M.E. (Communication Systems)

2021 Regulations, Curriculum & Syllabi

Stay Ahead

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

An Autonomous Institution Affiliated to Anna University - Chennai • Approved by AICTE • Accredited by NAAC with "A+" Grade

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BANNARI AMMAN INSTITUTE OF TECHNOLOGY
REGULATIONS 2021
(CHOICE BASED CREDIT SYSTEM)

Common to all M.E. / M.Tech. Degree Programmes

NOTE: *The regulations given hereunder are subject to amendments as may be decided by the Academic Council of the Institute from time to time. Any or all such amendments will be effective from such date and to such batches of students, including those already in the middle of the programme as may be decided by the Academic Council.*

1. ELIGIBILITY FOR ADMISSION

(i) Candidates seeking admission to the First Semester of M.E./M.Tech. degree programmes will be required to satisfy the eligibility criteria for admission thereto prescribed by the Directorate of Technical Education, Chennai and Anna University, Chennai.

(ii) Students admitted under 'Full-Time' should be available in the departments during the entire duration of working hours (from morning to evening on a full-time basis) for the curricular, co-curricular and extra-curricular activities.

The full-time students should not attend any other full-time programme(s) / course(s) or take up any full-time job / part-time job during working hours in any institution or company during the period of the full-time programme. Violation of the above rules will result in the cancellation of admission to the PG programme.

2. DURATION OF THE PROGRAMME

(i) **Minimum Duration:** Master of Engineering (M.E.) / Master of Technology (M.Tech.) extends over a period of two years. The two academic years will be divided into four semesters, with two semesters per year.

(ii) **Maximum Duration**: A candidate shall complete all the passing requirements of M.E./M.Tech. programmes within a maximum period of 4 years / 8 semesters, these periods being reckoned from the commencement of the first semester to which the candidate was first admitted, regardless of the break-of-study availed.

3. BRANCHES OF STUDY

Following M.E./M.Tech. programmes are offered by the institute

M.E. Programmes

1. Communication Systems
2. Computer Science and Engineering

3. Embedded Systems
4. Industrial Automation and Robotics
5. Industrial Safety Engineering
6. Power Electronics and Drives
7. Software Engineering
8. Structural Engineering

M. Tech. Programme

9. Biotechnology

4. STRUCTURE OF PROGRAMMES

(i) **Curriculum:** Every post-graduate programme will have a curriculum with syllabi consisting of theory and practical courses that include

Program Core Courses (PCC) include the core courses relevant to the chosen specialisation.

Program Elective Courses (PEC) include the elective courses relevant to the chosen specialisation.

Research Methodology and IPR Course to understand the importance and the process of creation of patents through research.

Employability Enhancement Courses (EEC) include project work, practical courses, internship, mini project and industrial/practical training.

Audit Courses (AC) expose the students to Disaster Management, Yoga, English for Research Paper Writing, Value education, Pedagogy Studies, Stress Management, and Personality Development through Life Enlightenment Skills. Registration for any of these courses is optional to students.

(ii) **Project Work:** Every student, individually, shall undertake Dissertation Phase I during the third semester and Dissertation Phase II during the fourth semester under the supervision of a qualified faculty. The project work can be undertaken in an industrial / research organisation or institute in consultation with the faculty guide and the Head of the Department. In the case of project work at an industrial / research organisation, the same shall be jointly supervised by a faculty guide and an expert from the organisation. The student shall be instructed to meet the supervisor periodically and attend the review committee meetings to evaluate the progress.

(iii) **Elective Courses: Five Elective** courses are offered to the students admitted in various disciplines as prescribed in the curriculum to widen their knowledge in their specialisation area.

(iv) **Online Courses:** A Student may be permitted to credit online courses with the approval of a Departmental Consultative Committee constituted by the Head of the Department, subject to a maximum of six credits. Such students may be exempted

from attending the classes if such course(s) are offered in the semester. Summary of such online courses, taken by the students, along with the offering agency shall be presented to the Academic Council for information and further suggestions. However, the student needs to obtain certification from the agency offering the course to become eligible for writing or seeking exemption from the End Semester Examinations. In case of credits earned through online mode from the Institute / University, the credits may also be transferred directly after due approval from the Departmental Consultative Committee and the Controller of Examinations.

(v) **Industrial Training:** Every full-time student shall take up training in industry/research laboratories, under the supervision of a faculty guide during summer/winter vacation till the pre-final semester of the programme subject to the evaluation prescribed in Clause 15.

If industrial training/internship is not prescribed in the curriculum, the student may undergo industrial training/internship optionally, and the credits earned will be indicated in the Mark Sheet. If the student earns three credits in industrial training/internship, the student may drop one Program Elective in the III semester. In such cases, industrial training/internships need to be undergone continuously from one organisation only. However, if the number of credits earned is 1 or 2, these credits shall not be considered for the classification of the degree. The student is only allowed to undergo a maximum of 6 weeks of industrial training/internship during the entire duration of the study.

Duration of Training / Internship	**Credits**
2 Weeks	1
4 Weeks	2
6 Weeks	3

(vi) **Mini Project**: The students shall undertake a mini project individually in consultation with the respective faculty and Head of the Department, as specified in the curriculum. A student is expected to make a presentation about the mini-project during the final evaluation as given in Clause 15.

(vii) **Value Added / Certificate Courses:** Students can opt for any one of the value-added courses in II and III semesters, approved by the Academic Council. A separate certificate will be issued on successful completion of the course by the Controller of Examinations.

(viii) **Credit Assignment:** Each course is normally assigned a certain number of credits with 1 credit per lecture hour per week, 1 credit for 2 hours of practical per week, 1 credit for 1 hour of tutorial per week. The exact numbers of credits assigned to the different courses of various programmes are decided by the respective Board of Studies.

(ix) **Minimum Credits:** For the award of the degree, the student shall earn a minimum number of total credits as prescribed by the respective Board of Studies as given below:

S.No.	M.E./M. Tech. Programmes	Total Credits
1.	M.E. Communication Systems	68
2.	M.E. Computer Science and Engineering	68
3.	M.E. Embedded Systems	68
4.	M.E. Industrial Automation and Robotics	68
5.	M.E. Industrial Safety Engineering	68
6.	M.E. Power Electronics and Drives	68
7.	M.E. Software Engineering	68
8.	M.E. Structural Engineering	68
9.	M.Tech. Biotechnology	68

5. COURSE ENROLLMENT AND REGISTRATION

5.1 Each student, on admission, shall be assigned to a Faculty Advisor (vide Clause 7) who shall advise/counsel the student about the details of the academic programme and the choice of courses considering the student's academic background and career objectives.

5.2 Every student shall enrol for the courses of the succeeding semester in the current semester. However, the student shall confirm the enrolment by registering for the courses within the first five working days after the commencement of the semester concerned.

5.3 After registering for a course, a student shall attend the classes, satisfy the attendance requirements, earn Continuous Assessment marks and appear for the End Semester Examinations.

5.3.1 Each student on admission to the programme shall register for all the **courses prescribed in the curriculum** in the **first semester of study**.

5.3.2 The enrolment for all the courses of semester II will commence 10 working days prior to the last working day of the semester I. The student shall confirm the enrolment by registering for the courses within the first five working days after the commencement of semester II.

5.3.3 If a student wishes, the student may drop or add courses (vide Clause 5.5)

within **five** working days after the commencement of the semester concerned and complete the registration process duly authorised by the PG coordinator of the programme. In this case, if a student fails in a course, he/she may be permitted to register for the course in the subsequent semester or when it is offered.

5.3.4 A student who has passed all the courses prescribed in the curriculum for the award of the degree shall not be permitted to re-enrol to improve the student's marks in a course or the aggregate marks / CGPA.

5.4 Minimum Credits to Register for Project work

The Project work for M.E./M.Tech. consists of dissertation phase I and dissertation phase II. Dissertation phase I is to be undertaken during the III semester, and dissertation phase II, which is a continuation of phase I, is to be undertaken during the IV semester. Minimum 24 credits are required to be earned to enrol on dissertation phase I.

If a student fails to earn the requisite minimum credits, the student cannot enrol for dissertation phase I. In such a case, the student can enrol for the project work in a subsequent semester after earning the minimum credits specified.

5.5 Flexibility to Add or Drop courses

5.5.1 A student has to earn the total number of credits specified in the curriculum of the respective programme of study in order to be eligible to obtain the degree. However, if a student wishes, the student is permitted to earn more than the total number of credits prescribed in the curriculum of the student's programme by opting for additional courses.

5.5.2 From the II to final semesters, the student has the option to register for additional courses or drop existing courses. The total number of credits that a student can add or drop is limited to 6, subject to a maximum of 2 courses. In such cases, the attendance requirement as stated in Clause 6 is mandatory.

The courses that a student registers in a particular semester may include:

i. Courses of the current semester and

ii. Courses dropped in the lower semesters.

The maximum number of credits that can be registered in a semester is 36. However, this does not include the number of Re-appearance (RA) and Withdrawal (W) courses registered by the student for the appearance of Examination.

5.6 Reappearance Registration

5.6.1 If a student fails in a theory course, the student shall do reappearance registration for that course in the subsequent semester or when it is offered next.

5.6.2 On registration, a student may attend the classes for the reappearance registration courses if the student wishes. However, the attendance requirement (vide Clause 6) is not compulsory for such courses.

5.6.3 The student who fails in any practical/mini project or any other EEC courses shall register for the same in the subsequent semester or when offered next and **repeat** the course. In this case, the student shall attend the classes, satisfy the attendance requirements (vide Clause 6) and earn continuous assessment marks.

5.6.4 The student who fails in dissertation phase I / II shall register for the same in the subsequent semester or when offered next and **repeat** the course. In this case, the student shall attend the classes, satisfy the attendance requirements (vide Clause 6), earn continuous assessment marks and appear for the end semester examinations. Reappearance registration is not available for such courses.

5.6.5 If a student is prevented from writing the end semester examination of a course due to lack of attendance, the student has to register for that course again, when offered next, attend the classes and fulfil the attendance requirements as per Clause 6.

6. REQUIREMENTS FOR APPEARING FOR THE END SEMESTER EXAMINATION OF A COURSE

A student who has fulfilled the following conditions (vide clause 6.1 and 6.2) shall be deemed to have satisfied the attendance requirements for appearing for the End Semester Examination of a particular course.

Each semester shall normally consist of 75 working days or 540 periods of each 50 minutes duration for the full-time mode of study.

6.1 Ideally, every student is expected to attend all the periods and earn 100% attendance. However, a student shall secure not less than 80% attendance course wise taking into account the number of periods required for that course as specified in the curriculum.

6.2 If a student secures attendance between 70% and 79% in any course in the current semester due to medical reasons (prolonged hospitalisation/accident / specific illness) or participation in Institution/University/State/National/International level extra and co-curricular activities, with prior permission from the Head of the Department, shall be permitted to appear for the current semester examinations subject to the condition that the student shall submit the medical certificate/participation certificate attested by the Head of the Department. Such certificates shall be forwarded to the Controller of Examinations for verification and permission to attend the examinations.

6.3 A student shall normally be permitted to appear for the end semester examination of a course if the student has satisfied the attendance requirements (vide Clause 6.1-6.2) and has registered for the examination in those courses of that semester by paying the prescribed fee.

6.4 A student who does not satisfy clauses 6.1 and 6.2 and secures less than 70% attendance in a course will not be permitted to write the end semester examination. The student has to register and repeat this course in the subsequent semester or when it is offered next (vide clause 5.6.4).

6.5 A student who has already appeared for a course in a semester and passed the examination is not entitled to reappear in the same course to improve grades/marks.

7. FACULTY ADVISOR

To help students plan their courses of study and for general advice on the academic programme, the Head of the Department of the students will attach a certain number of students to a teacher of the department, who shall function as a faculty advisor for those students throughout their period of study. The faculty advisor shall advise the students in registration and reappearance (Arrear) registration of courses, authorise the process, monitor their attendance and progress and counsel them periodically. If necessary, the faculty advisor may also discuss with or inform the parents about the progress/performance of the students concerned.

The responsibilities of the faculty advisor shall be:

i. To inform the students about the various facilities and activities available to enhance the student's curricular and co-curricular activities.

ii. To guide student enrolment and registration of the courses

iii. To authorise the final registration of the courses at the beginning of each semester.

iv. To monitor the academic and general performance of the students, including attendance, and to counsel them accordingly.

v. To collect and maintain the academic and co-curricular records of the students

8. COMMITTEES

8.1 Class Committee Meeting

i. For all the courses taught, prescribed in the curriculum, a class committee meeting shall be convened twice a semester, comprising faculty members handling all the courses and two student representatives from the class.

ii. One of the faculty members (not handling any courses to that class), nominated by the Head of the Department, shall coordinate the activities of

this Committee. During these meetings, the student members shall meaningfully interact and express their opinions and suggestions of all students to improve the effectiveness of the teaching-learning process. It is the responsibility of the student representatives to convey the proceedings of these meetings to all other students.

