufacturing and industrial processes. Advances in the theory and practice of automatic control provide the means for attaining optimal performance of dynamic systems improving productivity.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Compute transfer function of multiple subsystems modelled as state space representation.	TPS 3	70	60
CO2	Compute transfer function of multiple subsystems modelled as block diagram and signal flow graph.	TPS 3	70	60
CO3	Compute and describe the output response and steady state error of first, second and higher order systems for standard input signals	TPS 3	70	60
CO4	Determine the stability of a system using Routh Hurwitz criterion.	TPS 3	70	60
CO5	Determine the stability of a system using Root locus and Nyquist criterion.	TPS 3	70	60
CO6	Find the closed loop frequency response and time response parameter given the open loop frequency response.	TPS 3	70	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	L	-	L	-	-	M	M	M	-	L	M	-	M
CO2	S	M	L	-	L	-	-	M	M	M	-	L	M	-	M
CO3	S	M	L	-	L	-	-	M	M	M	-	L	M	-	M
CO4	S	M	L	-	L	-	-	M	M	M	-	L	M	-	M
CO5	S	M	L	-	L	-	-	M	M	M	-	L	M	-	M
CO6	S	M	L	-	L	-	-	M	M	M	-	L	M	-	M

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II *(%)					
TPS / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	10	20	100			-			100			-	4	10
CO2	-	10	20				-						-	4	10
CO3	-	10	30				-						-	4	15
CO4	-						-	10	20	100			-	-	15
CO5	-						-	10	30				-	4	15
CO6	-						-	10	20				-	4	15
Total	-	30	70	100			-	30	70	100			-	20	80

Syllabus

Modeling of Control Systems: Basic control system components: Open loop LTI systems, closed loop LTI systems, transfer function, electrical network transfer function, Electric circuits, general state-space representation, converting a transfer function to state space, converting from state space to a transfer function. **Reduction of multiple subsystems:** Block diagram representation, Analysis and Design of Feedback Systems Signal flow graph, Mason's Rule, Signal flow graphs of state equation. **Transient and steady-state analysis of LTI systems:** Poles, zeros and system response, first order systems, second order Systems, General second order systems, underdamped second order systems, Higher order systems, System response with additional poles, system response with zeros, Steady state error analysis. **Stability:** Routh Hurwitz criterion, Root locus techniques: Lag, lead and lag-lead compensation, Nyquist stability. **Frequency response techniques:** Bode plot, Nyquist diagram, Gain margin, phase margin, transient response via gain adjustment, Lag compensation, Lead compensation, Lag-Lead compensation

Text Book

- Norman S. Nise, 'Control Systems Engineering, Wiley India Edition, 2019
- G. Franklin, J. Powell, A.Emami-Naemi, 'Feedback Control of Dynamical Systems', Pearson, 8th Edition, 2019.
- R. C. Dorf, R. H. Bishop, 'Modern Control Systems', Pearson; 13th edition, 2016.
- K. Ogata, 'Modern Control Engineering', Pearson Education India; 5th edition, 2015

Reference Books

- M. Gopal, Control Systems: Principles and Design, 2nd Ed., Tata McGraw-Hill, 2012
- P. Belanger, Control Engineering: A modern approach, Saunders College Publishing, s1995.
- https://onlinecourses.nptel.ac.in/noc20_ee90/preview , C.S.Shankar Ram, IIT Madras

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Introduction to the Course, COs POs	1
1	**Modeling of Control Systems**, ,	
2	Basic control system components: Open loop LTI systems, closed loop LTI systems,	1
3	transfer function, electrical network transfer function ,Electric circuits,	1
4	general state-space representation,	1
5	converting a transfer function to state space	1
6	converting from state space to a transfer function	1
	Reduction of multiple subsystems,	
6	Block diagram representation	1
7	Analysis and Design of Feedback Systems	1
8	Signal flow graph	1
9	Mason's Rule	1
10	Signal flow graphs of state equation	2
	Transient and steady-state analysis of LTI systems	
11	Poles, zeros and system response	1
12	first order systems	1
13	second order Systems	1
14	General second order systems	1
15	underdamped second order systems	1
16	Higher order systems	1
17	System response with additional poles	1
18	system response with zeros, Steady state error analysis	1

	Stability	
19	Routh Hurwitz criterion	2
20	Root locus techniques	2
21	Lag, lead and lag-lead compensation,	2
22	Nyquist stability	2
	Frequency response techniques:	
23	Bode plot,	2
24	Nyquist diagram, Gain margin, phase margin	2
25	transient response via gain adjustment	2
24	Lag compensation, Lead compensation, Lag-Lead compensation	2
	TOTAL	**36**

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22ECPS0	VLSI DEVICE MODELING

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

In the ever-evolving landscape of VLSI systems, MOSFETs have emerged as the cornerstone of present and future generations. The VLSI industry has strategically transitioned towards the exclusive utilization of MOSFETs across all functionalities. This course serves as an introduction to the fundamental principles of device modeling, a discipline that amalgamates device physics with experimentally derived characteristics. Through this synthesis, participants will gain insights into formulating predictive equations and expressions that delineate device performance across various excitation scenarios

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Understand the fundamentals of VLSI device physics.	TPS 3	70	60
CO2	Analyze the I-V characteristics of MOSFET in a Long channel MOSFET.	TPS 3	70	60
CO3	Grasp the CMOS scaling theory, understand the threshold voltage requirements, and the effects of short-channel MOSFET	TPS 3	70	60
CO4	Explore advanced CMOS engineering techniques including quantum confinement.	TPS 3	70	60
CO5	Understand the operation principles and characteristics of non-classical transistors including SOI MOSFETs.	TPS 3	70	60
CO6	Learn the TCAD simulation flow for IC process and device simulation, including numerical solution methods.	TPS 3	70	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	L	-	-	-	-	-	L	L	-	-	M	-	L
CO2	S	M	L	-	-	-	-	-	L	L	-	-	M	-	L
CO3	S	M	L	-	-	-	-	-	L	L	-	-	M	-	L
CO4	S	M	L	-	-	-	-	-	L	L	L	-	M	-	L
CO5	S	M	L	-	-	-	-	-	L	L	L	-	M	-	L
CO6	S	M	L	-	M	-	-	-	L	L	L	-	M	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II *(%)					
TPS / Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	5	10	10	100			-						-	4	10
CO2	5	10	10				-						-	4	10
CO3	10	10	30				-						-	4	15
CO4	-						5	10	10	100			-	2	15
CO5	-						5	10	30				-	2	15
CO6	-						10	10	10				-	4	15
Total	**20**	**30**	**50**	**100**			**20**	**30**	**50**	**100**			**-**	**20**	**80**

Syllabus

Introduction to VLSI Device Modeling: Overview of VLSI technology and its importance**,** Semiconductor materials and their properties**,** Crystal structure and lattice constants**,** Energy band theory and charge carriers**,** Carrier transport mechanisms, MOSFET structure and operation**,** Threshold voltage and its dependence on device parameters.

Long Channel Effects: Ideal MOS C-V Characteristics, Effect of non-idealities on C-V, MOS Parameter extraction from C-V characteristics and I-V characteristics - MOSFET Channel Mobility – MOSFET capacitances, Inversion-Layer Capacitance effect and Frequency-dependent capacitance.

MOSFET Scaling and Short Channel Effects: CMOS Scaling theory - Threshold-Voltage Requirement – MOSFET Channel Length - Short Channel MOSFETs: Drain Induced Barrier Lowering, Channel Length Modulation, Velocity saturation, Punch through Effect, Hot Carrier effects, threshold roll-off, Sub-threshold conduction, Mobility Degradation.

MOSFET Scaling and Short Channel Effects: CMOS Scaling theory– MOSFET Channel Length - Short Channel MOSFETs: Drain Induced Barrier Lowering, Channel Length Modulation, Velocity saturation, Punch through Effect, Hot Carrier effects, threshold roll-off, Sub-threshold conduction, Mobility Degradation.

CMOS Engineering and Technological Remedies: Quantum effects, Volume inversion, Channel and Source / Drain engineering, High-k dielectric, Strain engineering, Multigate technology mobility, Gate stack Engineering, Halo implants.

Non – Classical Transistors: SOI MOSFET structures, Partially Depleted (PD) and Fully Depleted SOI MOSFETs – Double Gate, Surrounding Gate, Multigate MOSFETs – FINFETs - TFETs – HEMTs – Silicon Nanowires – Junction less FETs.

TCAD Simulation: TCAD Flow for IC Process and Device Simulation, Numerical Solution Methods, Drift Diffusion Calculations, Energy Balance Calculation, Classical Models - Thermodynamic and Schrodinger Model - Random Dopant Fluctuations, Ballistic Transport.

Text Book

- Das Gupta, Nandita, and Amitava Das Gupta. Semiconductor devices: Modelling and Technology. PHI Learning Pvt. Ltd., 2004.