9. ASSESSMENT AND PASSING REQUIREMENTS

9.1 Assessment

The assessment will comprise continuous assessment and end semester examination, carrying marks as specified in the scheme (Clause 15). All assessments will be done on absolute marks basis. However, to report the performance of a student, letter grades and grade points will be awarded as per Clause 9.4.

9.2 End Semester Examinations

End semester examinations will normally be conducted as per the timetable circulated by the CoE's Office. A student will be permitted to appear for the end semester examination of a semester only if he/she completes the study of that semester satisfying the requirements given in Clause 5 and 6, and registers simultaneously for the examinations of the highest semester eligible and the courses, pertaining to that semester, that needs reappearance.

9.3 Employability Enhancement Courses

Every candidate shall submit reports on industrial training / mini-project, dissertation phase I and dissertation phase II on dates announced by the institute/department through the faculty guide to the head of the department. If a candidate fails to submit the reports of any of these courses not later than the specified date, he/she is deemed to have failed in it. The reports /papers shall be orally presented by the student before a team of experts consisting of an internal examiner, usually the supervisor, and an external examiner, appointed by the Controller of the Examination.

A candidate is permitted to register for dissertation phase II only after passing dissertation phase I. A candidate who fails in industrial training / mini-project, dissertation phase I or dissertation phase II shall register for redoing the same at the beginning of a subsequent semester.

9.4 Letter Grade and Grade Point

The letter grade and the grade point are awarded based on the percentage of total marks secured by a candidate in an individual course as detailed below:

Letter Grade	**Grade Points**
O (Outstanding)	10
A + (Excellent)	9
A (Very Good)	8
B + (Good)	7
B (Above average)	6
C (Satisfactory)	5
RA (Reappearance Registration)	0
I (Incomplete)	0
W (Withdrawal)	0
AB (Absent)	0
SA(Shortage of Attendance)	0

'RA' - Reappearance registration is required for that particular course

'I' - Continuous evaluation is required for that particular course in the subsequent examinations.

After completion of the evaluation process, Semester Grade Point Average (SGPA) and Cumulative Grade Point Average is calculated using the formula:

$$SGPA/CGPA = \frac{\sum_1^n C_i * g_i}{\sum_1^n C_i}$$

where

C_i Credit allotted to the course.

g_i Grade Point secured corresponding to the course.

n number of courses successfully cleared during the particular semester in the case of SGPA and all the semesters, under consideration, in the case CGPA.

9.5 A student can apply for revaluation of his/her semester examination answer paper in a theory course, within 3 working days from the declaration of results, along with prescribed application to the Controller of Examinations through the Head of Department. Revaluation is not permitted for laboratory courses, industrial training, and project works.

9.6 Passing a Course

A candidate who secures Grade Point 6 or more in any course of study will be declared to have passed that course, provided he/she secures a minimum of 50% of the total mark in the end semester examination of that course.

If a student fails to secure a pass in theory courses and laboratory courses in the current semester examination, he/she is allowed to write arrear examinations for the next three consecutive semesters, and their internal marks shall be carried over for the above mentioned period of three consecutive semesters.

In case if he/she has not completed all the courses of the semester I at the end of semester IV, he/she shall redo the semester I courses along with regular students. The same procedure shall be followed for the subsequent semesters of II, III and IV, subject to the maximum permissible period for this programme.

9.7 If a candidate fails in the end semester examinations of Phase I, he/she has to resubmit the project report within 30 days from the date of declaration of the results. If he/she fails in the end semester examination of Phase II of M.E. / M.Tech., he/she shall resubmit the project report within 60 days from the date of declaration of the results. The resubmission of the project report and the subsequent viva voce examination will be considered as reappearance with payment of the exam fee. If a student fails to resubmit the project report within the stipulated period and fails in the subsequent viva-voce examination, the student shall register for the course again in the subsequent semester.

10. REJOINING THE PROGRAMME

A candidate who has not completed the study of any of the semesters as per Clause 6 or who is allowed to rejoin the programme after the period of discontinuance or who on his/her own request is permitted to repeat the study of any semester (break of study), may join the semester which he/she is eligible or permitted to join, only at the time of its normal commencement for a regular batch of candidates and after obtaining the approval from the Director of Technical Education and Anna University, Chennai. In such a case, earlier continuous assessment in the repeated courses will be disregarded. However, no candidate will be allowed to enrol in more than one semester at any point of time.

11. QUALIFYING FOR THE AWARD OF THE DEGREE

A candidate will be declared to have qualified for the award of the M.E. / M.Tech. Degree provided:

i. He/she has completed the course requirements and has passed all the prescribed courses of study of the respective programme listed in Clause 3 within the duration specified in Clause 2.

ii. No disciplinary action is pending against the candidate.

12. CLASSIFICATION OF THE DEGREE AWARDED

12.1 First Class with Distinction:

A student who satisfies the following conditions shall be declared to have passed the examination in First class with Distinction:

- Should have passed the examination in all the courses of all the four semesters in the student's First Appearance within two years (Three years in case of authorised break of study of one year (if availed)). Withdrawal from examination (vide Clause 13) will not be considered as an appearance.
- Should have secured a CGPA of not less than 8.50.
- Should NOT have been prevented from writing end Semester examination due to lack of attendance in any of the courses.

12.2 First Class:

A student who satisfies the following conditions shall be declared to have passed the examination in first-class:

- Should have passed the examination in all the courses of all four semesters within three years, including one year of authorised break of study (if availed) or prevention from writing the End Semester Examination due to lack of attendance (if applicable).
- Should have secured a CGPA of not less than 6.50

12.3 Second Class:

All other students (not covered in clauses 12.1 and 12.2) who qualify for the award of the degree shall be declared to have passed the examination in the second class.

12.4 A student who is absent in the End Semester Examination in a course/project work after having registered for the same shall be considered to have appeared in that examination (except approved withdrawal from end semester examinations as per clause 13) for the purpose of classification.

13. WITHDRAWAL FROM EXAMINATION

13.1 A student may, for valid reasons, be granted permission by the Head of the Department to withdraw from appearing in the examination in any course(s) only once during the entire duration of the degree programme.

13.2 Withdrawal application shall be valid only if the student is eligible to write the examination as per Clause 6 and if such withdrawal request is made prior to the submission of marks of the continuous assessment of the course(s) with the recommendations from the Head of the Department.

13.3 If a student withdraws a course or courses from writing end semester examinations, he/she shall register the same in the subsequent semester and write the end semester examination(s)

13.4 Withdrawal shall not be considered as an appearance for deciding the eligibility of a candidate for first class with distinction or first class.

13.5 Withdrawal is permitted for the end semester examinations in the final semester only if the period of study the student concerned does not exceed 3 years for M.E. / M.Tech. as per clauses 12.1 and 12.2.

14. AUTHORISED BREAK OF STUDY FROM A PROGRAMME

14.1 A student is permitted to go on a break of study for a fixed period of one year as a single break in the entire course of study.

14.2 A student who would like to avail the break of study, on account of short term employment / medical treatment / personal reasons) shall apply to the Head of the Institution through the concerned Head of the Department (application available with the Controller of Examinations), in any case, not later than the last date for registering for the semester.

14.3 The students permitted to re-join the programme after a break of study/prevention

due to lack of attendance shall be governed by the curriculum and regulations in force at the time of re-joining. A committee constituted by the Head of the Institution shall prescribe additional/equivalent courses, if any, from the regulation in force to bridge the requirement between the curriculum in force and the old curriculum.

14.4 The total period for completion of the programme reckoned from the commencement of the first semester to which the student is admitted shall not exceed the maximum period specified in Clause 2, irrespective of the period of break of study in order that he/she may be eligible, for the award of the degree (vide Clause 11 and 12).

14.5 In case of any valid reasons for the extension of break-of-study, such extended break-of-study may be granted by the Head of the Institution for a period not more than one year in addition to the earlier authorised break of study. Such extended break-of-study shall be counted for the purpose of classification of degree (vide clause 12).

14.6 If a student does not report back to the institute, even after the extended break of study, the name of the student shall be deleted permanently from the college enrolment. Such candidates are not entitled to seek readmission under any circumstances.

15. SCHEME OF ASSESSMENT

I	**THEORY COURSES**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Periodical Test I (15)	
	Periodical Test II (15)	
	Term Paper Report (10) & Presentation (10)	
	End Semester Examination	**50**
	Total Marks	**100**

II	**THEORY COURSES WITH LAB COMPONENT**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Periodical Test I (15)	
	Periodical Test II (15)	
	Lab Examination (10)	
	Viva-voce (10)	
	End Semester Examination	**50**
	(QP pattern as per (I))	
	Total Marks	**100**

III	**PRACTICAL COURSES**	**Marks**
	Continuous Assessment	**100**
	Distribution of marks for Continuous Assessment:	
	Conduct of Experiment	
	i. Preparation (10)	
	ii. Experiment and Analysis of Results (20)	
	iii. Record (5)	
	Self-Learning Experiment (15)	
	Test - Cycle I (15)	
	Test - Cycle II (15)	
	Final Viva-voce (20)	
	Total Marks	**100**

IV	**DISSERTATION PHASE I**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Review I	
	Identification of topic and Justification (5)	
	Literature Survey (5)	
	Review II	
	Work plan & Approach (10)	
	Progress, Results and Discussion (10)	
	Review III	
	Conclusion (10)	
	Implementation & Applications (10)	

	End Semester Examination	
	Presentation (20)	**50**
	Report (10)	
	Viva Voce (20)	
	Total Marks	**100**

V	**DISSERTATION PHASE II**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Review I	
	Work plan & Approach (10)	
	Review II	
	Progress (10)	
	Results and Discussion (10)	
	Review II	
	Conclusion (10)	
	Implementation & Applications *(10)*	
	End Semester Examination	
	Presentation (20)	**50**
	Report (10)	
	Viva Voce (20)	
	Total Marks	**100**

VI	**MINI PROJECT**	**Marks**
	Continuous Assessment	**100**
	Distribution of marks for Continuous Assessment:	
	Review I	**25**
	Review II	**25**
	Presentation & Viva voce	**50**
	Total Marks	**100**

VII	**INDUSTRIAL TRAINING / INTERNSHIP**	**Marks**
	Continuous Assessment	**100**
	Presentation	**30**
	Viva-voce	**30**
	Case study / Report	**40**
	Total Marks	**100**

VIII	**VALUE ADDED COURSES / CERTIFICATE COURSES (Continuous Assessment Only)**	**Marks**
	Test I	50
	Test II	50
	Grades: Excellent (>80) / Good (61≤Marks ≤ 80) / Satisfactory (50≤Marks ≤ 60))	

Optional Test: *A student becomes eligible to appear for the one optional test conducted after the Periodical Test II, only under the following circumstances, if absent for Test I or Test II or both, on account of (i) medical reasons (hospitalisation / accident / specific illness) (ii) participation in the college/university/state / national/international level Sports events with prior permission from the Head of the Institution and (iii) on satisfying the conditions (i) or (ii), the student should have registered for the Optional Test, through the concerned faculty member who handles the course or through the respective Head of the Department, submitted to the Controller of Examinations. Such Optional Tests are not conducted for the courses under the categories III, IV, V, VI, VII and VIII listed above.*

16. DISCIPLINE

A student is expected to follow the rules and regulations laid down by the Institute and the affiliating University, as published from time to time. Any violations, if any, shall be treated as per the procedures stated thereof.

If a student indulges in malpractice in any of the end semester / continuous assessments, he/she shall be liable for punitive action as prescribed by the institution / university from time to time.

M.E. - COMMUNICATION SYSTEMS

VISION OF THE DEPARTMENT

- To foster academic excellence in Electronics and Communication Engineering Education and Research and turn out students into competent professionals to serve society.

MISSION OF THE DEPARTMENT

1. To establish a unique learning environment and to enable the students to face the challenges in Electronics and Communication Engineering.
2. To provide a framework for professional career, higher education and research activities.
3. To impart ethical and value based education by promoting activities addressing the social needs.

M.E. - COMMUNICATION SYSTEMS

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

I. The Graduates will demonstrate their skills and knowledge to design and develop communication systems for offering solutions to real world problems.

II. The Graduates will undertake research and development of projects for multidisciplinary situations.

III. The Graduates will serve the community as ethical and responsible professionals.

PROGRAMME OUTCOMES (POs)

a) Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.

b) Use research-based knowledge to interpret / investigate the problems, provide solutions and work towards the development of socially relevant products.

c) Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.

d) Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.

e) Comprehend and write effective technical reports, design documentation, and make effective presentations.

f) Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

MAPPING OF PEOs AND POs

PEO(s)	Programme Outcome (s)					
	(a)	(b)	(c)	(d)	(e)	(f)
I	X	X	X			X
II	X	X	X	X	X	X
III				X	X	X

M.E: COMMUNICATION SYSTEMS
Minimum credits to be earned: 68

First Semester								
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**	**Hours/ Week**
		PEOs	**POs**					
21CO11	Research Methodology and IPR	I,II,III	a,b,f	2	0	0	2	2
21CO12	Detection and Estimation Theory	I,II,III	a,b,c,d,f	3	1	0	4	4
21CO13	Advanced Radiating Systems	I,II,III	a,b,c,d,f	3	0	0	3	3
21CO14	Digital Image and Video Processing	I,II,III	a,b,c,d,f	3	0	0	3	3
	Program Elective I	-	-	-	-	-	3	3
21CO16	Digital Image and Video Processing Laboratory	I,II	a,b,c	0	0	4	2	4
21CO17	Advanced Communication Laboratory	I,II,III	a,b,f	0	0	4	2	4
	Audit course I[1]	-	-	2	0	0	-	2
			Total	**13**	**1**	**8**	**19**	**25**
Second Semester								
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**	**Hours/ Week**
		PEOs	**POs**					
21CO21	Digital Communication Techniques	I,II,III	a,b,c,d,f	3	0	0	3	3
21CO22	Microwave Integrated Circuits	I,II,III	b,c,d,f	3	0	0	3	3
21CO23	High Speed Networks	I,II,III	a,b,c,d,f	3	0	0	3	3
	Program Elective II	-	-	-	-	-	3	3
	Program Elective III	-	-	-	-	-	3	3
21CO26	Wireless and Networking Laboratory	I,II,III	a,b,c,d,f	0	0	4	2	4
21CO27	Miniproject	I,II,III	a,b,c,d,e,f	0	0	4	2	4
	Audit course II*	-	-	2	0	0	-	2
			Total	**11**	**0**	**8**	**19**	**25**
Third Semester								
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**	**Hours/ Week**
		PEOs	**POs**					
	Program Elective IV	-	-	-	-	-	3	3
	Program Elective V	-	-	-	-	-	3	3
21CO33	Dissertation Phase I	I,II,III	a,b,c,d,e,f	0	0	20	10	20
			Total	**0**	**0**	**20**	**16**	**26**
Fourth Semester								
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**	**Hours/ Week**
		PEOs	**POs**					
21CO41	Dissertation Phase II	I,II,III	a,b,c,d,e,f	0	0	28	14	28

[1] Audit Course is optional

List of Core Electives								
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**	**Hours/ Week**
		PEOs	**POs**					
21CO51	MIMO Communication	I,II,III	a,b,c,d,f	3	0	0	3	3
21CO52	Deep Learning for Wireless Communication	I,II,III	a,b,c,d,f	3	0	0	3	3
21CO53	Advanced Wireless Communication	I,II,III	a,b,c,d,f	3	0	0	3	3
21CO54	Wireless Sensor Network	I,II,III	a,b,c,d,f	3	0	0	3	3
21CO55	Free Space Optical Communication	I,II,III	a,b,c,d,f	3	0	0	3	3
21CO56	Communication Protocol for IoT	I,II,III	a,b,c,d,f	3	0	0	3	3
21CO57	Phased Array Antennas	I,II,III	a,b,c,d,f	3	0	0	3	3
21CO58	Smart Antennas for Mobile Communication	I,II,III	a,b,c,d,f	3	0	0	3	3
21CO59	RF Circuit Design	I,II,III	a,b,c,d,f	3	0	0	3	3
21CO60	Modeling of Wireless Applications	I,II,III	a,b,c,d,f	3	0	0	3	3
21CO61	All-Optical High Speed Signal Processing Devices	I,II,III	a,b,c,d,f	3	0	0	3	3
21CO62	Multimedia Compression Techniques	I,II,III	a,b,c,d,f	3	0	0	3	3
21CO63	VLSI Signal Processing	I,II,III	a,b,c,d,f	3	0	0	3	3
21CO64	Machine Learning	I,II,III	a,b,c,d	3	0	0	3	3
21CO65	Computer Vision	I,II,III	a,b,c,d	3	0	0	3	3
21CO66	Underwater Acoustic Signal Processing	I,II,III	a,b,c,d,f	3	0	0	3	3
21CO67	VLSI for Wireless Communication	I,II,III	a,b,c,d,f	3	0	0	3	3
21CO68	ASIC Design	I,II,III	a,b,c,d	3	0	0	3	3
21CO69	Global Positioning Systems and Navigational Aids	I,II,III	a,b,c,d,f	3	0	0	3	3
21CO70	Mixed Signal Circuit Design	I,II,III	b,c,d	3	0	0	3	3
21CO71	Electronic Design Automation Tools	I,II,III	a,b,c,f	3	0	0	3	3
21CO72	Scripting Languages for VLSI	I,II,III	b,c,d	3	0	0	3	3
List of Audit courses I & II								
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**	**Hours/ Week**
		PEOs	**POs**					
21XE01	English for Research Paper Writing	II,III	d,e	2	0	0	-	2
21XE02	Cost Management of Engineering Projects	II,III	d,e	2	0	0	-	2
21XE03	Stress Management	II,III	d	2	0	0	-	2
21XE04	Disaster Management	II,III	d	2	0	0	-	2

21XE05	Value Education	II,III	d,e	2	0	0	-	2
21XE06	Pedagogy Studies	II,III	d,e	2	0	0	-	2
21XE07	Business Analytics	I,II,III	b,d,e	2	0	0	-	2

21CO11 RESEARCH METHODOLOGY AND IPR 2 0 0 2

Course Objectives

- To enable the student to understand the research problem formulation.
- To apply the Patents, Designs, Trade and Copyright.
- To understand that IPR protection provides an incentive to inventors for further research work and investment in R & D.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Analyze the research problem formulation.
2. Analyze research related information
3. Apply the IPR in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property
4. Right to be promoted among students in general & engineering in particular.
5. Analyze IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

UNIT I **6 Hours**

MEANING OF RESEARCH PROBLEM

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

UNIT II **6 Hours**

EFFECTIVE LITERATURE

Effective literature studies approaches, analysis Plagiarism, and Research ethics.

UNIT III **6 Hours**

EFFECTIVE TECHNICAL WRITING

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT IV **6 Hours**

NATURE OF INTELLECTUAL PROPERTY

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V **6 Hours**

PATENT RIGHTS

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Total: 30 Hours

Reference(s)

1. Stuart Melville and Wayne Goddard, Research methodology: an introduction for science & engineering students,1996.
2. Wayne Goddard and Stuart Melville, Research Methodology: An Introduction
3. Ranjit Kumar, 2nd Edition, Research Methodology: A Step by Step Guide for beginners
4. Halbert, Resisting Intellectual Property, Taylor & Francis Ltd , 2007.
5. Mayall , Industrial Design, McGraw Hill, 1992.
6. Asimov , Introduction to Design, Prentice Hall, 1962.

21CO12 DETECTION AND ESTIMATION THEORY 3 1 0 4

Course Objectives

- Understand the mathematical background of signal detection and estimation
- Use classical and bayesian approaches to formulate and solve problems for signal detection and parameter estimation from noisy signals.
- Derive and apply filtering methods for parameter estimation.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Apply the basic concepts of vector spaces, eigen values in signal detection and estimation
2. Analyze the clustered data and signals using PCA and SVD
3. Apply stochastic process concepts in detection and estimation applications

4. Analyze the qualitative problems of detection in the framework of statistical inference.
5. Apply probability and stochastic process concepts in estimation and to design Wiener and Kalman filters to solve linear estimation problems

UNIT I **9 Hours**

VECTORS AND MATRICES

Vector Spaces: notation and properties, orthogonality and linear independence, bases, distance properties, matrix operations, Eigen values and eigenvectors.

UNIT II **9 Hours**

PROPERTIES OF SYMMETRIC MATRICES

Diagonalization of symmetric matrices, symmetric positive definite and semi definite matrices, Principal Component Analysis (PCA), singular value decomposition.

UNIT III **9 Hours**

STOCHASTIC PROCESSES

Time average and moments, ergodicity, autocorrelation, power spectral density, covariance matrices, response of LTI system to random process, cyclostationary process, and spectral factorization.

UNIT IV **9 Hours**

DETECTION THEORY

Detection in white Gaussian noise, correlator and matched filter interpretation, Bayes criterion of signal detection, MAP,LMS,entropy detectors, detection in colored Gaussian noise, Karhunen Loeve expansions and whitening filters.

UNIT V **9 Hours**

ESTIMATION THEORY

Minimum variance estimators, Cramer-Rao lower bound, examples of linear models, system identification, Markov classification, clustering algorithms. Linear transformation and orthogonality principle. Wiener filters. Discrete wiener filters. Kalman filters dynamical signal models, Kalman Bucy filtering, Wiener Kolmogorov filtering

Total: 60 Hours

Reference(s)

1. Harry L. Van Trees, Detection, Estimation and Modulation Theory, Part I John Wiley and Sons, New York, 2013. Wiley and Sons, New York, 2013.
2. Yao, Kung, FlavioLorenzelli, and Chiao-En Chen,Detection and estimation for communication and radar systems,Cambridge; New York: Cambridge University Press, 2013.
3. Thomas Schonhoff,Detection and Estimation Theory, Prentice Hall, New Jersy, 2007.
4. Thomas Kailath, BabakHassibi, Ali H. Sayed,Linear Estimation, Prentice Hall,2000.
5. Steven M. Kay, Fundamentals of Statistical Signal Processing, Volume I:Estimation Theory, Prentice Hall, 1993
6. Steven M. Kay, Fundamentals of Statistical Signal Processing, Volume II: Theory, 1st Edition, Prentice Hall, 1998

21CO13 ADVANCED RADIATING SYSTEMS 3 0 0 3

Course Objectives

- To learn fundamental concepts of antennas and explore the types of radiation from aperture antennas.
- To synthesize antennas using Fourier Transform method, Dolph-Chebyshev Method and Taylor Series method for different applications.
- To design and analyse microstrip, UWB, wearable and MIMO antennas for specific applications.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Compute the far field parameters, radiation pattern and gain of an antenna for given current distribution.
2. Analyse and estimate the radiation properties of aperture antennas.
3. Synthesis antenna arrays using different techniques.
4. Analyse microstrip antennas and feed networks for microstrip antennas.
5. Analyse the properties of antennas for specific applications.

UNIT I **9 Hours**

ANTENNA FUNDAMENTALS

Review of Electromagnetic Theory, Vector Potential Approach, Antenna fundamental parameters Solution Procedure Hertzian Dipole Short Dipole, Radiation Resistance and Directivity, Half-wave Dipole.

UNIT II **9 Hours**

APERTURE ANTENNAS

Aperture Antennas: Introduction, Magnetic Current and its Fields, Uniqueness Theorem Field Equivalence Principle, Huygens"" Principle- Radiation Equation- Directivity- Rectangular Aperture- TE10-Mode- Circular Aperture- TE11-Mode- Design Considerations- Fourier Transforms in Aperture Antenna Theory, E-Plane Sectoral Horn, H-Plane Sectoral Horn, Pyramidal horn, - applications.

UNIT III **9 Hours**

ANTENNA SYNTHESIS

Linear array and Planar array- Characteristics, synthesis techniques-Fourier Transform method, and Taylor Line Source synthesis and Dolph-Chebyshev distributions. Circular array antennas.

UNIT IV **9 Hours**

DESIGN AND ANALYSIS OF MICROSTRIP PATCH ANTENNAS

Configurations- Excitations and radiation mechanism of microstrip patch antennas- Radiation resistance- Power and input impedance. Modelling of rectangular and circular microstrip patch antennas - Transmission line model and cavity model method. Circular polarization and bandwidth of microstrip patch antennas. Simulation of microstrip antennas using Simulation Software-Case studies.

UNIT V **9 Hours**

ANTENNAS FOR SPECIAL APPLICATIONS

Slot antenna-UWB antennas-MIMO antennas-Wearable antennas for wireless communications-monopole antenna and loop antenna.

Total: 45 Hours

Reference(s)

1. Balanis. A, 'Antenna Theory Analysis and Design', 4 th Edition, John Wiley and Sons, New York, 2016.
2. John D Kraus, 'Antennas for all applications', 3 rd Edition, McGraw-Hill, 2008.
3. Hubregt.J.Visser 'Antenna Theory and Applications' 1st Edition, John Wiley & Sons Ltd, 2012.
4. Xavier Begaud, 'Ultra-Wide Band Antennas', 1 st Edition, John Wiley & Sons Ltd, 2013.
5. Albert Sabban,Wearable Systems and Antennas Technologies for 5G, IOT and Medical Systems, CRC Press, 2020

21CO14 DIGITAL IMAGE AND VIDEO PROCESSING 3 0 0 3

Course Objectives

- To provide the fundamental knowledge on image and video signals for efficient processing
- To improve the quality of image and video signals using appropriate methodologies.
- To process image and video signals for real time applications.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Apply the fundamentals of image and video signals and transform the signals from spatial domain to frequency domain.