Reference Books

- N. B. Balamurugan - “Analog Electronic circuits: Theory and Practicals”, AICTE, New Delhi, 2024, https://ekumbh.aicte-india.org/book.php#.
- Y. Taur and T. H. Ning – “Fundamentals of Modern VLSI Devices”, Cambridge University Press, Cambridge, United Kingdom, 2014.
- A.B.Bhattacharyya – “Compact MOSFET Models for VLSI Design”, John Wiley, 2015
- Trond Ytterdal, Yuhua Cheng and Tor A. Fjeldly Wayne Wolf – “Device Modeling for Analog and RF CMOS Circuit Design”, John Wiley & Sons Ltd, 2015
- J.P.Colinge —FinFETs and other Multigate Transistors‖, Springer, Germany, 2010.
- Visvendra Singh Poonia, IIT Roorkee, Physics of Nano Scale Devices, NPTEL video Lectures: https://onlinecourses.nptel.ac.in/noc24_ee70.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Introduction to VLSI Device Modeling:	
1	Overview of VLSI technology and its importance.	2
2	Semiconductor materials and their properties, Crystal structure and lattice constants	2
3	Energy band theory and charge carriers.	1
4	Carrier transport mechanisms	2
5	MOSFET structure and operation, Threshold voltage and its dependence on device parameters.	1
	Long Channel Effects:	
6	Ideal MOS C-V Characteristics, Effect of non-idealities on C-V.	1
7	MOS Parameter extraction from C-V characteristics and I-V characteristics.	1
8	MOSFET Channel Mobility.	1
9	MOSFET capacitances, Inversion-Layer Capacitance effect and frequency dependent capacitance.	1
	MOSFET Scaling and Short Channel Effects:	
10	CMOS Scaling theory	1
11	Threshold-Voltage Requirement	1
12	MOSFET Channel Length	1
13	Short Channel MOSFETs: Drain Induced Barrier Lowering, Channel Length Modulation, Velocity saturation, Punch through Effect, Hot Carrier effects, threshold roll-off, Sub-threshold conduction, Mobility Degradation.	1
	MOSFET Scaling and Short Channel Effects:	
14	Quantum effects, Volume inversion	1
15	Channel and Source / Drain engineering.	2
16	High-k dielectric, Strain engineering	1
17	Multigate technology mobility	1
18	Gate stack Engineering, Halo implants.	1
	Non – Classical Transistors:	
19	SOI MOSFET structures.	1
20	Partially Depleted (PD) and Fully Depleted SOI MOSFETs.	1
21	Double Gate.	1
22	Surrounding Gate, Multigate MOSFETs.	1
23	FINFETs - TFETs – HEMTs.	1
24	Silicon Nanowires – Junctionless FETs.	1
	TCAD Simulation:	
25	TCAD Flow for IC Process and Device Simulation, Numerical Solution Methods.	1
26	Drift Diffusion Calculations, Energy Balance Calculation.	1
27	Classical Models - Thermodynamic and Schrodinger Model.	1
28	Random Dopant Fluctuations, Ballistic Transport.	1
	TOTAL	**36**

Course Designers:

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- Dr.V.R.Venkatasubramani venthiru@tce.edu
- Dr.J.Shanthi jsiece@tce.edu

SYLLABI

FOR

INDUSTRY SUPPORTED COURSES

B.E. DEGREE PROGRAMME

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

FOR THE STUDENTS ADMITTED IN THE

ACADEMIC YEAR 2022-23 ONWARDS

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
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22EC1A0	FIELD TESTS FOR 5G COMMUNICATION	Category	L	T	P	Credit
		PEES	1	0	0	1

Preamble

The advent of the Fifth Generation of Mobile Networks is creating a huge expectation in the enhancements of mobile services regarding higher throughput, low latency, ultra-high reliability, and higher connectivity density. The main goal of field test is to determine the throughput and coverage that the 5G-range transceiver can achieve under real conditions. This course aims to provide solid foundation on basic understanding of RF test and measurements for 5G, base station RF parametric test, Interference troubleshooting, electromagnetic field measurements, Over the air test and Inter-RAT (Radio access technology).

Prerequisite

Nil

Course Outcomes

On the successful completion of the course students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Interpret RF test instruments, passive & active component test and characterization	TPS 2	70	60
CO2	Illustrate the base station test, EVM measurement, Interference troubleshooting with real time spectrum analysis	TPS 3	70	60
CO3	Illustrate the EM field measurement test, OTA, Coverage test with phased array antenna, Inter-RAT	TPS 3	70	60

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	M	L	-	-	-	-	-	-	-	-	-	-	M	-	L
CO2	S	M	L	-	S	-	-	-	M	M	-	-	M	M	L
CO3	S	M	L	-	S	-	-	-	M	M	-	-	M	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

TPS Scale / CO	Continuous Assessment Test-I (%)			Terminal Exam (%)		
	1	**2**	**3**	**1**	**2**	**3**
CO1	-	10	20	-	10	20
CO2	-	5	30	-	5	30
CO3	-	5	30	-	5	30
Total	**-**	**20**	**80**	**-**	**20**	**80**

Syllabus

RF concepts and understanding of RF Test & RF Instruments -Frequency vs Time domain analysis - testing active and passive devices **Base station RF Parametric Test** - Performance verification of gNB such as cable and antenna conditions, transmit power, RF spurious responses. **Interference troubleshooting with Real time Spectrum Analysis** - Detect 5G synchronization signals and interference with RTSA, EVM measurement, detection of SSB offset, subcarrier spacing. **Electromagnetic Field Measurement for total human RF exposure** - Measurement of total field strength, Pass/fail limit testing. **5G NR Over the air testing** - Capturing and demodulating over-the-air transmissions of 5G NR FR1 and FR2 control channels, key performance indicators, isolate power issues **Coverage test with phased array antenna** - Coverage testing of 5G base stations, collecting signal power data across azimuth and elevation. **Inter-RAT (Radio access technology) optimization** - RAT handovers between 4G and 5G networks in non-standalone (NSA) mode.

Learning Resources

- Joel P. Dunsmore, Handbook of Microwave Component Measurements: with Advanced VNA Techniques, 2nd Edition, Wiley, 2020.
- Carvalho N, Schreurs D, Microwave and Wireless Measurement Techniques, Cambridge University Press, 2013.
- Allen W. Scott, Rex Frobenius, RF Measurements for Cellular Phones and Wireless Data Systems, Wiley-IEEE Press, 2011.
- Richard Collier, Doug Skinner, Microwave Measurements, Third edition, IET, 2007.

Course Contents and Lecture Schedule

No.	Topic	Lecture Hours
1.	**RF concepts and basic understanding of RF Test & RF Instruments** -Frequency vs Time domain, spectrum analysis	2
2.	Testing active and passive devices, time domain analysis.	2
3.	**Base station RF Parametric Test** - Performance verification of gNB such as cable and antenna conditions, transmit power, RF spurious responses.	2
4.	**Interference troubleshooting with Real time Spectrum Analysis** - Detect 5G synchronization signals and interference with RTSA, EVM measurement, detection of SSB offset, subcarrier spacing	2
5.	**Electromagnetic Field Measurement for total human RF exposure** - Measurement of total field strength, Pass/fail limit testing.	1
6.	**5G NR Over the air testing** - Capturing and demodulating over-the-air transmissions of 5G NR FR1 and FR2 control channels, key performance indicators, isolate power issues.	2
7.	**Coverage test with phased array antenna** - Coverage testing of 5G base stations, collecting signal power data across azimuth and elevation	2
8.	**Inter-RAT (Radio access technology) optimization** - RAT handovers between 4G and 5G networks in non-standalone (NSA) mode.	1
Total Hours		**14**

Course Designers:

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- Dr.S.Kanthamani skmece@tce.edu
- Dr.K.Vasudevan kvasudevan@te.edu

22EC1B0	DEEP LEARNING WITH TENSOR FLOW

Category	L	T	P	Credit
PEES	1	0	0	1

Preamble

Deep Learning has received a lot of attention over the past few years and has been employed successfully by companies like Google, Microsoft, IBM, Facebook, Twitter. Recent developments in deep learning approaches have significantly advanced the performance of many computer visionapplications. This course is a deep dive into the details of deep learning architecture with a focus on learning end-to-end models for the image classification task. Students will gain a detailed understanding of neural networks and will learn to implement and train their neural networks.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Illustrate the design of deep neural network architecture.	TPS 3	70	70
CO2	Explore an entire TensorFlow deep learning pipeline.	TPS 3	70	70
CO3	Construct the design of convolutional neural network architecture.	TPS 3	70	70
CO4	Make use of the Alexnet deep convolutional model for imageclassification.	TPS 3	70	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L	-	-	-	-	-	-	L	-	-	M	L	L	L
CO2	S	M	L	-	M	-	-	-	M	-	-	M	M	L	M
CO3	S	M	L	-	M	-	-	-	M	-	-	M	M	L	M
CO4	S	M	L	-	M	-	-	-	M	-	-	M	M	L	M

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

	CAT – I (%)			Terminal Exam (%)		
TPS / CO	1	2	3	1	2	3
CO1	-	5	20	-	5	20
CO2	-	5	20	-	5	20
CO3	-	5	20	-	5	20
CO4	-	5	20	-	5	20
Total	-	20	80	-	20	80

Syllabus

Learning Paradigms: AI, Machine learning, Deep learning, ANN, Designing a Deep Neural Network**. Tensor flow and its elements:** TensorFlow's core API, tensors, operations, graphs, and sessions. Running a simple TensorFlow net and establishing a baseline, Dropout, testing different optimizers in TensorFlow, Increasing the number of epochs, Controlling the optimizer learning rate**. Convolutional Neural Network:** CNN Architecture, CNN for classification: Training, vanishing gradients,Testing, Validation**. Deep Convolutional Model:**

Alexnet Architecture, Anchor boxes**,** Loss functions. **Case Study:** Alexnet based Image classification by Transfer learning with TensorFlow. Auto Encoders.