2. Apply different enhancement technique for image, and video signals to improve its quality and restore the data.
3. Analyze various techniques for image and video segmentation.
4. Apply the compression techniques to reduce the data rate.
5. Analyze the processing methods and models of color images.

UNIT I **9 Hours**

DIGITAL IMAGE AND VIDEO FUNDAMENTALS

Digital image and video fundamentals and formats, 2-D and 3-D sampling and aliasing, filtering, image decimation/interpolation, video sampling and interpolation, Basic image processing operations, Image Transforms - DFT, DCT, Walsh, Hadamard transform, Haar transform, Wavelet transform

UNIT II **9 Hours**

IMAGE AND VIDEO ENHANCEMENT AND RESTORATION

Histogram, Histogram equalization and specification, Point processing, filtering, image restoration, algorithms for 2-D motion estimation, video resolution enhancement, Image and Video restoration (recovery).

UNIT III **9 Hours**

IMAGE AND VIDEO SEGMENTATION

Image segmentation- Line detection, edge detection, thresholding, Region based segmentation, Video segmentation-Scene Change Detection, Spatiotemporal Change Detection, Motion Segmentation, Morphological image processing.

UNIT IV **9 Hours**

IMAGE AND VIDEO COMPRESSION

Lossless image compression including entropy coding, lossy image compression, video compression techniques, and international standards for image and video compression (JPEG, JPEG 2000, MPEG-2/4, H.264, SVC)

UNIT V **9 Hours**

COLOUR IMAGE PROCESSING

Colour fundamentals, Colour models, Conversion of colour models, Pseudo colour image processing, Full colour processing

Total: 45 Hours

Reference(s)

1. Ed. Al Bovik ,Handbook of Image and Video Processing, 2 nd Edition, Academic Press, 2000.
2. J. W. Woods, Multidimensional Signal, Image and Video Processing and Coding, 2 nd Edition, Academic Press, 2011.
3. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, 3rd Edition, Prentice Hall, 2008.
4. A. M. Tekalp, Digital Video Processing, 2nd Edition, Prentice Hall, 2015.
5. S. Shridhar, Digital Image Processing, 2nd Edition, Oxford University Press, 2016.

21CO16 DIGITAL IMAGE AND VIDEO PROCESSING LABORATORY

0 0 4 2

Course Objectives

- Analyze the image/video signals using various transforms
- Analyze classical enhancement techniques to improve the quality of image and video signals.
- Detect an object in an image or video using appropriate recognition techniques

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.

Course Outcomes (COs)

1. Analyze the image/video signals using transforms and apply the histogram equalization technique for the given signal.
2. Apply suitable enhancement techniques to improve the quality of image and video signals.
3. Perform segmentation process for image and video signals.
4. Perform color conversion from one form to another based on the requirement in the application.
5. Detect an object in an image or video using appropriate recognition techniques.

1 **4 Hours**

EXPERIMENT 1

Perform various Image Transform.

2 **4 Hours**

EXPERIMENT 2

Identify the histogram plot for the given image and perform histogram equalization.

3 **4 Hours**

EXPERIMENT 3

Perform Filtering Operations on Images.

4 **4 Hours**

EXPERIMENT 4

Perform various Image Enhancement Techniques.

5 **4 Hours**

EXPERIMENT 5

Perform video enhancement techniques for improving the quality.

6 **4 Hours**

EXPERIMENT 6
Perform Image/video Restoration Operation.

7 **4 Hours**

EXPERIMENT 7
Perform Edge Detection Operations on Images.

8 **4 Hours**

EXPERIMENT 8
Perform video object segmentation.

9 **4 Hours**

EXPERIMENT 9
Perform Morphological Operations on Images.

10 **4 Hours**

EXPERIMENT 10
Conversion of color models.

11 **5 Hours**

EXPERIMENT 11
Perform image compression using lossy/lossless techniques.

12 **5 Hours**

EXPERIMENT 12
Calculate boundary and regional features of an image.

13 **10 Hours**

EXPERIMENT 13
Self-Learning (Minimum -2)

Total: 60 Hours

Reference(s)

1. Ed. Al Bovik Ha,ndbook of Image and Video Processing, 2nd Edition, Academic Press, 2000.
2. J. W. Woods, Multidimensional Signal, Image and Video Processing and Coding, 2nd Edition, Academic Press, 2011.
3. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, 3rd Edition, Prentice-Hall, 2008.
4. A. M. Tekalp, Digital Video Processing, 2nd Edition, Prentice Hall, 2015.
5. S. Shridhar, Digital Image Processing, 2nd Edition, Oxford University Press, 2016.

21CO17 ADVANCED COMMUNICATION LABORATORY

0 0 4 2

Course Objectives

- Analyze the process of signal detection and estimation.
- Use classical and Bayesian approaches to formulate and solve problems for signal detection and parameter estimation from noisy signals.
- Analyze the performance of microstrip antennas for various applications.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.

b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.

f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Analyze the random signals and noise with different receiver models.
2. Analyze signals in the presence of correlated and uncorrelated white and colored noise with spatially separated target signal.
3. Analyze and compare MLE, MMSE, and Bayes Estimator, MAP Estimator, Expectation Maximization (EM)estimation techniques.
4. Analyze the performance of microstrip patch antennas application.
5. Analyze the performance of microstrip array antennas.

1 **4 Hours**

EXPERIMENT 1

Simulate signal and noise models.

2 **4 Hours**

EXPERIMENT 2

Simulate spatially separated target signal in the presence of Additive Correlated White Noise.

3 **4 Hours**

EXPERIMENT 3

Simulate spatially separated target signal in the presence of Additive Uncorrelated White Noise.

4 **4 Hours**

EXPERIMENT 4

Simulate spatially separated target signal in the presence of Additive Correlated Colored Noise.

5 **4 Hours**

EXPERIMENT 5

Detect Constant amplitude Signal in AWGN.

6 **4 Hours**

EXPERIMENT 6

Detect Time varying Known and Unknown Signals in AWGN.

7 **4 Hours**

EXPERIMENT 7

Compare performance of the Estimation techniques- MLE, MMSE, and Bayes Estimator, MAP Estimator, Expectation Maximization (EM) algorithm.

8 **4 Hours**

EXPERIMENT 8

Performance comparison of conventional Energy Detectors and Coherent Matched Filter Techniques.

9 **4 Hours**

EXPERIMENT 9

Determine the parameters of square patch antenna with different types of feeds

10 **4 Hours**

EXPERIMENT 10

Determine the parameters of rectangular patch antenna with different types of feeds.

11 **4 Hours**

EXPERIMENT 11

Determine the parameters of circular patch antenna with different types of feeds.

12 **4 Hours**

EXPERIMENT 12

Determine the parameters of monopole antenna with different types of feeds.

13 **4 Hours**

EXPERIMENT 13

Determine the parameters of dipole patch antenna with different types of feeds.

14 **4 Hours**

EXPERIMENT 14

Determine the parameters of fractal antenna with different types of feeds.

15 **4 Hours**

EXPERIMENT 15

Determine the parameters of microstrip array antenna with different types of feeds.

Total: 60 Hours

Reference(s)

1. Harry L. Van Trees, "Detection, Estimation and Modulation Theory", Part I John Wiley and Sons, New York, 2013.
2. Yao, Kung, FlavioLorenzelli, and ChiaoEn Chen,Detection and estimation for communication and radar systems,Cambridge; New York: Cambridge University Press, 2013.
3. Thomas Schonhoff,Detection and Estimation Theory, Prentice Hall, New Jersy, 2007.
4. Thomas Kailath, BabakHassibi, Ali H. Sayed, Linear Estimation, Prentice Hall, 2000.
5. Steven M. Kay,Fundamentals of Statistical Signal Processing, Volume I: EstimationÃ‚Â Theory, Prentice Hall, 1993
6. Steven M. Kay, Fundamentals of Statistical Signal Processing, Volume II: Detection Theory, 1st Edition, Prentice Hall, 1998

21CO21 DIGITAL COMMUNICATION TECHNIQUES 3 0 0 3

Course Objectives

- To analyze the spectra of various signaling schemes.
- To analyze the synchronization issues in communication systems.
- To apply different Equalization techniques for effective communication.
- To design complex circuits in digital communication.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Analyze the power spectrum of different signaling schemes in communication systems.
2. Apply various block coding and convolutional coding methods for efficient error detection and correction in digital communication techniques.
3. Analyze synchronization issues in spread spectrum.
4. Apply the concept of channel equalization in receivers for better error performance.
5. Analyze the performance of different multiple access techniques.

UNIT I **9 Hours**

SIGNALING SCHEMES

Line Coding schemes and their Power spectra-band pass Signaling-Geometric Representation of signals-Principles of Binary ASK, PSK, FSK-QPSK and QAM-CPFSK, OQPSK, MSK, GMSK-BER, PSDs-Link Budget.

UNIT II **9 Hours**

ERROR CONTROL TECHNIQUES

Channel coding-bandwidth expansion-Error correction Vs detection- coding gain-Matrix Parity Check Codes-Linear Block Codes-Error Detection Correction capability-Cyclic Codes -CRC-Hamming codes-Convolutional codes-Viterbi Decoding algorithm-Turbo Codes-LDPC.

UNIT III **9 Hours**

SYNCHRONIZATION

Sources of synchronization Uncertainty, Carrier Synchronization-Code Synchronization Acquisition-Matched Filter Acquisition, Serial Search Acquisition, Sequential Acquisition, Code Tracking-Delay Lock Tracking loop, Noncoherent Tracking loop.

UNIT IV **9 Hours**

CHANNEL EQUALIZATION

The Channel Model- Eye Diagrams, Maximum likelihood sequence estimation- Linear Equalization-Decision feedback equalization- Performance analysis of MLSE- Comparison of equalization techniques - Adaptive equalization- Least Mean Squares (LMS) and Recursive Least Square (RLS) algorithms for adaptive equalization.

UNIT V **9 Hours**

MULTIPLEXING

TDM/TDMA, FDM/FDMA, Space DMA, Polarization DMA, OFDM, ALOHA, Slotted ALOHA, Reservation ALOHA, CSMA-CD, CSMA-CA-basic techniques and comparative performances e.g. signal bandwidth, delay, probability of error etc.

Total: 45 Hours

Reference(s)

1. B.Sklar, Digital Communications, Fundamentals and Applications,2nd Edition, Pearson Education 2001.
2. Rodger E. Ziemer, Fundamentals of Spread Spectrum Modulation", Morgan Claypool, Publishers series, 2007.
3. J.G.Proakis, M.Salehi, Fundamentals of Communication Systems, Pearson Education 2014.
4. B.P.Lathi, Modern Digital and Analog Communication Systems, 3rd Edition, Oxford University Press, 2011.
5. Simon Haykin, Michael Moher and David Koilpillai, Modern Wireless communications, Pearson, 2011.
6. Robert C. Dixon, Spread Spectrum Systems with Commercial Applications, 3rd Edition, John Wiley & Sons, Ins, 1994.

21CO22 MICROWAVE INTEGRATED CIRCUITS 3 0 0 3

Course Objectives

- To acquire an insight view and knowledge to design different types of resonators, filters and advanced microwave structures.
- To gain proficiency regarding microwave integrated circuit concepts and relation between different parameters.
- To analyse and design microwave integrated circuit design using lumped elements and transmission lines.

Programme Outcomes (POs)

b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Apply the concept of production methods, substrates, packaging and components in Monolithic MIC technology.
2. Analyze and design the different types of microwave integrated circuits by using transmission lines and lumped elements.
3. Design different types of resonators to create, filter and select frequencies in microwave communication circuits.
4. Design the different types of microwave filters, transformations and its realizations.
5. Analyze the design and development of advanced microwave structures to enable the current MIC technologies in near future.

UNIT I **9 Hours**

MONOLITHIC MIC TECHNOLOGY

Introduction - Characteristics of Microwave and Millimeter waves - MMIC technology: Applications, Substrates, Production Methods, Packaging, and Electrical Connections, Components for Integrated Microwave Circuits.

UNIT II **9 Hours**

TRANSMISSION LINES AND LUMPED ELEMENTS

Transmission Lines: Characteristics of Conventional Transmission structures - Characteristics of Planar Transmission lines: Strip line, Microstrip, Suspended and Inverted Microstrip Lines, Slot Lines and Co-planar lines, Coupled Lines and its Discontinuities - Lumped elements: Design of Lumped elements, Inductors, Capacitors, and Resistors.

UNIT III **9 Hours**

RESONATORS

Introduction - Resonator parameters - Cavity Resonators - Planar Microstrip resonant structures - Dielectric resonator - YIG Resonators

UNIT IV **9 Hours**

FILTERS

Introduction - Filter parameters, Types, Applications, and Measurements - Filter Synthesis: Low pass filter, Special response filter, Filter transformations, Impedance and Admittance Inverters - Filter Modelling: Narrowband approximation, Filter Analysis, and Numerical techniques - Filter Realizations - Dielectric Resonant filters - Practical considerations.

UNIT V **9 Hours**

ADVANCED MICROWAVE STRUCTURES

Defect Ground Structure: Introduction, Base structure, Circuit topologies, Characteristics, Modelling of DGS and Application of DGS. Substrate Integrated Waveguides: Introduction - Geometry - Operation principle - Analysis Techniques of SIW - Design Considerations - Other SIW Configurations.

Total: 45 Hours

Reference(s)

1. Ramesh Garg, InderBahl, Maurizio Bozzi - Microstrip Lines and Slotlines, Third Edition- Artech House (2013).
2. Ulrich L. Rohde, Matthias Rudolph - RF/Microwave Circuit Design for Wireless Applications-Wiley (2012).
3. InderBahl, Prakash Bhartia - Microwave Solid State Circuit Design-Wiley-Interscience(2003).
4. Hoffman R.K, Handbook of Microwave Integrated Circuit, Artech House (1987).
5. S.Y.Liao, Microwave circuit Analysis and Amplifier Design, Prentice Hall (1987).
6. Gupta K.C and Amarjit Singh, Microwave Integrated Circuits, John Wiley & Sons-Wiley Eastern Reprint (1978).

21CO23 HIGH SPEED NETWORKS 3 0 0 3

Course Objectives

- To enable the student to understand the basics of switching technologies and their implementation LANs, SONET and ATM networks.
- To provide an analysis in networking protocols for real time applications.
- To provide security analysis in different layers of network.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.

d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Apply the packet switching concepts in wired networks and circuit switching concepts in SONET and ATM networks.
2. Analyze the protocols suitable for streaming stored video and Voice-over-IP in real time multimedia networking applications.
3. Compare the performance of internetworking protocols and analyze the implementation procedure of Switches and Routers.
4. Analyze the issues in network resource allocation due to network congestion and discuss the congestion avoidance mechanism.
5. Analyze the Cryptography principles and network layer security protocols suitable for VPN, Wireless LAN networks.

UNIT I **10 Hours**

SWITCHING NETWORKS

Switching-Packet switching-Ethernet, Token Ring, FDDI, DQDB, Frame Relay, SMDS, Circuit Switched-SONET, DWDM, DSL, Intelligent Networks-CATV, ATM-Features, Addressing Signaling Routing, Header Structure, ATM Adaptation layer, Management control, BISDN, Internetworking with ATM.

UNIT II **8 Hours**

MULTIMEDIA NETWORKING

Multimedia Networking Applications - Streaming Stored Video - Voice-over-IP - Protocols for Real-Time Conversational Applications.

UNIT III **9 Hours**

INTERNETWORKING

Basic Internetworking-Service Model-Global Addresses-Sub netting and Classless Addressing-ARP-DHCP-ICMP -Implementation and Performance-Switch Basics -Ports-Fabrics- Router Implementation-MPLS-Destination Based Forwarding-Routing among Mobile Devices.

UNIT IV **9 Hours**

CONGESTION CONTROL AND RESOURCE ALLOCATION

Issues in Resource allocation-Queuing Disciplines-TCP Congestion control-Congestion Avoidance Mechanisms-RED-Quality of Service-Application Requirements-Integrated Services-Differentiated Services.

UNIT V **9 Hours**

SECURITY IN COMPUTER NETWORKS

Introduction-Network Security-Principles of Cryptography- Message Integrity and Digital Signatures-End-Point Authentication-Securing E-Mail-Securing TCP Connections: SSL-Network-Layer Security: IPsec and Virtual Private Networks- Securing Wireless LANs-Operational Security: Firewalls and Intrusion Detection Systems.

Total: 45 Hours

Reference(s)

1. James F. Kurose& Keith W. Ross, Computer Networking A Top-down Approach Featuring the Internet, PHI, 2007.
2. Larry Peterson & Bruce David, Computer Networks: A System Approach, Morgan Kaufmann, 2003.
3. Behrouz Foruzan, Data communication and Networking, 5th Edition Tata McGraw-Hill, 2017.
4. Stallings W., High-Speed Networks: TCP/IP and ATM Design Principles, Prentice Hall, 1998.
5. William Stalling, Network security, essentials, Pearson education Asia publication, 6th Edition, 2017.
6. George Kesidis, ATM Network Performance, Kluwer Academic, Research Papers, 2005.

21CO26 WIRELESS AND NETWORKING LABORATORY

0 0 4 2

Course Objectives

- To learn network cable types and network devices.
- To learn network command and configuration.
- Performance analysis of various digital modulation techniques.
- To analyze the BER and PSD for different modulation techniques.
- To apply channel coding and source coding techniques in digital communication channel.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Apply the knowledge to identify a suitable architecture and systematically design a communication network.
2. Analyze the performance of Networks using Networking protocols.
3. Analyze the experimental measurement data and produce meaningful conclusions.
4. Analyze the BER and PSD for different modulation techniques.
5. Apply channel coding and source coding techniques in digital communication channel.

1 **4 Hours**

EXPERIMENT 1

Simulation and performance evaluation using
(QUALNET /GLOMOSIM / NS2/ Packet Tracer Equivalent).

2 **4 Hours**

EXPERIMENT 2

Connect the computers in LAN.

3 **4 Hours**

EXPERIMENT 3

Implementation of Ethernet LAN Protocol for Bus (Token Bus).

4 **4 Hours**

EXPERIMENT 4

Configure Host IP, Subnet Mask and Default Gateway in a System in LAN (TCP/IP Configuration).

5 **5 Hours**

EXPERIMENT 5

Assigning a Dynamic IPv4 Address to a Host using DHCP.

6 **5 Hours**

EXPERIMENT 6

Simulation of Congestion Control Algorithms using NS2.

7 **4 Hours**

EXPERIMENT 7

Simulation of Congestion Control Algorithms using NS2.

8 **4 Hours**

EXPERIMENT 8

Implementation and analysis of data security and network security algorithms.

9 **4 Hours**

EXPERIMENT 9

Analyze the BER and PSD plot for QPSK and MSK in Rayleigh channel.

10 **4 Hours**

EXPERIMENT 10

Simulate Error detection and correction using convolution codes.

11 **4 Hours**

EXPERIMENT 11

Simulate Error detection and correction using cyclic codes.

12 **4 Hours**

EXPERIMENT 12

Apply linear equalization in wireless communication systems.

13 **10 Hours**

EXPERIMENT 13

Self-Learning (Minimum 2)

Total: 60 Hours

Reference(s)

1. Ying-Dar Liu, Ren-Hung Hwang, Fred Baker; Computer Networks: An Open Source Approach;, McGraw-Hill, 2011.
2. W Stallings, Cryptography and Network Security, Principles and Practice, 5th Ed., Prentice- Hall, 2010.
3. Srinivasan Keshav - Mathematical Foundations of Computer Networking-Addison-Wesley Professional (2012).
4. Andrew S. Tanenbaum,;Computer Networks;, Fifth Edition, Pearson Education India, 2013.
5. Simon Haykin, Communication Systems, John Wiley & Sons. Pvt. Ltd, 2009.
6. Shu Lin & Daniel J. Costello, Error Control Coding: Fundamentals and Applications, Jr., Prentice Hall Inc, 2004.

21CO27 MINI PROJECT 0 0 4 2

Course Objectives

- Speculate the problem identifying ability.
- Improve the analyzing capability of the students.
- Increase the exuberance in finding the solution to various problems.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.

b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.

c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.

d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.

e. Comprehend and write effective technical reports, design documentation, and make effective presentations.

f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Formulate a real-world problem, identify the requirement, and develop the design solutions.
2. Identify technical ideas, strategies, and methodologies.

3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
5. Prepare report and present oral demonstrations.

Total: 60 Hours

21CO33 DISSERTATION PHASE I 0 0 16 10

Course Objectives

- Understand and incorporate engineering standards and multiple realistic constraints, within realistic design time, budget, and performance objectives.
- Develop a prototype of the proposed design and demonstrate the prototype in accordance with the specifications.
- Effectively communicate information relating to all aspects of the design process in written, oral, and graphical form.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
e. Comprehend and write effective technical reports, design documentation, and make effective presentations.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Ability to synthesize knowledge and skills previously gained and applied to an in-depth study and execution of new technical problem.
2. Capable to select from different methodologies, methods and forms of analysis to produce a suitable research design, and justify their design.
3. Ability to present the findings of their technical solution in a written report.
4. Presenting the work in International/ National conference or reputed journals.

Total: 240 Hours

21CO41 DISSERTATION PHASE II 0 0 32 14

Course Objectives

- Understand and incorporate engineering standards and multiple realistic constraints, within realistic design time, budget, and performance objectives.
- Develop a prototype of the proposed design and demonstrate the prototype in accordance with the specifications.
- Effectively communicate information relating to all aspects of the design process in written, oral, and graphical form.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
e. Comprehend and write effective technical reports, design documentation, and make effective presentations.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Ability to synthesize knowledge and skills previously gained and applied to an in-depth study and execution of new technical problem.
2. Capable to select from different methodologies, methods and forms of analysis to produce a suitable research design, and justify their design.
3. Ability to present the findings of their technical solution in a written report.
4. Presenting the work in International/ National conference or reputed journals.

Total: 240 Hours

ELECTIVES

21CO51 MIMO COMMUNICATION 3 0 0 3

Course Objectives

- To learn the concepts of MIMO channel propagation and MIMO channel model.
- To understand spatial diversity and MIMO channel capacity performance in wireless communication.
- To provide the fundamental knowledge on Space-Time Codes and MIMO detection techniques.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Analyze the channel models and power allocation of MIMO Systems.
2. Apply the mathematics concepts and calculate the capacity of deterministic and random MIMO channels and fading channels.
3. Analyze the implication of spatial diversity method and calculate the diversity order and channel variability.
4. Analyze the concept of different space time coding techniques like STBCs, STTCs and Space time turbo codes.
5. Apply the various algorithms used to detect the received signal in MIMO systems like Maximum likelihood, MMSE, ZFE.

UNIT I **9 Hours**

MIMO CHANNEL MODELS

Diversity-multiplexing trade-off, transmit diversity schemes, advantages and applications of MIMO systems, Fading Channel Models: Uncorrelated - fully correlated - separately correlated - keyhole MIMO fading models, parallel decomposition of MIMO channel, Power allocation in MIMO: Uniform - adaptive - near optimal power allocation.

UNIT II **9 Hours**

MIMO CHANNEL CAPACITY

Capacity for deterministic MIMO Channels: SISO, SIMO, MISO, MIMO, Capacity of random MIMO channels: SISO, SIMO, MISO, MIMO (Unity Channel Matrix, Identity Channel Matrix), Capacity of

independent identically distributed channels, Capacity of separately correlated Rayleigh fading MIMO channels, Capacity of keyhole Rayleigh fading MIMO channel.

UNIT III **9 Hours**

SPATIAL DIVERSITY

Diversity gain, Receive antenna diversity, Transmit antenna diversity, Diversity order and channel variability, Diversity performance in extended channels, combined space and path diversity, Indirect transmit diversity, Diversity of a space-time- frequency selective fading channel.

UNIT IV **9 Hours**

SPACE-TIME CODES

Advantages, code design criteria, Alamouti space-time codes, SER analysis of Alamouti space-time code over fading channels, Space-time block codes, Space-time trellis codes, Performance analysis of Spacetime codes over separately correlated MIMO channel, Space-time turbo codes, BLAST Architectures: VBLAST, HBLAST, SCBLAST, DBLAST.

UNIT V **9 Hours**

MIMO DETECTION TECHNIQUES

Maximum Likelihood, Zero Forcing, Minimum Mean Square Error, Zero Forcing Equalization with Successive Interference Cancellation, Minimum Mean Square Error Successive Interference Cancellation, Lattice Reduction based detection.

Total: 45 Hours

Reference(s)

1. TolgaM.Duman and Ali Ghrayeb, Coding for MIMO Communication Systems, John Wiley & Sons Ltd.,2007.
2. EzioBiglieri, Robert Calderbank and Anthony Constantinides. MIMO Wireless Communications Cambridge University Press, 08-Jan-2007 - Technology & Engineering.
3. R. S. Kshetrimayum, Fundamentals of MIMO Wireless Communications, Cambridge University Press, 2017.
4. B. Kumbhani and R. S. Kshetrimayum, MIMO Wireless Communications over Generalized Fading Channels, CRC Press, 2017.
5. T. L. Marze_a, E. G. Larsson, H. Yang and H. Q. Ngo, Fundamentals of Massive MIMO, Cambridge University Press, 2016.
6. A. Paulraj, Rohit Nabar, Dhananjay Gore., Introduction to Space Time Wireless Communication Systems, Cambridge University Press, 2003.