Learning Resources

- GGiancarlo Zaccone, Md. Rezaul Karim, "Deep Learning with TensorFlow: Explore neural networks with Python", 2018.
- Kapoor, Amita, Gulli, Antonio, Pal, Sujit, Chollet, Francois, "Deep learning with Tensor Flow and Keras 3/e, ISBN: 9781803232911, 2017.
- Ian Goodfellow, Yoshuva Benjio, Aaron Courville, "Deep Learning", MIT Press, 2016.
- Richard O Duda, Peter E. Hart, David G. Stork, "Pattern Classification", Wiley, 2/e, 2007.
- Dr.Prabir Kumar Biswas, Deep Learning, NPTEL Video Lectures: https://nptel.ac.in/courses/106/105/106105215/
- https://www.coursera.org/specializations/deep-learning
- https://online.stanford.edu/courses/cs230-deep-learning

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Learning Paradigms:	
1.	AI, Deep learning, ANN, Designing a Deep Neural Network: Neural Networks, Architecture with one hidden layer	1
2.	Activation function, Derivatives, Gradient Descent, Batch size, Scaling features, number of epochs, Optimization, Hyperparameterstuning	1
3.	Batch Normalization, drop out, learning rate, Loss function, choosing the loss function: Regression loss (MSE), Binary classification loss and multi-classification loss	2
	Simple neural network using TensorFlow:	
4.	Running a simple TensorFlow net and establishing a baseline	1
5.	Improving the simple net in TensorFlow with hidden layers and Dropout	1
6.	Testing different optimizers in TensorFlow	1
7.	Increasing the number of epochs, Controlling the optimizer learningrate	1
	Convolutional Network	
8.	CNN Architecture:Convolution	1
9.	Stride and padding in convolutional layers, activation function, Pooling layers, Normalization, FCN	1
10.	CNN for classification: Training, Testing, Validation	1
	Deep Convolutional Model Alexnet	
11.	Anchor boxes, Ground Truth Anchor boxes, Loss functions	1
12.	Alexnet Model Architecture	1
13.	**Case Study:** Alexnet based image classification	1
		14

Course Designers:

- Dr. D.Antony Louis Piriyakumar, antony@piriyakumar.co.in. Indian patent agent, Founder director, BudhiAI (GoI recognized Startup)
- Dr.S.Md.Mansoor Roomi, smmroomi@tce.edu
- Dr.B.Yogameena, ymece@tce.edu
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22EC1C0	EMBEDDED FIRMWARE

Category	L	T	P	Credit
PEES	1	0	0	1

Preamble

Embedded systems have seamlessly integrated into the fabric of contemporary society, permeating sectors ranging from domestic appliances and transportation networks to cutting-edge healthcare devices and industrial machinery. Proficiency in understanding embedded systems serves as a cornerstone for a prosperous career in Embedded Engineering. This course explores the pivotal role of the C and RUST programming languages in the realm of embedded systems, along with practical applications of data structures. Participants will delve into the intricacies of the power-on-reset sequence of an MCU, bootloader functionality, and the memory organization of C programs. Through meticulously crafted practical demonstrations, participants will glean a comprehensive understanding of these concepts, ensuring a robust grasp of embedded systems principles.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Compile and build a C program using cross-compiler for MCU by developing linker and make files and understand the various memory sections of the program's executable	TPS 3	70	60
CO2	Develop startup code for an MCU	TPS 3	70	60
CO3	Design and develop bootloader	TPS 3	70	60
CO4	Implement embedded C, RUST and Data structure concepts	TPS 3	70	60

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	S	M	M	-	S	-	-	-	M	L	-	L	M	M	L
CO2	S	M	L	-	S	-	-	-	M	L	-	L	M	M	L
CO3	S	M	L	-	S	-	-	-	M	L	-	L	M	M	M
CO4	S	M	L	-	S	-	-	-	M	L	-	L	M	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

	CAT – I (%)			Terminal Exam (%)		
TPS Scale / CO	1	2	3	1	2	3
CO1	-	6	20	-	6	20
CO2	-	4	20	-	4	20
CO3	-	6	20	-	6	20
CO4	-	4	20	-	4	20
Total	-	20	80	-	20	80

Syllabus

Language Processing System: Cross-compilation Toolchain, Preprocessing, Compiling, Assembling, Linking and Debugging. **Memory Organization in C:** Memory layout of a C program, Storage Classes. **Boot Sequence:** How a MCU is booted upon Power-on-Reset, Vector Table, Reset Handler, Introduction and development of Startup Code. **Bootloader:** Introduction to Bootloader & Memory Design considerations for bootloader and bootable application, Development of a simple bootloader and bootable application. **Embedded C Programming**: Data types, Variables, Keywords and Constants, Preprocessors, Macros and Board Support Package (BSP)**. Implementation of Data Structure:** Queue, Singly Linked List, Double Linked List. **RUST Programming:** Variables and Data types, Ownership, Structs, Enums, Generics and Traits, Smart Pointers and Memory management. **Version Control System:** Importance of version control system with Git.

Learning Resources

- Using the GNU Compiler Collection, https://gcc.gnu.org/onlinedocs/gcc-8.1.0/gcc/ARM-Options.html
- David E Simon, An Embedded Software Primer, First Edition, 2002
- https://www.beningo.com/wp-content/uploads/images/Papers/bootloader_design_for_microcontrollers_in_embedded_systems%20.pdf
- https://doc.rust-lang.org/book/

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
1.	**Language Processing System:** Cross-compilation Toolchain, Preprocessing, Compiling, Assembling, Linking and Debugging.	1.5
2.	**Memory Organization in C:** Memory layout of a C program, Storage Classes.	1
3.	**Boot Sequence:** How a MCU is booted upon Power-on-Reset, Vector Table, Reset Handler, Introduction and development of Startup Code.	2
4.	**Bootloader:** Introduction to Bootloader & Memory Design considerations for bootloader and bootable application, Development of a simple bootloader and bootable application.	2.5
5.	**Embedded C Programming**: Data types, Variables, Keywords and Constants, Preprocessors, Macros and Board Support Package (BSP)**.**	2
6.	**Implementation of Data Structure:** Queue, Singly Linked List, Double Linked List.	2
7.	**RUST Programming:** Variables and Data types, Ownership, Structs, Enums, Generics and Traits, Smart Pointers and Memory management.	2
8.	**Version Control System:** Importance of version control system, Hands-on demo using Git.	1
Total Hours		14

Course Designers:

- Ms.A.Ishwarya, Senior Firmware Engineer, Analog Devices, ishwarya.ashokkumar@analog.com
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- Dr.G.Prabhakar, gpece@tce.edu

22EC1D0	AUTOMOTIVE RADAR SYSTEMS

Category	L	T	P	Credit
PEES	1	0	0	1

Preamble

Radio Detection and Ranging (Radar) is at the forefront of modern technology, playing crucial roles in various fields like aviation, meteorology, defence, and even automotive safety. Understanding RADAR systems can give insights into the latest technological advancements. In this course, comprehensive insights are offered on Radar terminologies, typical system configurations, and advanced signal processing techniques essential for Radar operations. Moreover, applications in in-cabin radar are highlighted to ensure a thorough understanding of its current practical significance.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Design radar parameters by understanding the terminologies and components of different types Radar.	TPS 3	70	60
CO2	Measure range, doppler shift, angle of arrival and radar cross-section (RCS) using RADAR equations.	TPS 3	70	60
CO3	Detect targets using frequency representation of the received RADAR signal	TPS 3	70	60
CO4	Design automotive in-cabin radar system to monitor the interior of the vehicle to enhance the passenger safety and comfort.	TPS 3	70	60

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	S	M	L	-	-	-	-	-	-	-	-	L	S	-	L
CO2	S	M	L	-	S	-	-	-	M	M	-	L	S	M	L
CO3	S	M	L	-	S	-	-	-	M	M	-	L	S	M	M
CO4	S	M	L	-	S	-	-	-	M	M	-	L	S	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

TPS Scale / CO	CAT – I (%)			Terminal Exam (%)		
	1	2	3	1	2	3
CO1	-	5	20	-	5	20
CO2	-	5	20	-	5	20
CO3	-	5	20	-	5	20
CO4	-	5	20	-	5	20
Total	-	**20**	**80**	-	**20**	**80**

Syllabus

Introduction: Automotive Radar, Types of Automotive Radars, Frequency and Band of Operation, How Radar Sensor Look, Radar sensors on Vehicle, Different types of Radar, FMCW. **Radar Terminologies:** Frequency, Wavelength, Bandwidth, ADC bits, Signal to Noise Ratio (SNR), Noise, Radar Cross Section (RCS), Channel behaviour – properties, Attenuation, Absorption, Multipath. **Typical Radar System:** Components of Radar System, Radar System Design, Design Limitations. **Radar Signal Processing:** Components of Radar Signal processing, Range Equation, Measurement of Range (Distance) & Doppler (Velocity), Measurement of Angle/Angle of Arrival, Measurement of RCS. **Radar Signal Processing using FFT:** Range FFT and Doppler FFT, Angle FFT and RD Map, Clutter Removal and CFAR, Final Detection List. **Automotive in-Cabin Radar:** Near Range Applications - Occupant Detection, Classification, Gesture Recognition, Automotive Radar Trends.