21CO52 DEEP LEARNING FOR WIRELESS COMMUNICATION

3 0 0 3

Course Objectives

- Understand the operation of Deep Learning Neural Networks.
- Understand the Architecture of Deep Learning Artificial Neural Networks.
- Introduce major deep learning algorithms and their applications to solve wireless communication problems.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Analyze the concept of deep neural networks and the potential of such networks in automatic learning.
2. Analyze the need for deep learning algorithms which are more appropriate for different types of learning tasks in various domains.
3. Apply convolutional architectures for supervised learning and solve real time problems.
4. Analyze various types of recurrent neural networks and auto encoders and apply their potential in different domains.
5. Analyze and implement Deep Learning Architectures for wireless communication system.

UNIT I **9 Hours**

DEEP LEARNING ANALYSIS

History of Deep Learning - Deep Learning Success Stories - McCulloch Pitts Neuron - Thresholding Logic, Perceptrons - Perceptron Learning Algorithm - Multilayer Perceptrons (MLPs) - Representation Power of MLPs - Sigmoid Neurons - Gradient Descent- Feedforward Neural Networks- Backpropagation.

UNIT II **9 Hours**

DEEP NEURAL NETWORKS

Difficulty of training deep neural networks - Greedy layerwise training - optimization methods: Gradient Descent (GD) , Momentum Based GD , Nesterov Accelerated GD , Stochastic GD, AdaGrad , RMSProp , Adam , Eigenvalues and eigenvectors , hyper parameters in deep neural network-Regularization: Bias Variance Tradeoff, L2 regularization, Early stopping ,Dataset augmentation , Dropout.

UNIT III **9 Hours**

CONVOLUTIONAL NEURAL NETWORKS

CNN Architectures , Convolution , Pooling Layers , Transfer Learning , Image Classification using Transfer Learning , LeNet , AlexNet , ZF-Net , VGGNet , GoogLeNet, ResNet , Visualizing Convolutional Neural Networks.

UNIT IV **9 Hours**

DEEP GENERATIVE MODELS

LSTM , GRU , Encoder/Decoder Architectures , Autoencoders , Standard, Sparse , Denoising , Contractive, Variational Autoencoders , Adversarial Generative Networks , Autoencoder and DBM.

UNIT V **9 Hours**

APPLICATION OF DEEP LEARNING IN WIRELESS COMMUNICATION

End-to-End communication system design using autoencoders- single antenna- MIMO, Multiuser - Deep learning in spectrum situation awareness - channel modelling and estimation using GAN - Signal detection and modulation classification using CNN.

Total: 45 Hours

Reference(s)

1. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016.
2. Bengio, Yoshua. Learning deep architectures for AI. Foundations and trends in Machine Learning 2.1 (2009) 1127.
3. Tugba Erpek, Timothy J. OShea, Yalin E. Sagduyu, Yi Shi, T. Charles Clancy, Deep Learning for Wireless Communications, arXiv:2005.06068, 2020.
4. Xiaofan Li , Fangwei Dong , Sha Zhang, and Weibin Guo, Survey on Deep Learning Techniques in Wireless Signal Recognition, Review article in Wireless Communications and Mobile Computing, 2019.
5. Abadi, MartIn, et al. Tensorflow Large-scale machine learning on heterogeneous distributed systems. arXiv preprint arXiv1603.04467 (2016).
6. Francois Chollet, Deep Learning with Python, Manning Publications, 2018.

21CO53 ADVANCED WIRELESS COMMUNICATION 3 0 0 3

Course Objectives

- To learn the concepts of wireless channel propagation and wireless channel model.
- To know about the multiple access techniques and capacity of wireless channels.
- To provide the fundamental knowledge on diversity and spatial diversity in MIMO Communication systems.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Analyze the wireless channel characteristics and identify appropriate channel models.
2. Apply the mathematics concepts behind the capacity calculation under different channel conditions.
3. Analyze the implication of diversity combining methods in the receiver side.

4. Analyze the multiplexing techniques and implement the algorithm in MATLAB coding for various aspects of MIMO.
5. Analyze the concepts in MIMO Communications and architecture of MIMO systems.

UNIT I **9 Hours**

WIRELESS CHANNEL PROPAGATION AND MODEL

Propagation of EM signals in wireless channel, Reflection, diffraction and Scattering, free space, two rays. Small scale fading, channel classification, channel models, COST ,231 Hata model, Longley-Rice Model, NLOS Multipath Fading Models: Rayleigh, Rician, Nakagami, Composite Fading ,shadowing Distributions, Link power budget Analysis.

UNIT II **9 Hours**

MULTIPLE ACCESS SCHEMES AND CAPACITY OF WIRELESS CHANNELS

OFDM Modem, Spread Spectrum Systems, RAKE receiver-Access methods - FDMA, TDMA , CDMA ,SDMA and CSMA. Capacity in AWGN, capacity of flat fading channel, capacity of frequency selective fading channels. Capacity of frequency flat deterministic MIMO channel: Channel unknown to the transmitter, Channel known to the transmitter, capacity of random MIMO channels, MIMO capacity, Capacity of frequency selective MIMO channels.

UNIT III **9 Hours**

DIVERSITY

Realization of independent fading paths, Receiver Diversity: Selection combining, Threshold Combining, Maximum-ratio Combining, Equal gain combining. Transmitter Diversity: Channel known at transmitter, Channel unknown at the transmitter.

UNIT IV **9 Hours**

SPATIAL MULTIPLEXING

MIMO spatial multiplexing: Space time receivers, ML, ZF, MMSE and Sphere decoding, BLAST receivers and Diversity multiplexing trade - off.

UNIT V **9 Hours**

MIMO COMMUNICATIONS

MIMO model, Parallel decomposition of the MIMO channel, MIMO channel capacity, MIMO Diversity Gain: Beam forming, Diversity, Multiplexing trade-offs, Space time Modulation and coding: STBC, STTC, Spatial Multiplexing and BLAST Architectures.

Total: 45 Hours

Reference(s)

1. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2007.
2. Harry R. Anderson, Fixed Broadband Wireless System Design, John Wiley, India, 2003.
3. Andreas.F. Molisch, Wireless Communications, 2nd Edition, John Wiley, India, 2010.
4. Simon Haykin & Michael Moher, Modern Wireless Communications, Pearson Education, 2007.
5. Rappaport. T.S., Wireless communications, Pearson Education, 2003.
6. Gordon L. Stuber, Principles of Mobile Communication, Springer International Ltd., 2001.

21CO54 WIRELESS SENSOR NETWORK 3 0 0 3

Course Objectives

- Understand the characteristic features of wireless sensor networks and their applications.
- Analyze architecture and middleware of WSN.
- Analyze the energy management models in network protocols.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Analyze the concept of sensor network and its protocols.
2. Analyze wireless sensor network for various network models.
3. Analyze the challenges in coverage and routing for wireless sensor networks.
4. Apply various routing strategies for wireless sensor networks.
5. Design the sensor network to sense the global phenomena.

UNIT I **9 Hours**

SENSOR NETWORKS

Cellular and Ad hoc wireless Networks, Mobile Ad-Hoc Networks , Sensor Networks , Comparison , Applications , Categories , Issues and challenges in designing a sensor network , Operating environment, Architecture ,Sensor node technology , Hardware and Software , Performance Metrics , Taxonomy.

UNIT II **9 Hours**

MIDDLEWARE AND TRANSMISSION TECHNOLOGIES

Middleware, Functions, Architecture, Data management functions, Operating Systems, Design issues, Examples Available wireless Technologies, WSN Campus Applications, Bluetooth, WLAN, Zigbee, WiMax, 3G and beyond, Performance modelling of WSN, Metrics, Task-driven sensing, Basic models, Traffic model, Energy model, Node model, Network models, MAC model, Routing model, System model.

UNIT I II **9 Hours**

MAC PROTOCOLS FOR WSN

Fundamentals of MAC, Requirements and design constrains, MAC protocols for WSN, Schedule-based protocols, SMAC, LEACH, TRAMA, Contention,based protocols, CSMA, PAMAS, IEEE 802.15.4, PHY layer, MAC layer. Case study: Sensor, MAC.

UNIT IV **9 Hours**

ROUTING PROTOCOLS FOR WSN

Challenges and Issues, Data Dissemination and Gathering, Location Discovery, Routing strategies, Flooding and Gossiping, SPIN, PEGASIS, Geographical routing, Localised and globalised forwarding, Greedy perimeter stateless routing, GEAR, Attribute-based routing, Direct diffusion, Rumor routing, Geographic hash tables.

UNIT V **9 Hours**

TRANSPORT PROTOCOLS AND APPLICATIONS OF WSN

Design Issues, Feasibility of using TCP/UDP for WSN, Design Considerations, CODA, GARUDA, Performance of Transport Control Protocols.

Total: 45 Hours

Reference(s)

1. Holger Karl, Andreaswillig, Protocol and Architecture for Wireless Sensor Networks, John wiley publication, Jan 2006.
2. C. Siva Ram Murthy and B. S. Manoj, Ad Hoc Wireless Networks Architectures and Protocols, Prentice Hall, PTR, 2004
3. Feng Zhao, Leonidas Guibas, Wireless Sensor Networks: an information processing approach, Elsevier publication, 2004.
4. C. K. Toh, Ad Hoc Mobile Wireless Networks Protocols and Systems, Prentice Hall, PTR, 2002.

21CO55 FREE SPACE OPTICAL COMMUNICATION 3 0 0 3

Course Objectives

- To understand the concept and essential devices involved in designing a free space optical communication
- To learn the principles of FSO network and analyze the challenges in wireless optical channel
- To provide an adequate exposure to emerging FSO technology

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Analyze the free space optical communication systems that uses light for wireless transmission of data
2. Analyze the appropriate components for building a FSO system to provide optical bandwidth connections.

3. Analyze the FSO channels with their mathematical representation to exploit the noiseless system.
4. Analyze the novel formulation of optical beam propagation mechanism in free space optical system.
5. Apply the networking principles of FSO technology to explore the high speed data delivery.

UNIT I **9 Hours**

FSO TECHNOLOGY

Introduction - History of Optical Telecommunications - Maxwells Equations - Electromagnetic wave propagation in an isotropic, linear homogenous medium - Propagation of a wave in a non- homogenous medium - Coherent and incoherent waves - Alternate Bandwidth Technologies - Fiber versus FSO - The Role of FSO in the Network - Factors affecting FSO.

UNIT II **9 Hours**

OPTICAL COMPONENTS AND SUBSYSTEMS

Transmitters - LED - Laser Diodes - Modulation Schemes - Receivers - Types of Detectors - Receiver Configuration - Optical Post and Preamplifiers - Link Design Trade-off - Acquisition, Tracking and Pointing.

UNIT III **9 Hours**

FREE OPTICAL CHANNEL MODELS

Atmospheric Channel - Losses - Absorption and Scattering Losses - Free Space Loss - Beam Divergence Loss - Pointing Loss - Loss due to Weather Conditions - Atmospheric Turbulence - Atmospheric Turbulent Channel Model - Techniques for Turbulence Mitigation - Visibility - Atmospheric attenuation - Meteorological disturbances - Free space optical links.

UNIT IV **9 Hours**

OPTICAL BEAM PROPAGATION

Various mechanism of propagation - Propagation channel - Modeling - Additional power required to reach a given bit error rate - Optical noise - BER performance of FSO System - Link Feasibility Study - Concept of quality of service and availability - Regulation of FSO equipment - Safety and Confidentiality.

UNIT V **9 Hours**

INTEGRATION OF FSO IN OPTICAL NETWORKS

Revolution of Optical Networking - Next Generation Optical Networking - Classifying the Global Optical Network - Driving FSO from the EDGE - FSO in Metropolitan Optical Networks - FSO Market - Installation of Free space Optical Systems - Free space optics and Laser safety.

Total: 45 Hours

Reference(s)

1. Heinz Willebrand, Baksheesh S. Ghuman, Free-Space Optics: Enabling Optical Connectivity in Todays Networks, Sams Publishing, 2002
2. Hemani Kaushal, V.K Jain, Subrat Kar, Free Space Optical Communication, Springer (India) Pvt. Ltd., 2017
3. Olivier Bouchet, Herve Sizun, Christian Boisrobert, Frederique de Fornel, Pierre-Noel Favennec, Free-Space Optics: Propagation and Communication, ISTE Ltd, John Wiley & Sons, 2006.

4. Arun K. Majumdar, Jennifer C. Ricklin, Free-Space Laser Communications: Principles and Advances, Springer Science + Business Media, LLC, 2008.
5. Morris Katzman, Laser Satellite Communication, Prentice Hall Inc, Newyork, 1991.
6. Rajiv Ramaswami, Kumar Sivarajan and Galen Sasaki Optical Networks: A Practical Perspective, Morgan Kaufmann, 3rd Edition, 2009.

21CO56 COMMUNICATION PROTOCOL FOR IOT 3 0 0 3

Course Objectives

- To analyze the architecture, design principles of Internet of Things and M2M & IoT fundamentals.
- To analyze the technical design constraints of IoT architecture.
- To analyze the various layered communication protocols with real time examples.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Apply the IoT networking components with respect to OSI layer.
2. Analyze the design constraints to build schematic for IoT solutions.
3. Apply the suitable IoT protocols and software which handles the transfer of packets in network layer.
4. Analyze the Layered protocol for IoT that leads to interoperability.
5. Analyze the need for IoT Trust and its variants.

UNIT I **9 Hours**

ARCHITECTURE OF IOT

IoT architecture outline, standards -IoT Technology Fundamentals- Devices and gateways, LAN &WAN, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints, Technical Design constraints.

UNIT II **9 Hours**

IOT DATA LINK LAYER PROTOCOLS

PHY/MAC Layer (3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART, ZWave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7.

UNIT III **9 Hours**

NETWORK LAYER PROTOCOLS

Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH, ND, DHCP, ICMP, RPL, CORPL, CARP.

UNIT IV **9 Hours**

IOT TRANSPORT AND SESSION LAYER PROTOCOLS

Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP), (TLS, DTLS), Session Layer, HTTP, CoAP, XMPP, AMQP, MQTT.

UNIT V **9 Hours**

SERVICE LAYER PROTOCOLS AND SECURITY

Service Layer, one M2M, ETSI M2M, OMA, BBF, Security in IoT Protocols, MAC802.15.4, 6LoWPAN, RPL, Application Layer, M2M, Web of things, Cellular IoT, Industrial IoT, IoT standards.

Total: 45 Hours

Reference(s)

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.
2. Daniel Minoli, Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, ISBN: 978-1-118-47347-4, Willy Publications ,2016.
3. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, 1st Edition, Academic Press, 2015.
4. Bernd Scholz-Reiter, Florian Michahelles, Architecting the Internet of Things, ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer, 2016.
5. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.
6. Vijay Madisetti , Arshdeep Bahga, Adrian McEwen (Author), Hakim Cassimally,Internet of Things (A Hands-on Approach), Universities Press, 2015.

21CO57 PHASED ARRAY ANTENNAS 3 0 0 3

Course Objectives

- To provide the fundamental concepts of phased array antenna and its architecture.
- To design and analyze the radiation pattern characteristics of linear and planar arrays using covariance matrix inversion and optimization techniques.
- To synthesis the patterns of non-planar phased arrays using various excitation modes.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Analyze the various antenna architecture designs and array characterization for Radar and Communication systems.
2. Design the elements for phased arrays using wire, aperture and microstrip elements and analyze its polarization characteristics.
3. Analyze the radiation pattern characteristics of linear and planar arrays using covariance matrix inversion and optimization techniques.
4. Synthesis the different patterns of non-planar antenna arrays using different excitation modes and to meet the requirements of real time applications.
5. Analyze the effect of various noise errors in the antenna array and to estimate the its effect in radiation characteristics.

UNIT I **9 Hours**

PHASED ARRAYS IN RADAR AND COMMUNICATION SYSTEMS

Introduction-System Requirements for Radar and Communication Antennas. Array Characterization for Radar and Communication Systems- Array Size Determination-Time-Delay Compensation. Array Architecture and Control Technology-Array Aperture-Feed Architectures-Beam forming Modalities and Relevant Architectures.

UNIT II **9 Hours**

ELEMENTS FOR PHASED ARRAYS

Array Elements, Polarization Characteristics of Infinitesimal Elements in Free Space, Electric Current (Wire) Antenna Elements, Aperture Antenna Elements, Microstrip Patch Elements, Elements for Alternative Transmission Lines, Elements and Row (Column) Arrays for One-Dimensional Scan, Elements and Polarizers for Polarization Diversity.

UNIT III **9 Hours**

PATTERN CHARACTERISTICS AND SYNTHESIS FOR LINEAR AND PLANAR ARRAYS

Array analysis, characteristics of linear and planar arrays, scanning to end-fire, thinned arrays ,Linear Arrays and Planar Arrays with Separable Distributions, Circular Planar Arrays, Methods of Pattern Optimization/Adaptive Arrays, Generalized Patterns Using Covariance Matrix Inversion; Pattern Synthesis Using Measured Element Patterns.

UNIT IV **9 Hours**

PATTERNS OF NONPLANAR ARRAYS

Introduction-Methods of Analysis for General Conformal Arrays, Patterns of Circular and Cylindrical Arrays-Phase Mode Excitation of Circular Arrays-Circular and Cylindrical Arrays of Directional Elements-Sector Arrays on Conducting Cylinders, Spherical and Hemispherical Arrays, Truncated Conical Arrays.

UNIT V **9 Hours**

ARRAY ERROR EFFECTS

Introduction, Effects of Random Amplitude and Phase Errors in Periodic Arrays-Pattern Characteristics-Beam Pointing Error- Peak Sidelobes. Sidelobe Levels Due to Periodic Phase, Amplitude, and Time-Delay Quantization-Characteristics of an Array of Uniformly Illuminated Contiguous Subarrays-Phase Quantization in a Uniformly Illuminated Array-Reduction of Sidelobes Due to Phase Quantization-Discrete Phase or Time-Delayed Subarrays with Quantized Subarray Amplitudes.

Total: 45 Hours

Reference(s)

1. Robert J. Mailloux, Phased Array Antenna Hand Book, Artech House, Boston, London, 2017.
2. R.C. Hansen, Phased Array Antennas, Wiley Series in Microwave and optical Engg, John Wiley & Sons Inc, Wiley- Interscience Publication,2009.
3. Eli Brookner, Practical Phased Array Antenna Systems, Editor, Artech House, Boston , London ,1991.
4. R. A. Monzingo and TW Miller, Introduction to Adaptive Arrays, John Wiley and Sons,1980.
5. B Widrow and SD Stearns,Adaptive Signal Processing, Prentice Hall,1985.
6. P.J.B. Clarricoats Advanced Antenna Technology, Microwave Exhibitions & Publishers,1981.

21CO58 SMART ANTENNAS FOR MOBILE COMMUNICATION

3 0 0 3

Course Objectives

- To provide the fundamental knowledge on smart antenna systems and its configuration
- To estimate the Direction of arrival and using appropriate techniques.
- To simulate and measure the performance of the antenna structures using software tools

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.

b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.

c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.

d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.

f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Analyze the architecture of smart antenna systems and its configuration to meet the requirements of real time applications
2. Analyze the different modules for smart antenna systems
3. Design adaptive and smart antennas, antenna arrays, beam forming algorithms, interference cancelation, bandwidth-efficient signaling systems, and direction of arrival (DOA) estimation schemes using spatial processing techniques to support multi
4. Analyze the direction of arrival of the signal from the smart antenna array using appropriate methodologies
5. Design and analyze the smart antennas using simulation tools and to evaluate its performance with vector network analyzer

UNIT I **9 Hours**

SMART ANTENNAS

Spatial Processing for Wireless Systems, Key Benefits of Smart Antennas, smart antenna configuration, SDMA, architecture of smart antenna systems.

UNIT II **9 Hours**

SMART ANTENNA SYSTEMS

The Vector Channel Impulse Response and the Spatial Signature, Spatial Processing Receivers, Fixed Beam forming Networks, Switched Beam Systems, Adaptive Antenna Systems, Wideband Smart Antennas, Spatial Diversity, Diversity Combining, and Sectoring, Digital Radio Receiver Techniques and Software Radios for Smart Antennas, Transmission Beam forming.

UNIT III **9 Hours**

MULTI-USER SPATIAL PROCESSING TECHNIQUES

Multi user spatial Processing, Dynamic resectoring- Range and capacity extension Range and Capacity analysis using smart antennas. Spatio temporal channel models. Wireless Multipath Channel Models, Environment, and Signal Parameters, Spatio Temporal Channel Models for Smart Antenna design, Spatial Channel Measurements, Application of Spatial Channel Models, Environment and signal parameters. Geometrically based single bounce elliptical model.

UNIT IV **9 Hours**

DOA ESTIMATION

DOA estimation, conventional and subspace methods. ML estimation techniques. Estimation of the number of sources using Eigen decomposition. DOA Estimation under Coherent Signal Conditions, The Integrated Approach to DOA Estimation, Direction finding and true ranging PL systems. Elliptic and hyperbolic PL systems. TDOA estimation techniques, Introduction to AOA estimation.

UNIT V **9 Hours**

ANTENNA MEASUREMENT

Introduction to Simulation tools for smart antenna design- ADS, HFSS. Antenna measurement and instrumentation Gain, Impedance and antenna factor measurement; Introduction to Vector Network Analyzer, Antenna test range Design.

Total: 45 Hours

Reference(s)

1. T.S. Rappaport and J.C. Liberti, Smart Antennas for Wireless Communications, Prentice Hall, 2007.
2. Tapan K Sarkar , Smart Antennas ,IEEE Press, John Wiley & Sons Publications,2004.
3. L.C.Godara, Applications of antenna arrays to mobile communications, Part I: Performance improvement, feasibility, and system considerations, Proc. IEEE, vol. 85, no.7, pp.1031-1060, 2003.

21CO59 RF CIRCUIT DESIGN 3 0 0 3

Course Objectives

- To analyze the characteristics of noise and distortion in wireless RF systems
- To identify and realize the different specification parameters of a wireless system
- To design RF systems using behavior models of the subsystems present in the receiver chains

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Analyze the characteristics of noise and distortion in the microwave systems due to temperature, mismatched terminations and inter-modulations
2. Design and implement the Filters using image impedance, insertion loss and prototype techniques
3. Analyze the performance of amplifier circuits in the receivers in different configuration modes
4. Design the different mixer circuits using Schottky barrier diode, FETs and analyze its characteristics
5. Analyze the devices for switches, oscillator circuits, frequency synthesizers and evaluate its performance at the receiver end.

UNIT I **9 Hours**

NOISE AND DISTORTION IN RF SYSTEMS

Basic threshold detection, noise temperature and noise figure, noise figure of a lossy transmission line; Noise figure of cascade systems: Noise figure of passive networks, two-port networks, mismatched transmission lines and Wilkinson power dividers; Dynamic range and inter-modulation distortion.

UNIT II **9 Hours**

RF FILTER DESIGN

Image impedance based RF filter design-constant K prototype filter design-derived prototype filter design. Insertion loss method- Maximally flat low pass prototype, Equal ripple low pass prototype, Filter transformation and filter implementation.

UNIT III **9 Hours**

RF AMPLIFIER DESIGN

Comparison of active devices such as BJT, MOSFET, MESFET, HEMT, and HBT; Circuit models for FETs and BJTs; Two-port power gains; Stability of transistor amplifier circuits; Amplifier design using S-parameters: Design for maximum gain, maximum stable gain, design for specified gain, low-noise amplifier design, design of class-A power amplifiers.

UNIT IV **9 Hours**

MIXERS

Mixer characteristics: Image frequency, conversion loss, noise figure; Devices for mixers: p-n junctions, Schottky barrier diode, FETs; Diode mixers: Small-signal characteristics of diode, single-ended mixer, large-signal model, switching model; FET Mixers: Single-ended mixer, other FET mixers; Balanced mixers; Image reject mixers.

UNIT V **9 Hours**

SWITCHES

Devices for microwave switches: PIN diode, BJT, FET; Device models; Types of switches; Switch configurations; Basic theory of switches; Multi-port, broad-band and isolation switches. Oscillators and Frequency Synthesizers: General analysis of RF oscillators, transistor oscillators, voltage controlled oscillators, dielectric resonator oscillators, frequency synthesis, methods, analysis of first and second order phase-locked loop, oscillator noise and its effect on receiver performance.

Total: 45 Hours

Reference(s)

1. Pozar, D.M. Microwave and RF Design of Wireless Systems, John Wiley & Sons.
2. Gonzalez, G., Microwave Transistor Amplifiers: Analysis and Design, 2nd Ed., Prentice-Hall. 1997
3. Bahl, I. and Bhartia, P., Microwave Solid State Circuit Design, 2nd Ed., John Wiley & Sons. 2003
4. Chang, K., Bahl, I. and Nair, V., RF and Microwave Circuit and Component Design for Wireless Systems, Wiley Interscience. 2002
5. Rohde, U.L. and Newkirk, D.P., RF/Microwave Circuit Design for Wireless Applications, John Wiley & Sons. 2000
6. Larson, L.E., RF and Microwave Circuit Design for Wireless Applications, Artech House. 1996

21CO60 MODELING OF WIRELESS APPLICATIONS 3 0 0 3

Course Objectives

- To understand the necessity of modeling and simulation approach.
- To provide an introduction to different error sources, impairments and performance metrics.