Learning Resources

- Simon Kingsley & Shaun Quegan, Understanding RADAR Systems, McGraw Hill Books Co., 2001.
- Merrill Skolnik, Introduction to RADAR Systems, McGraw Hill Education, 2nd Edition, 2017.
- NPTEL Course, Principles and Techniques of Modern RADAR Systems, https://archive.nptel.ac.in/courses/108/105/108105154/

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
1.	**Introduction**: Automotive Radar, Types of Automotive Radars, Frequency and Band of Operation, How Radar Sensor Looks, Radar sensors on Vehicle, Different types of Radar, FMCW.	1
2.	**Radar Terminologies:** Frequency, Wavelength, Bandwidth, ADC bits, Signal to Noise Ratio (SNR), Noise, Radar Cross Section (RCS), Channel behaviour – properties, Attenuation, Absorption, Multipath.	2
3.	**Typical Radar System:** Components of Radar System, Radar System Design, Design Limitations.	2
4.	**Radar Signal Processing:** Components of Radar Signal processing, Range Equation, Measurement of Range (Distance) & Doppler (Velocity), Measurement of Angle/Angle of Arrival, Measurement of RCS.	2
5.	**Radar Signal Processing using FFT:** Range FFT and Doppler FFT, Angle FFT and RD Map,	2
6.	Clutter Removal and Constant False Alarm Rate (CFAR) Detection, Final Detection List.	2
7.	**Automotive in-Cabin Radar:** Near Range Applications - Occupant Detection, Classification, Gesture Recognition, Automotive Radar Trends	4
Total Hours		15

Course Designers:

- Dr.A.R.Karthikeyan, Sr.Principal Engineer, Harman International India Pvt. Ltd., Karthikeyan.Rajarathinam@harman.com
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22EC1E0	VLSI IMPLEMENTATION OF COMMUNICATION TRANSCEIVERS

Category	L	T	P	Credit
PEES	1	0	0	1

Preamble

In the ever-evolving world of telecommunications, this course delves into communication transceivers and digital signal processing (DSP). Students explore FM transceivers and DSP techniques, laying a robust foundation. Through lectures and labs, they learn digital filter design principles, emphasizing FPGA implementation. The course elucidates PLLs in communication systems, differentiating between analog and digital variants. Practical sessions provide hands-on experience, preparing students to tackle real-world challenges in telecommunications.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Understanding of communication transceivers, including both receivers and transmitters, with a focus on Frequency Modulation (FM) transceivers	TPS 3	70	60
CO2	Acquire knowledge and skills in Digital Signal Processing (DSP) techniques applicable to communication systems, particularly in the context of FM transceivers.	TPS 3	70	60
CO3	Demonstrate proficiency in designing and implementing digital filters using Real-Time Logic (RTL) coding techniques, with a specific emphasis on Finite Impulse Response (FIR) filters	TPS 3	70	60
CO4	Understand the principles and applications of Phase-Locked Loops (PLLs) in communication systems, distinguishing between different types including Integer PLLs and Fractional PLLs	TPS 3	70	60

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	S	M	L	-	-	-	-	-	-	-	-	L	M	-	L
CO2	S	M	L	-	S	-	-	-	M	M	-	L	M	M	L
CO3	S	M	L	-	S	-	-	-	M	M	-	L	M	M	M
CO4	S	M	L	-	S	-	-	-	M	M	-	L	M	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

	CAT – I (%)			Terminal Exam (%)		
TPS Scale / CO	1	2	3	1	2	3
CO1	-	5	20	-	5	20
CO2	-	5	20	-	5	20
CO3	-	5	20	-	5	20
CO4	-	5	20	-	5	20
Total	-	20	80	-	20	80

Syllabus

Introduction to Communication Transceivers: Communication receivers and transmitters**,** Frequency Modulation (FM) transceivers**,** Digital signal processing in communication systems**,** Digital Filters and Phase-Locked Loops (PLLs). **Digital Signal Processing in Communication Transceivers:** FM Transceiver with a focus on digital signal processing techniques, Digital filter design principles and techniques, Real-time logic (RTL) coding for digital synthesis. **Design and Implementation of Digital Filters:** RTL coding and synthesis for digital FIR filters**,** FPGA implementation of digital FIR filters**,** Architectures for digital filters: Pipelining, Parallel architecture, CSD implementation**,** Low power implementation of multi-rate filters. **Phase-Locked Loops (PLLs) in Communication Systems:** Types of PLLs: Integer PLLs, Fractional PLLs**,** Analog vs. digital PLLs: Tradeoffs and applications**,** Analysis of PLL metrics: Response time, Noise bandwidth, Performance evaluation. **Building Blocks of PLLs:** Components of a PLL: Voltage Controlled Oscillator (VCO), Phase Frequency Detector (PFD), Time-to-Digital Converter (TDC) **Laboratory practices:** Emulation of basic digital FIR filters and PLLs on FPGA **I**mplementation of ALU-RAM based multi-rate digital filters

Learning Resources

- PLL Performance, Simulation and Design Handbook 4th Edition, National Semiconductor, http://www.national.com/analog/timing/pll_designbook
- K K Parhi, “VLSI Digital Signal Processing Systems’, Wiley India Pvt Ltd, 2007,
- B Razavi, “RF Microelectronics”, Prentice Hall, 1998

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
1.	**Introduction to Communication Transceivers:** Communication receivers and transmitters**,** Frequency Modulation (FM) transceivers**,** Digital signal processing in communication systems**,** Digital Filters and Phase-Locked Loops (PLLs).	2
2.	**Digital Signal Processing in Communication Transceivers:** FM Transceiver with a focus on digital signal processing techniques, Digital filter design principles and techniques, Real-time logic (RTL) coding for digital synthesis.	2
3.	**Design and Implementation of Digital Filters:** RTL coding and synthesis for digital FIR filters**,** FPGA implementation of digital FIR filters**,** Architectures for digital filters: Pipelining, Parallel architecture, CSD implementation**,** Low power implementation of multi-rate filters.	2
4.	**Phase-Locked Loops (PLLs) in Communication Systems:** Types	2

	of PLLs: Integer PLLs, Fractional PLLs**,** Analog vs. digital PLLs: Tradeoffs and applications**,** Analysis of PLL metrics: Response time, Noise bandwidth, Performance evaluation.	
5.	**Building Blocks of PLLs:** Components of a PLL: Voltage Controlled Oscillator (VCO), Phase Frequency Detector (PFD), Time-to-Digital Converter (TDC)	2
6.	**Laboratory practices:** Emulation of basic digital FIR filters and PLLs on FPGA **I**mplementation of ALU-RAM based multi-rate digital filters	2
Total Hours		**12**

Course Designers:

- Mr.Sundarrajan, Texas Instruments
- Dr.N.B.Balamurugan, nbbalamurugan@tce.edu
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- Dr D.Gracia Nirmala Rami, gracia@tce.edu
- Dr.V.R.Venkatasubramani, venthiru@tce.edu
- Dr.J.Shanthi, jsiece@tce.edu

22EC1F0	EMBEDDED SYSTEM HARDWARE

Category	L	T	P	Credit
PEES	1	0	0	1

Preamble

Microcontrollers are at the heart of almost every engineering system around us. It is essential that an applications engineer is equipped with the knowledge to understand and design an embedded system. This course provides insight on the key components of a microcontroller-based system, focusing on the core peripherals and their interfacing to develop a complete solution. The course aims to bring a hands-on experience to developing firmware on a microcontroller using the latest IDEs and programming/debugging tools.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Explain the architecture of PIC devices, AVR devices and the working of essential peripherals	TPS 2	70	60
CO2	Develop embedded-c code for various peripherals	TPS 3	70	60
CO3	Use low power techniques, linking, compilation and start-up process	TPS 3	70	60
CO4	Implement a complete system by interfacing various peripherals, using latest development tools	TPS 3	70	60

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	L	-	-	-	-	-	-	-	-	L	L	-	L
CO2	S	M	L	-	S	-	-	-	M	M	-	L	M	M	L
CO3	S	M	L	-	S	-	-	-	M	M	-	L	M	M	M
CO4	S	M	L	-	S	-	-	-	M	M	-	L	M	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

	CAT – I (%)			Terminal Exam (%)		
TPS Scale / CO	1	2	3	1	2	3
CO1	-	25	-	-	25	-
CO2	-	5	20	-	5	20
CO3	-	5	20	-	5	20
CO4	-	5	20	-	5	20
Total	-	40	60	-	40	60

Syllabus

Introduction: Architecture Overview: AVR and PIC, 8-bit and 32-bit MCUs
Essential peripherals: Introduction to basic MCU peripherals and their purpose, Clocks, GPIOs, Timer and Counter, Waveform Generation (PWM), Lab-1, Serial Communication: Universal Asynchronous Receiver Transmitter (UART), Two Wire Interface (I2C), Lab-2
Low power design techniques: Sleep modes, Event System, Factors affecting low power, Lab-3**,** Hardware design considerations
Moving the design from concept to reality: Ecosystem (Development Tools), From Embedded-C to Microcontroller, Home Automation – Putting together a real-world application

Learning Resources

- I2C(Master):http://ww1.microchip.com/downloads/en/AppNotes/00002480A.pdf
- I2C(Slave):http://ww1.microchip.com/downloads/en/AppNotes/atmel-2565-using-the-twi-module-as-i2c-slave_applicationnote_avr311.pdf
- USART: http://ww1.microchip.com/downloads/en/AppNotes/Atmel-1451-Using-the-AVR-USART-on-tinyAVR-and-megaAVR-devices_ApplicationNote_AVR306.pdf
- Efficient C coding for VR:http://ww1.microchip.com/downloads/en/AppNotes/doc1497.pdf
- Low power techniques: http://ww1.microchip.com/downloads/en/AppNotes/00002515B.pdf
- Muhammad Ali Mazidi, The AVR microcontroller and embedded systems using assembly and C, Pearson Education,2011.
- Ajay V. Deshmukh, Microcontrollers –Theory and applications, TMH Publication,2005.
- Fernando E. Valdes –Perez, Microcontrollers-Fundamentals and applications with PIC, CRC Press, 2009.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
1.	**Introduction:** Architecture Overview: AVR and PIC, 8-bit and 32-bit MCUs	2
2.	**Essential peripherals:** Introduction to basic MCU peripherals and their purpose, Clocks, GPIOs, Timer and Counter, Waveform Generation (PWM), Lab-1, Serial Communication: Universal Asynchronous Receiver Transmitter (UART), Two Wire Interface (I2C), Lab-2	4
3.	**Low power design techniques:** Sleep modes, Event System, Factors affecting low power, Lab-3**,** Hardware design considerations	3
4.	**Moving the design from concept to reality:** Ecosystem (Development Tools), From Embedded-C to Microcontroller, Home Automation – Putting together a real-world application	3
Total Hours		**12**

Course Designers:

- Mr. Enoch Richbert, Application Engineer, Microchip Technology, enochrichbert.jebakumar@micorchip.com
- Dr.K.Hariharan, khh@tce.edu
- Dr M S K Manikandan, manimsk@tce.edu
- Dr.V.R. Venkatasubramani, venthiru@tce.edu
- Dr. G. Prabhakar, gpece@tce.edu

22EC1G0	GREEN NETWORKS

Category	L	T	P	Credit
PEES	1	0	0	1

Preamble

Green networking is the practice of selecting energy-efficient networking technologies and products and minimizing resource use whenever possible. The goal of the course is to understand and apply the concepts of Energy Consumption Models, Battery Life Estimations and Enhancements

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Understand Digital Networking Fundamentals and Energy Consumption Models	TPS 2	70	60
CO2	Apply Modulation Costs Energy Efficiency & Entropy	TPS 3	70	60
CO3	Apply QoS Approximations and Workload Characterizations	TPS 3	70	60
CO4	Understand Battery Life Estimations and Enhancements and AI Techniques in Symbol Recovery	TPS 2	70	60

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L	L	-	-	-	-	-	-	-	-	L	L	-	L
CO2	S	M	L	-	S	-	-	-	M	M	-	L	M	M	L
CO3	S	M	L	-	S	-	-	-	M	M	-	L	M	S	S
CO4	M	L	L	-	S	-	-	-	M	S	-	L	L	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

	CAT – I (%)			Terminal Exam (%)		
TPS Scale / CO	1	2	3	1	2	3
CO1	-	10	15	-	10	15
CO2	-	10	15	-	10	15
CO3	-	10	15	-	10	15
CO4	-	10	15	-	10	15
Total	-	40	60	-	40	60

Syllabus

Digital Networking Fundamentals: Introduction to All-IP Networks, IP protocol overview**,** Reduced Header Compression Cross Layer Optimizations. **Energy Consumption Models:** Joules / Bit. **Modulation Costs Energy Efficiency & Entropy:** Error Correction Codes, Error Correction Costs. **QoS Approximations and Workload Characterization:** Energy Aware Computing & Communications, Computing Energy Costs**,** Connection Overhead Costs **Battery Life Estimations and Enhancements:** Energy Harvesting Technique, Advancements in Energy Harvesting, Introduction to TSN. **AI Techniques in Symbol Recover:** 6G Advancements.

Learning Resources

- Konstantinos Samdanis, Peter Rost, Andreas Maeder, Michela Meo, and Christos Verikoukis, “Green Communications: Principles, Concepts and Practice”, Wiley, 2017.
- Brendan Gregg, “Systems Performance”, Addison Wesley, 2021.
- Anne Currie, Sarah Hsu, and Sara Bergman, “Building Green Software”, O'Reilly Media, Inc.,2024

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
1.	**Digital Networking Fundamentals-** • Introduction to All-IP Networks • IP protocol overview • Reduced Header Compression • Cross Layer Optimizations	3
2.	**Energy Consumption Models** • Joules / Bit	2
3.	**Modulation Costs Energy Efficiency & Entropy** • Error Correction Codes • Error Correction Costs	3
4.	**QoS Approximations and Workload Characterizations** • Energy Aware Computing & Communications • Computing Energy Costs • Connection Overhead Costs	3
5.	**Battery Life Estimations and Enhancements** • Energy Harvesting Techniques • Advancements in Energy Harvesting • Introduction to TSN	1
6.	**AI Techniques in Symbol Recovery** • 6G Advancements	2
Total Hours		14

Course Designers:

- Dr S B Anand, Senior Architech, Qualcomm, Bengaluru
- Dr MSK Manikandan, manimsk@tce.edu
- Dr E Murugavalli, murugavalli@tce.edu

SYLLABI

FOR

INTERDISCIPLINARY ELECTIVE COURSES

B.E. / B.Tech. DEGREE PROGRAMME

FOR THE STUDENTS ADMITTED IN THE

ACADEMIC YEAR 2022-23 ONWARDS

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
THIAGARAJAR COLLEGE OF ENGINEERING
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22ECGA0	CONSUMER ELECTRONICS

Category	L	T	P	Credit
IE	3	0	0	3

Preamble

This course offers a comprehensive overview of consumer electronics. It provides a better understanding to students about the construction and working principles of audio systems, display technologies, automotive electronics, and a wide array of consumer devices and home appliances.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Describe the characteristics and working principle of microphones and loud speakers	TPS 2	70	60
CO2	Describe the key features of digital audio system.	TPS 2	70	60
CO3	Construct digital television system with essential features and functionalities.	TPS 3	70	60
CO4	Utilize the characteristics of display technologies to build an output devices.	TPS 3	70	60
CO5	Identify the components present in the infotainment of automotives	TPS 3	70	60
CO6	Idetify the features and functionalities of various electronic components and circuitry present in consumer devices and domestic appliances.	TPS 3	70	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L	L	L	-	-	-	L	L	M	-	L	L	-	L
CO2	M	L	L	L	-	-	-	L	L	M	-	L	L	-	L
CO3	S	M	L	L	-	-	-	L	L	M	-	L	M	-	L
CO4	S	M	L	L	-	-	-	L	L	M	-	L	M	-	L
CO5	S	M	L	L	-	-	-	L	L	M	-	L	M	-	L
CO6	S	M	L	L	-	-	-	L	L	M	-	L	M	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam(%)		
	CAT – I(%)			Assg. I *(%)			CAT – II(%)			Assg. II *(%)					
TPS Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	10	30	100			-						-	4	20
CO2	-	10	20				-						-	4	10
CO3	-	10	20				-						-	4	10
CO4	-						-	10	20	100			-	-	10
CO5	-						-	10	20				-	4	10
CO6	-						-	10	30				-	4	20
Total	-	**30**	**70**	**100**			**-**	**30**	**70**	**100**			**-**	**20**	**80**

Syllabus

Introduction: Overview, Era of consumer devices, Components of a typical consumer device.
Analog Audio System: Microphones and its types- Carbon, Velocity, Crystal, Condenser, Cordless; Loud Speaker**:** Direct radiating, horn loaded woofer, tweeter, mid-range, multi-speaker system, baffles and enclosures, Hi-Fi system, pre-amplifier, amplifier, Equalizer system, stereo amplifiers, Sound bars.
Digital Audio System: Digital Audio player, storage audio formats, Internet Audio Formats, MP3 Portable Players, Internet Radio Digital Audio Radio Online Music Distribution, Digital Physical Media Formats, Audio over IP – Dante, AES67.
Digital Television System: Digital TV System and Standards, HDTV, Hardware Architecture of a Digital Set-top Box, Home Theatre, DTH. Cable TV and Cable TV in internet and Digital Video Recorder, Audio Video Receiver.
Digital Display System: Organic LEDs, LCD, Plasma, Plasma Addressed LCD, and Quantum LED.
Automotive Electronics: Standards for In-vehicle Multimedia Electronics, Vehicle Area Network Bus, Controller Area Networks, Media-oriented Systems Transfer Technologies, Components of a Telematics System and Automotive Software Technologies.
Consumer Devices/Domestic appliances: Smart Phones, Smart TV, Digital Still Cameras, Refrigeration cycle, Types of compressors, Refrigerator, Air Conditioner, Induction cook top, Washing machines, Microwave oven, Dish washer, Vacuum cleaner, GPS Tracker.

Text Book

- Bali S.P, “Consumer Electronics”, Pearson Education, 2022.
- Amit Dhir, “The Digital Consumer Technology Handbook: A Comprehensive Guide to Devices, Standards, Future Directions, and Programmable Logic Solutions”, Elsevier 2004

Reference Books

- Jordan Frith, "Smartphones as Locative Media ", Wiley. 2014.
- R.S. Khandpur, “Troubleshooting Electronic Equipment: Includes Repair and Maintenance”, Second Edition, McGraw Hill Education (India) Private Limited., 2003.
- Philp Hoff "Consumer Electronics for Engineers" - Cambridge University Press.1998.
- Lal A. K, “Trouble Shooting and Maintenance of Electronics Equipments”, McGraw Hill Education, 2020.
- Thomas M. Coughlin, "Digital Storage in Consumer Electronics", Elsevier and Newness 2012.
- Nick vandome, Smart homes in easy steps, - Master smart technology for your home 2018.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Introduction	
1	Overview of consumer electronics, Era of consumer devices	2
2	Components of a typical consumer device	
3	**Analog Audio System**	
4	Microphones and its types- Carbon, Velocity, Crystal, Condenser, Cordless	2
5	Loud Speaker**:** Direct radiating, horn loaded woofer, tweeter	2
6	Mid-range, multi-speaker system	1
7	baffles and enclosures	
8	Hi-Fi system	
9	Pre-amplifier/amplifier	
10	Equalizer system	1
11	Stereo amplifiers	
12	Sound bars	
	Digital Audio System	
13	Digital Audio player	1

14	Storage audio formats	
15	Internet Audio Formats	
16	MP3 Portable Players	1
17	Internet Radio	1
18	Digital Audio Radio	
19	Online Music Distribution	1
20	Digital Physical Media Formats	
21	Audio over IP – Dante, AES67	1
	Digital Television System	
22	Digital TV System and Standards	1
23	HDTV	
24	Hardware Architecture of a Digital Set-top Box	1
25	Home Theatre	1
26	DTH	
27	Cable TV	1
28	Cable TV in internet	
29	Digital Video Recorder	1
30	Audio Video Receiver	1
	Digital Display System	
31	Organic LEDs	1
32	LCD	1
33	Plasma	1
34	Plasma Addressed LCD	
35	Quantum LED	1
	Automotive Electronics	
36	Standards for In-vehicle Multimedia Electronics	1
37	Vehicle Area Network Bus	
38	Controller Area Networks	1
39	Media-oriented Systems Transfer Technologies	
40	Components of a Telematics System	1
41	Automotive Software Technologies	1
	Consumer Devices/Domestic appliances	
42	Smart Phones, Smart TV	2
43	Digital Still Cameras	1
44	Refrigeration cycle, Types of compressors, Refrigerator	2
45	Air Conditioner	1
46	Induction cook top, Microwave oven	1
47	Washing machines, Dish washer	1
48	Vacuum cleaner, GPS Tracker	1
	TOTAL	**36**

Course Designers:

- Dr.S.Mohamed Mansoor Roomi smmroomi@tce.edu
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22ECGB0	MULTIMEDIA SYSTEMS

Category	L	T	P	Credit
IE	3	0	0	3

Preamble

Multimedia Systems are becoming an integral part of our heterogeneous computing and communication environment. There is an explosive growth of multimedia computing, communication, and applications over the last decade. The World Wide Web, conferencing, digital entertainment, and other widely used applications are using not only text and images but also video, audio, and other continuous media. In the future, all computers and networks will include multimedia devices. They will also require corresponding processing and communication support to provide appropriate services for multimedia applications in a seamless and often also ubiquitous way.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Understand the fundamentals of multimedia and networks to support media and data streams, sound/audio, image, graphics, and video.	TPS 2	70	75
CO2	Use the digitization mechanisms to encode multimedia information.	TPS 3	70	70
CO3	Use the compression principles including coding requirements, entropy and hybrid coding, encoders and decoders to multimedia.	TPS 3	70	70
CO4	Apply the compression techniques to text, image, audio and video.	TPS 3	70	70
CO5	Relate the communication network standards and protocols to multimedia information.	TPS 2	70	70
CO6	Analyze the multimedia networking and steaming protocols.	TPS 4	70	65

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L	L	-	-	-	-	L	-	M	-	-	L	L	L
CO2	S	M	L	-	-	-	-	L	-	M	-	-	M	L	L
CO3	S	M	L	-	L	-	-	L	-	M	-	-	M	-	L
CO4	S	M	L	L	L	-	-	L	M	M	-	L	M	-	L
CO5	M	L	L	-	-	-	-	L	-	M	-	-	L	-	L
CO6	S	S	M	L	L	-	-	L	M	M	-	L	S	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam(%)		
	CAT – I(%)			Assg. I *(%)			CAT – II(%)			Assg. II *(%)					
TPS Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	20	-	100			-						-	6	-
CO2	-	10	30				-						-	4	10
CO3	-	10	30				-						-	4	15
CO4	-						-	10	40	100			-	5	30
CO5	-						-	15	-				-	6	-
CO6	-						-	10	35				-	5	15
Total	-	**40**	**60**	**100**			**-**	**35**	**65**	**100**			**-**	**30**	**70**

Syllabus

Multimedia communications: Introduction to Multimedia information, Multimedia networks-telephone networks, data networks, broadcast television networks, integrated services digital networks, broadcast multiservice networks. Multimedia applications - interpersonal communications, interactive applications over the internet, and entertainment applications. Networking terminology- media types, communication modes, network types, network QoS, application QoS.periodic. **Multimedia information representation:** Digitization principles-analog signals, encoder design, decoder design. Text - unformatted text, formatted text, hypertext. Images- graphics, digitized documents, digitized pictures. Audio-PCM speech, CD quality audio, Video- Broadcast television. **Text and image compression:** Compression principles-source encoders and destination decoders, lossless and lossy compression, entropy encoding. Text compression- Huffman coding, Image compression – JPEG standard, High Efficiency Image File Format (HEIF). **Audio and video compression:** Audio compression-differential pulse code modulation, adaptive differential PCM, adaptive predictive coding, linear predictive coding, MPEG audio coders, Surround sound - Dolby Digital Video compression - Principles, H.261, H.263, H.264, MPEG standards, High Efficiency Video Coding (HEVC) **Standards for multimedia communications:** Reference models- TCP/IP reference model, protocol basics, Real time streaming transport protocols –, RTP and RTCP, Session Initiation Protocol (SIP)Real Time Streaming Protocol (RTSP),P2P Video Streaming, Standards relating to interpersonal communications-circuit mode networks, packet switched networks

Text Book

- Fred Halsall, “Multimedia Communications: Applications, Networks, Protocols and Standards”, Addison-Wesley, 2012.

Reference Books

- Larry L. Peterson, Bruce S. Davie, “Computer Networks: A Systems Approach”, Sixth Edition, Morgan Kaufmann Publishers, 2021
- K. Rammohan Rao, Z. S. Bolzkovic and D. A. Milanovic, “Multimedia Communication: Techniques, Standards, and Networks”, Prentice Hall, 2002.
- Ze-Nian Li and Mark S. Drew, “Fundamentals of Multimedia”, Pearson Prentice Hall, October 2011.
- Yao Wang, Joern Ostermann, and Ya-Qin Zhang, “Video Processing and Communications”, Prentice Hall, 2011.
- Stephen McGloughlin, “Multimedia: Concepts and Practice”, November 2000, Prentice Hall, 2012.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Introduction to the Course, COs POs	1
1	**Multimedia communications:**	
2	Introduction to Multimedia information, Multimedia networks	1
3	telephone networks, data networks, broadcast television networks	1
4	integrated services digital networks, broadcast multiservice networks.	1
5	Multimedia applications - interpersonal communications, interactive applications over the internet, and entertainment applications	1
6	Networking terminology- media types, communication modes, network types, network QoS, application QoS.periodic	1
	Multimedia information representation:	
7	Digitization principles- analog signals	1
8	encoder design, decoder design.	1
9	Text - unformatted text, formatted text, hypertext	1
10	Images- graphics, digitized documents, digitized pictures.	2
11	Audio-PCM speech, CD quality audio, Video- Broadcast television.	2
	Text and image compression:	
12	Compression principles-source encoders and destination decoders	1
13	lossless and lossy compression, entropy encoding	1
14	Text compression- Huffman coding	1
15	Image compression – JPEG standard	2
	High Efficiency Image File Format (HEIF).	1
	Audio and video compression:.	
16	Audio compression-differential pulse code modulation, adaptive differential	2
17	PCM, adaptive predictive coding, linear predictive coding,	3
18	MPEG audio coders, Surround sound - Dolby Digital	2
19	Video compression - Principles, H.261, H.263, H.264,	1
20	MPEG standards, High Efficiency Video Coding (HEVC)	3
	Standards for multimedia communications:	
21	Reference models- TCP/IP reference model, protocol basics	1
22	Real time streaming transport protocols –, RTP and RTCP,	2
23	Session Initiation Protocol (SIP)	1
24	Standards relating to interpersonal communications-circuit mode networks, packet switched networks	2
	TOTAL	**36**

Course Designers:

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- Dr E Murugavalli murugavalli@tce.edu

22ECGC0	TELECOMMUNICATION SYSTEMS

Category	L	T	P	Credit
IE	3	0	0	3

Preamble

The objective of this course is to introduce the concepts of digital communication systems, satellite communication systems, Radio Detection and Ranging (RADAR) systems, Optical communication systems and wireless communication systems & Standards. In this course, mathematical techniques have been kept relatively at modest level, making it accessible to any discipline of Engineering.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Describe the functionality of digital communication system and determine the signal to noise ratio (SNR) at the input of a digitalcommunication receiver and at the output of the detector.	TPS 3	70	70
CO2	Describe the functionality of Radar system and determine the link analysis using Friss formula	TPS 3	70	70
CO3	Describe the optical fiber communication link and the physical structure and guiding properties of optical fibers.	TPS 3	70	70
CO4	Describe the functionality of Satellite communication system and determine the SNR for both the uplink and downlink	TPS 3	70	70
CO5	Describe the functionality of a data communication network	TPS 2	70	75
CO6	Describe the cellular concept of Wireless Communication Systems, 2G, 3G and 4G wireless standards for mobile communication, IEEE 802.11b, g Wireless Local area network (WLAN) standards.	TPS 2	70	75

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	S	M	L	-	-	-	-	M	M	-	-	-	M	L	-
CO2	S	M	L	-	-	-	-	M	M	-	-	-	M	L	-
CO3	S	M	L	-	-	-	-	M	M	-	-	-	M	L	-
CO4	S	M	L	-	-	-	-	M	M	-	-	-	M	L	-
CO5	M	L	-	-	-	-	-	M	M	-	-	-	M	L	-
CO6	M	L	-	-	-	-	-	M	M	-	-	-	M	L	-

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II *(%)					
TPS Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	10	20	100			-						-	4	15
CO2	-	20	20				-						-	4	15
CO3	-	10	20				-						-	4	15
CO4	-						-	20	40	100			-	4	15
CO5	-						-	20	-				-	12	-
CO6	-						-	20	-				-	12	-
Total	-	40	60	100			-	60	40	100			-	40	60

Syllabus

Introduction: Communication system model, Bandwidth and spectrum, modulation and demodulation, decibel gain and loss ratios, Signal to noise ratio and system level decibel Analysis **Transmission Media** : Twisted-Pair, Coaxial Cable, Microwave, Satellite, Fiber Optics **Propagation mechanism:** Friis Link Equation, Decibel forms for the oneway link equations, Line of Sight Propagation Reflection and refraction, Ground wave propagation, Sky wave propagation ,Satellite link. **Digital Communication System:** Pulse code modulation(PCM)-encoding and quantization, baseband encoding forms, Time Division Multiplexing, Binary digital modulation schemes (ASK, PSK, FSK), Bit Error Rate Analysis. **Radar system:** Radar link equation, pulse radar. **Fiber Optic Communication System:** Optical Spectral bands, WDM Concepts, Key Elements of Optical Fiber Systems, Optical Fiber Modes and Configurations. **Satellite Communication Systems:** Orbital Mechanics, Satellite Alignment, Space craft communication Systems, Antennas Aboard Satellites and Earth Station, Satellite Link Analysis. **Data communication networks:** Networking Modes and Switching Modes-The PSTN Versus the Internet- The Evolution of Data Communications, Data Flow, The OSI Reference Model and the TCP/IP Reference Model. **Wireless Communication Systems:** Cellular Concept: Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Interference, System Capacity, Wireless Standards: 2G, 3G, 4G and 5G Mobile Standards, IEEE 802.11b, g Wireless Local Area Network (WLAN) standards

Text Book

- Goleniewski," Telecommunications essentials the Complete Global Source", 2nd edition, Addison Vesley,2006.
- William D.Stanley amd John.M. Jeffords, " Electronic Communications Principles and Systems", Cengage Learning, 2009 ,India Editi, B.P.Lathi, ZhiDing, Hari Mohan Gupta, "Modern Digital and Analog Communication Systems", Fourth Edition, Oxford University Press, 2017.
- Theddore S.Rappaport, "Wireless Communications: Principles and Practice", Second Edition, PHI,2006.
- Gerd kaiser, "Optical Fiber Communications", Fifth Edition, Tata McGraw – Hill Publishing Company Limited, 2013.
- George Kennedy, "Electronic Communication Systems", Tata McGraw Hill, Third Edition, 1996. Wayne Tomasi, "Advanced Electronic Communication Systems", Prentice Hall International Inc., Fourth Edition, 1998Book1 (Author(s), Title, edition, publisher, year of publication).

- Satellite Communication Systems Coursein NPTEL: https://nptel.ac.in/courses/117/105/117105131/, By Professor Kalyan Kumar Bandyopadhyay, IIT Kharagpur.
- Principles and Techniques of Modern RADAR Systems Course in NPTEL: https://nptel.ac.in/courses/108105154/ By Professor Amitabha Bhattacharya, IIT Kharagpur.
- Fiber Optic Communication Systems and Techniques – Course in NPTEL: http://www.digimat.in/nptel/courses/video/117104127/L22.html By Professor Pradeep Kumar K, IIT Madras.
- Introduction to Wireless and Cellular Communications Course in NPTEL: https://nptel.ac.in/courses/106/106/106106167/ By Professor David Koilpillai, IIT Madras

Reference Books

- Principles of Communication Systems Part - 1 Course in NPTEL: http://www.digimat.in/nptel/courses/video/108104091/L25.html By Professor Aditya K Jagannatham, IIT Kanpur.
- Principles of Communication Systems Part - 2 Course in NPTEL: https://nptel.ac.in/courses/108104098/#, By Professor Aditya K Jagannatham, IIT Kanpur.

Course Contents and Lecture Schedule

No.	Topic	Lecture Hours	COs
1	**Introduction**		
1.1	Communication system model	1	CO1
1.2	Bandwidth and spectrum, modulation and demodulation	1	CO1
1.3	decibel gain and loss ratios	1	CO1
1.4	Signal to noise ratio and system level decibel Analysis	1	CO1
2	**Transmission Media**		
2.1	Twisted-Pair, Coaxial Cable, Microwave,	1	CO1
2.2	Satellite, Fiber Optics	1	CO1
3	**Propagation mechanism**		
3.1	Friis Link Equation	1	CO1
3.2	Decibel forms for the oneway link equations	1	CO1
3.3	Line of Sight Propagation Reflection and refraction	1	CO1
3.4	Ground wave propagation, Sky wave propagation	1	CO1
3.5	Satellite link	1	CO1
4	**Digital Communication System**		
4.1	Pulse code modulation (PCM)- encoding and quantization	1	CO1
4.2	baseband encoding forms	1	CO1
4.3	Time Division Multiplexing	1	CO1
4.4	Binary digital modulation schemes (ASK, PSK, FSK)	1	CO1
4.5	Bit Error Rate Analysis	1	CO1
5	**Radar system**		
5.1	Radar link equation	2	CO2
5.2	pulse radar	1	CO2
6	**Fiber Optic Communication System**		
6.1	Optical Spectral bands, WDM Concepts	1	CO3
6.2	Key Elements of Optical Fiber Systems	1	CO3
6.3	Optical Fiber Modes and Configurations	1	CO3
7	**Satellite Communication Systems**		
7.1	Orbital Mechanics, Satellite Alignment, Space craft communication Systems	1	CO4

7.2	Antennas Aboard Satellites and Earth Station, Satellite Link Analysis	1	CO4
8	**Data communication networks**		
8.1	Networking Modes and Switching Modes-The PSTN Versus the Internet	1	CO5
8.2	The Evolution of Data Communications, Data Flow	1	CO5
8.3	The OSI Reference Model and the TCP/IP Reference Model	2	CO5
9	**Wireless Communication Systems**		
9.1	Cellular Concept	1	CO6
9.2	Frequency Reuse, Channel Assignment Strategies, Handoff Strategies	2	CO6
9.3	Interference, System Capacity,	1	CO6
9.4	Wireless Standards: 2G, 3G, 4G and 5G Mobile Standards,	2	CO6
9.5	IEEE 802.11b,g Wireless Local Area Network (WLAN) standards	2	CO6
	Total Hours	**36**	

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22ECGD0	APPLIED IMAGE PROCESSING

Category	L	T	P	Credit
IE	3	0	0	3

Preamble

The purpose of this course is to provide the basic concepts and methodologies for digital Image Processing in three different levels. At the lower level, the course introduces the terminology of image processing, image acquisition, digitization, formation, storage, and the relationship between pixels. Further, it provides image enhancement by improving the contrast and noise removal in spatial domain and applications of transformations for enhancement and coding. In the middle-level, it addresses region-based segmentation, representation, and description processes to extract meaningful information with geometrical operations. Morphological processing is introduced to clean up and cluster such regions for real world image processing applications.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Demonstrate the human visual perception, digital image acquisition and relationship between pixels for grayscale and color images.	TPS 2	70	75
CO2	Enhance the visual perception of digital imagery from poor contrast and noise degradation in spatial domain.	TPS 3	70	70
CO3	Enhance the given image in frequency domain by applying image transforms such as Fourier and DCT.	TPS 3	70	70
CO4	Extract regions of interest from an image using thresholding, edge and region-based segmentation algorithms.	TPS 3	70	70
CO5	Describe the segmented region using boundary as well as region representors and descriptors with the combination of morphological operations.	TPS 3	70	70
CO6	Develop image processing algorithms for detecting vehicle license plate, missing component, abnormality in CT/US images, Watermarking, fault analysis in power system, change detection in satellite images, DCT coding for image compression.	TPS 3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L	-	-	-	L	-	L	-	-		-	L	-	-
CO2	S	M	L	-	L	L	-	L	-	L	-	-	M	-	L
CO3	S	M	L	-	L	L	-	L	L	L	-	-	M	-	L
CO4	S	M	L	-	-	-	-	-	-	-	-	-	M	-	-
CO5	S	M	L	-	-	-	-	-	-	-	-	-	M	-	-
CO6	S	M	L	-	L	L	-	L	-	L	-	L	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II *(%)					
TPS / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	20					-						-	15	-
CO2	-		40		100		-						-	-	20
CO3	-		40				-						-	-	15
CO4	-						-	10	20				-	-	15
CO5	-						-		30		100		-	-	15
CO6	-						-		40				-	-	20
Total	-	20	80		100		-	10	90		100		-	15	85

Syllabus

Image acquisition and Fundamentals: Elements of visual perception, light and the Electromagnetic spectrum, Imaging modalities, Digital image model, Image file formats, Image Sampling and Quantization. Basic relationship between pixels: Adjacency, Connectivity- 4, 8 and m connectivity, region, boundaries, and Distance measures Color models and Conversion **Image Enhancement:** Intensity Transformation functions, Image negatives, Contrast stretching, Log transformation, Gamma correction, Histogram Equalization, Color Histogram processing, Noise Removal: Noise models, Gaussian, Uniform, salt and pepper noise. **Spatial Filtering**: Smoothing: mean, Order statistics filter: median, min, max and mid-point filtering. Sharpening: Laplacian filter, unsharp masking. **Frequency domain filtering**: Transformations: Fourier, Discrete cosine Transforms, Low pass and high pass filters in frequency domain, Principal Component Analysis Transform (PCA) **Image Compression:** JPEG compression. **Segmentation:** Thresholding: Local and global, Edge based: Point, Line and Edge detection, Prewitt, Sobel, Canny and Robert's operators. Region based segmentation: Region growing, Region splitting and merging. Gray-scale Morphological operations. **Feature Extraction:** Boundary feature descriptors, Region feature Descriptors, Topological descriptors: Texture feature descriptors. **Real world Applications:** Vehicle license plate detection, PCA-based face recognition, Digital image watermarking, Missing component detection for automatic industry inspection, Non-destructive testing, Detecting cyst/tumour in Ultrasound (US)/CT images, Fault analysis in power system, Remote sensing-change detection, building, road extraction in satellite images.

Sample Assignments/Mini projects:

1. Vehicle number plate detection for traffic surveillance applications
2. Detecting cyst/tumour or muscle disorders in US/CT/MRI/XRay images.
3. Industry inspection in IR/Thermal images (Non-Destructive Testing).
4. Change detection between two remotely sensed satellite images, land cover usage.
5. Fault diagnosis/analysis in power systems.

Text Book

- Rafael.C.Gonzalez, Richard.E. Woods and Steven L. Eddins, "Digital Image Processing using Matlab", 4th Edition, Gatesmark Publishing, 2018, ISBN 10: 1-292-22304-9.

Reference Books

- William K. Pratt, "Introduction to Digital Image Processing", CRC Press, 2013.
- Oge Marques, "Practical Image and Video Processing using MATLAB", Wiley-IEEE Press, 2011, ISBN: 978-0-470-04815-3.
- Al.Bovik, "The Essential Guide to Image Processing", Academic Press, 2009.
- Anil K.Jain, "Fundamentals of Digital Image Processing", Pearson Education 2003.
- NPTEL course Digital Image Processing: https://nptel.ac.in/courses/noc18_ee40/
- www.imageprocessingplace.com/
- http://www.mathworks.com/
- https://www.coursera.org/course/images

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
1	**Introduction to the Course and course outcomes** Introduction to Image processing, Need and applications	1
2	Elements of visual perception	1
3	Light and the Electromagnetic spectrum	1
4	Imaging modalities- X-Ray, CT, Ultrasound,	1
5	Visible, Infrared, Thermal	1
6	Digital image Model, Image file formats, Color space conversion	1
7	Image Sampling and Quantization	1
8	Basic relationship between pixels, Adjacency, Connectivity- 4, 8 and m connectivity, region, boundary	1
9	Distance measures- Euclidean, city-block, chessboard	1
	Full color image processing, Color model-RGB, CMY, HSI	1
10	Color models-RGB, CMY, HSI	1
11	HVS and color space: (RGB to HSI, YCbCr color space), Extendible of grayscale methods into color	1
12	**Image Enhancement:** Intensity Transformations, Image Negative, Contrast stretching	1
13	Log transformation- Gamma correction	1
14	Histogram equalization, color histogram processing	1
15	Assignment 1: Image contrast Enhancement	
16	**Noise Removal-Spatial Filtering**- **Smoothing**-Noise models – Salt and Pepper, Uniform, Gaussian	1
17	Mean- Order statistics filter-median filters Min, Max and Mid-point	1
18	**Spatial filtering** – **Sharpening**- Laplacian filter, unsharp masking	1
	Spectral representation for enhancement and coding:	
19	Fourier, Discrete cosine Transform	2
20	Principal Component Analysis Transform	2
21	Low pass and high pass filters in frequency domain	1
22	JPEG compression	1
23	Assignment II: Noise removal in spatial/frequency domain	
24	**Segmentation:** Thresholding – Local and global	1
25	**Edges-** Point, line detection, Edge detection, Prewitt, Sobel and Roberts operators	1
26	Region based segmentation- Region growing, Region splitting and merging	1
27	Gray-scale Morphological operations: dilation and erosion – opening and closing	1
	Representation and Description:	
28	Boundary representation- Chain codes–Signatures	1
29	Boundary descriptors–Shape numbers-Fourier descriptors	1
30	Regional Descriptors-Topological Descriptors-Texture	1
	Real world Applications:	
31	Vehicle number plate detection	1
32	Digital image watermarking, Missing component detection for automatic industry inspection	1
33	Detecting cyst/tumour in Ultrasound/CT images	1
34	Fault analysis in power system	1
	TOTAL	**36**

Course Designers:

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22ECGE0	COMPUTER VISION FOR ENGINEERING APPLICATIONS

Category	L	T	P	Credit
IE	3	0	0	3

Preamble

This course focuses on how computers treat vision to understand the human visual world. It deals with the construction of explicit meaningful descriptions of physical objects or other observable phenomena from images and how they are visualized by a computer and its applications. It focuses on the theoretical and algorithmic basis by which valuable information about the world can be automatically extracted and visualized from a single image or a set of images. Since images are two-dimensional projections of the three-dimensional world, knowledge about the objects in the scene and projection and photometric geometries are required for the low-level vision process. In mid-level, it describes how the feature points such as interest points corner points are detected, matched and the alignment of matched feature points. Subsequently, it deals with various clustering and segmentation algorithms to obtain meaningful segments using similarity and discontinuity properties for further analysis. The higher-level vision encompasses object recognition and categorization, which includes various classifiers. Finally, it explores applications such as face detection and recognition for visual authentication, Optical Character Recognition (OCR) for automatic number plate recognition, Image stitching, medical image segmentation, and augmented reality.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO#	Course Outcomes	TPS Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Illustrate image formation using projective and photometric geometry with the relationship between world coordinates and image coordinates.	TPS 2	70	75
CO2	Measure the similarity between two images by applying rotation, scale invariant and oriented gradient feature detectors with Euclidean distance matching and least squares alignment method.	TPS 3	70	70
CO3	Obtain meaningful segments using similarity-based K Means clustering segmentation algorithm and discontinuity based active contour segmentation algorithm.	TPS 3	70	70
CO4	Recognize the detected objects by applying supervised algorithms like K-nearest neighbour and SVM.	TPS 3	70	70
CO5	Recognize the detected objects by applying PCA, an unsupervised algorithm and deep learning algorithms such as Convolutional Neural Networks (CNN), and Region-based CNN.	TPS 3	70	70
CO6	Make use of algorithms for computer vision applications such as face detection and recognition, visual authentication, Optical Character Recognition (OCR) for automatic number plate recognition, Case study on implementing a vision system for robotic picking, medical image segmentation and Augmented Reality.	TPS 3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L	-	-	-	-	-	-	L	-	-	M	L	L	L
CO2	S	M	L	-	M	-	-	-	M	-	-	M	M	M	M
CO3	S	M	L	-	M	-	-	-	M	-	-	M	M	M	M
CO4	S	M	L	-	L	-	-	-	M	L	-	M	M	L	L
CO5	S	M	L	-	M	-	-	-	M	-	-	M	M	L	M
CO6	S	M	L	-	M	M	-	M	M	M	-	M	M	L	M

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II *(%)					
TPS Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	20		100			-						-	15	-
CO2	-		40				-						-	-	20
CO3	-		40				-						-	-	15
CO4	-						-	10	20	100			-	-	15
CO5	-						-		30				-	-	15
CO6	-						-		40				-	-	20
Total	-	**20**	**80**	**100**			**-**	**10**	**90**	**100**			**-**	**15**	**85**

Syllabus

Computer Vision: Low Level Vision: History and Evolution of Computer Vision, Applications, Geometric image formation, projection, Pinholes, Lenses, perspective, orthographic projections, 2D Transformations, 3D Transformations, camera intrinsic and extrinsic parameters, Photometric image formation, Image scaling, rotation, and translation.

Middle Level Vision: Feature detectors and descriptors, Interest points, Harris corner detection, Scale Invariant Feature Transform (SIFT), blob detection, feature matching algorithms, Euclidean distance metric, Error rates, K-Means Clustering, Active Contour Model

High Level Vision: Classifiers-Machine Learning**:** Supervised vs Unsupervised, K-nearest neighbour, SVM, PCA, Deep Learning: Neural networks, Convolutional Neural Networks (CNN), Region-based CNN (R-CNN).

Applications: Face detection using R-CNN and face recognition using PCA, Optical Character Recognition (OCR) for automatic number plate recognition, Case study on implementing a vision system for robotic picking, Medical Image Segmentation, and augmented reality.

Text Book

- R Szeliski, “Computer vision: algorithms and applications”, Springer Science & Business Media, 2021.

Reference Books

- David A. Forsyth, Jean Ponce, “Computer Vision – A Modern Approach”, Prentice Hall, 2015, ISBN: 9781292014081.
- Prince, S.J.D, “Computer Vision: Models, Learning, and Inference”, Cambridge University Press, 2012
- Richard Hartley and Andrew Zisserman, “Multiple View Geometry in Computer Vision”, Second Edition, Cambridge University Press, March 2004.
- Al Bovik, “Handbook of Image & Video Processing”, Academic Press, 2000, ISBN: 0121197905.
- Ragav VenRagav Venkatesan and Baoxin Li, “Convolutional Neural Networks in
  - Visual Computing A Concise Guide”, CRC Press, Taylor and Francis Group, LCCN
  - 2017029154| ISBN 9781498770392 (hardback: alk. paper), 2017.
- http://www.ius.cs.cmu.edu/demos/facedemo.html

- https://nptel.ac.in/courses/106105216/Course on Computer Vision by Jayanta Mukhopadhyay.
- https://www.coursera.org/courses?query=computer%20vision.

Course Contents and Lecture Schedule

#	Topic	Lecture Hours
	Introduction to the Course and course outcomes	1
1	**Low Level Vision –** Introduction -Pinholes	1
2	**Image formation**-Geometric image formation-projection	1
3	Lenses-perspective-orthographic	1
4	Camera intrinsic and extrinsic parameters	1
5	2D Transformations	1
6	3D Transformations	1
7	Photometric image formation	1
8	Image scaling	1
9	Rotation and Translation	1
	Middle Level Vision- Feature detection, matching and alignment	1
10	Feature detectors and descriptors**-**Interest points-Harris corner detection	1
11	Scale Invariant Feature Transform (SIFT)	1
12	Histogram of Oriented Gradients (HOG)	1
13	Feature matching algorithms	1
14	Euclidean distance metric	1
15	Feature alignment algorithms	1
16	Error rates	1
17	Clustering and Segmentation- K-Means Clustering	2
18	Active Contour Model	1
	Assignment 1: Feature Extraction and Segmentation	
19	**High Level Vision**-**Classifiers**	1
20	-**Machine Learning: Supervised**	1
21	K-nearest neighbour	1
22	SVM	2
23	**Unsupervised**- PCA	1
24	Deep Learning	1
25	Neural networks	1
26	Convolutional Neural Networks (CNN)	1
27	Region-based CNN	1
	Assignment II: PCA/ RCNN classifiers	
	Applications: Face detection using RCNN	1
28	Face recognition using PCA for visual authentication	1
29	Face recognition using RCNN for visual authentication	
30	Optical Character Recognition (OCR) for automatic number plate recognition	1
31	Case study: Implementing a vision system for robotic picking	1
32	Medical Image Segmentation	1
33	Augmented reality	1
	Assignment III: Mini Project on CV Applications	
	TOTAL	**36**

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