- To determine the type and appropriate model of wireless fading channel based on the system Parameters and the property of the wireless medium.
- To understand different queuing models for communication and networking applications.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Apply simulation approach to evaluate the performance of a communication system
2. Evaluate the performance of communication system in terms of performance metrics like bit error rate, outage probability etc.
3. Evaluate the multipath fading channels that are used in the performance analysis of wireless standards like GSM, WCDMA, LTE, Wi-Fi, WiMAX etc.
4. Apply queueing models to design cellular network with given quality of service constraints
5. Design as well as conduct experiments, analyze and interpret the results to provide valid conclusions for wireless communication using MATLAB tool.

UNIT I **9 Hours**

RANDOM VARIABLES AND RANDOM PROCESSES FOR SIMULATION

Simulation approach, Advantages and limitations, Methods of performance evaluation, Error sources in simulation, Role of simulation in communication systems. Introduction to random variables (continuous and discrete), Univariate and Bivariate models, Transformation of random variables, Moments, Central moments, Characteristic function, Moment generating function, Stationarity, Wide sense stationary, Ergodicity, auto correlation, Power spectral density, Cross correlation, Sampling of stationary random processes.

UNIT II **9 Hours**

BOUNDS, APPROXIMATIONS AND MONTE CARLO SIMULATIONS

Chebyshevs inequality, Chernoff bound, Union bound, Central limit theorem, approximate computation of expected values. Variations of Monte Carlo Simulation, Random number generation, generating independent random sequences, Generation of correlated random sequences, testing of random number generators.

UNIT III **9 Hours**

SYSTEM MODELING

Modeling the information sources, Source coding, Channel coding, Baseband modulation, Multiplexing, Multiple access, Band pass modulation, Detection, Equalization, Carrier and timing recovery for BPSK and QPSK, Performance analysis of communication system under noisy channel conditions.

UNIT IV **9 Hours**

CHANNEL MODELING

Large scale fading models, Small scale fading models, Types of fading, Parameters characterizing fading, Rayleigh fading, Jakes model, Clarkes model, Path loss models for LTE and Wi Max networks, Performance analysis of communication systems under fading channel, Performance analysis of communication systems with MIMO.

UNIT V **9 Hours**

QUEUING MODELING

Markovian models, Basic queuing models, M/G/1 queuing system, Pollaczek-Khinchine formula, Network of queues, Fundamentals of teletraffic theory, blocked call cleared system, blocked call delayed system, Queuing theory for teletraffic modeling.

Total: 45 Hours

Reference(s)

1. William H. Tranter, K. Sam Shanmugan, T. S Rappaport, Kurt L. Kosbar, Principles of Communication System Simulation with Wireless Applications, 2011, 1st Edition, Prentice Hall Press, USA.
2. M. N. Sadiku, S. M. Musa, Performance Analysis of Computer Networks, 2013, 1st Edition, Springer, Switzerland.
3. John G. Proakis, Masoud Salehi, Gerhard Bauch, Contemporary Communication Systems using MATLAB, 2013, 3rd Edition, Nelson Engineering, Canada.
4. http://web.stanford.edu/class/ee359/lectures.html
5. http://www.cse.wustl.edu/~jain/cse567-15/index.html

21CO61 ALL-OPTICAL HIGH SPEED SIGNAL PROCESSING DEVICES

3 0 0 3

Course Objectives

- Impart extensive knowledge on signal processing in modern optical communication.
- Provide in-depth knowledge on optical transmitters, amplifiers and receivers used in the state of the art optical communication networks.
- Demonstrate the technology implanted in the optical devices used for connectivity and routing of optical networks

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.

f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Analyze and discuss increasing Communication Traffic and Power Consumption.
2. Demonstrate the principle of operation of SOA as a high speed signal switching device.
3. Design of high speed optical signal processing devices for opto-electronic conversion and signal processing.
4. Apply the high speed operating capacity of the ISBT gate to the wavelength conversion process of optical signals.
5. Apply the concepts of Four Wave Mixing in the optical signal processing for wavelength conversion of optical signals in the network.

UNIT I **9 Hours**

OPTICAL SIGNAL PROCESSING AND LIGHT SOURCES

Evolution of Optical Communication Systems and Device Technologies- Increasing Communication Traffic and Power Consumption - Future Networks and Technologies - High speed All-Optical Signal Processing Devices -Overview of the Devices and Their Concepts- Requirement for Light Sources - Mode-locked Laser Diodes - Electro-absorption Modulator Based Signal Source.

UNIT II **9 Hours**

SOA BASED HIGH SPEED SIGNAL PROCESSING DEVICES

Introduction - Fundamentals of SOA - SOA as a High speed Nonlinear Medium - Use of High speed Response Component by Filtering- Symmetric Mach-Zehnder (SMZ) All-Optical Gate.

UNIT III **9 Hours**

HIGH SPEED-HIGH OUTPUT OPTICAL SIGNAL INTERFACING DEVICES

Introduction - Uni-traveling-carrier Photodiode (UTC-PD) - Concept of a New Opto-electronic Integrated Device -PD-EAM Optical Gate Integrating UTC-PD and TW-EAM.

UNIT IV **9 Hours**

INTERSUB-BAND TRANSITION ALL-OPTICAL GATE SWITCHES

Operation Principle- GaN/AlN ISBT Gate - (CdS/ZnSe)/BeTe ISBT Gate - InGaAs/AlAs/AlAsSb ISBT Gate - Cross-phase Modulation in an InGaAs/AlAs/AlAsSb-based ISBT Gate.

UNIT V **9 Hours**

WAVELENGTH CONVERSION DEVICES

Introduction - Wavelength Conversion Schemes - Physics of Four-wave Mixing in LDs or SOAs - Wavelength Conversion of Short Pulses Using FWM in Semiconductor Devices- Experimental Results of Wavelength Conversion Using FWM in SOAs or LDs- The Future View of Wavelength Conversion Using FWM.

Total: 45 Hours

Reference(s)

1. Hiroshi Ishikawa Ultrafast All-Optical Signal Processing Devices John Wiley& Sons Ltd, 2008.
2. Rajiv, Ramaswami and Kumar Sivarajan, Optical Networks: A practical perspective, 2nd Edition, Morgan Kaufmann, 2001.

3. Sueta and Okoshi, Fundamental of Ultra fast& Ultra Parallel Opto Electronics, John Wiley & Sons, New York, 1996.
4. Klaus Grobe, Michael Eiselt, Wavelength Division Multiplexing John Wiley & Sons, 2014.
5. Ghafouri-Shiraz The Principles of Semiconductor Laser Diodes and Amplifiers Imperial College Press, 2004.

21CO62 MULTIMEDIA COMPRESSION TECHNIQUES

3 0 0 3

Course Objectives

- Explore the special features and representations of different data types.
- Analyze different compression techniques for text data and audio signals
- Analyze various compression techniques for image and video signals

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Identify the concepts of multimedia and compression techniques.
2. Perform different text compression techniques.
3. Apply and analyze various compression techniques for speech and audio signals.
4. Apply and analyze the compression techniques for images.
5. Apply and analyze the video compression techniques.

UNIT I **9 Hours**

MULTIMEDIA CONCEPTS

Special features of Multimedia - Graphics and Image Data Representations - Fundamental Concepts in Text, Images, Graphics, Video and Digital Audio - Storage requirements for multimedia applications - Need for Compression - Lossy & Lossless compression techniques - Overview of source coding, Information theory & source models- Kraft McMillan Inequality - vector quantization - LBZ algorithm.

UNIT II **9 Hours**

TEXT COMPRESSION

Compression techniques - Huffmann coding - Adaptive Huffmann Coding - Arithmetic coding - Shannon- Fano coding - Dictionary techniques - LZ77, LZ78, LZW family algorithms.

UNIT III **9 Hours**

AUDIO COMPRESSION

Audio compression techniques :A AuLaw ALaw companding frequency domain and filtering Basic sub band coding -DPC M-ADPCM-DM-LPC-CELP -Application to speech coding - G.722 -Application to audio coding - MPEG audio, progressive encoding for audio - Silence compression techniques.

UNIT IV **9 Hours**

IMAGE COIMAGE COMPRESSIONMPRESSION

MMR coding - Transform Coding - JPEG Standard - Sub-band coding algorithms - Design of Filter banks - Wavelet based compression - Implementation using filters - EZW, SPIHT coders - JPEG 2000 standards - Run length coding.

UNIT V **9 Hours**

VIDEO COMPRESSION

Video compression techniques and standards - MPEG Video Coding I: MPEG-1 and 2 - MPEG Video Coding II - MPEG - 4 and 7 - Motion estimation and compensation techniques - H.261 Standard

Total: 45 Hours

Reference(s)

1. Khalid Sayood, Introduction to Data Compression, Morgan Kauffman Harcourt India, 2017.
2. David Salomon, Data Compression,The Complete Reference, Springer Verlang, 2007.
3. Yun Q.Shi and Huifang Sun, Image and Video Compression for Multimedia Engineering. Fundamentals,Algorithms & Standards, CRC press, 2003.
4. Peter Symes, Digital Video Compression, McGraw Hill Publication, 2004.
5. Mark Nelson, Data Compression, BPB Publishers, 2000.
6. Mark S.Drew and Ze-Nian Li, Fundamentals of Multimedia, PHI, 2003.

21CO63 VLSI SIGNAL PROCESSING 3 0 0 3

Course Objectives

- To have an advanced level knowledge on VLSI DSP Systems, Design and implementation
- To introduce techniques for alternating the existing DSP structures to suit VLSI implementation
- To introduce efficient design of VLSI architecture

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.

b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.

c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.

d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.

f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Analyze the depth study of DSP structures amenable to VLSI implementation
2. Apply the concept of VLSI system design with high speed and low power.
3. Develop the students to implement DSP algorithm in an optimized method.
4. Classify the optimization techniques in VLSI signal processing.
5. Compare the different types of filters and its application.

UNIT I **9 Hours**

DSP SYSTEMS AND ITS STRUCTURE

Introduction; representation of DSP algorithms: Block Diagram, signal flow graph, data flow graph, dependence graph.

UNIT II **9 Hours**

ITERATION BOUND

Data flow graph representations, loop bound and iteration bound, longest path matrix algorithm, iteration bound of Multirate data flow graphs.

UNIT III **9 Hours**

PIPELINING AND PARALLEL PROCESSING

Pipelining and parallel processing of FIR digital filters, pipeline interleaving in digital filters: signal and multichannel interleaving.

UNIT IV **9 Hours**

RETIMING, UNFOLDING AND FOLDING

Retiming techniques; algorithm for unfolding, Folding transformation, systolic architecture design, systolic array design methodology.

UNIT V **9 Hours**

FAST CONVOLUTION, FILTERS AND TRANSFORMS

Cook-toom algorithm, modified cooktoom algorithm, winogard algorithm, iterated convolution Algorithm strength reduction in filters and transforms.

Total: 45 Hours

Reference(s)

1. Keshab k. Parhi, VLSI Digital Signal Processing Systems: Design and Implementation, Wiley, inter science, 1994.
2. 2. U. Meyer , Baese, Digital Signal Processing with Field Programmable Gate Arrays, Springer, Second Edition, 2014
3. S.Y.kung, H.J.White house, T. Kailath,VLSI and Modern Signal Processing, Prentice hall, 2005.

21CO64 MACHINE LEARNING 3 0 0 3

Course Objectives

- Interpret the introductory concepts and techniques of Machine Learning and thorough understanding of the Supervised and Unsupervised learning techniques
- Summarize the different types of artificial neural network

- Develop appropriate solutions for various real time problems using machine learning algorithms

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.

b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.

c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.

d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.

Course Outcomes (COs)

1. Analyze supervised, unsupervised and semi-supervised learning
2. Apply the various types of regression and classifier algorithms for real time applications
3. Analyze the different types of clustering algorithms and dimensionality reduction techniques
4. Interpret the analogy between biological neuron and artificial neuron and thereby form different types of artificial neural networks architectures
5. Design various real time applications based on machine learning algorithms

UNIT I **9 Hours**

MACHINE LEARNING CONCEPTS

Introduction-Definitions, Types of learning, Designing learning systems, Issues in machine learning, Hypothesis space and Inductive bias, Selection of Hypothesis Space, Variance Bias Trade Off, Cost Function, Overfitting, Underfitting, Generalization, Gradient Descent Optimizer - Evaluation, Confusion Matrix, Precision, Recall, Specificity, F Beta Measure, Crossvalidation.

UNIT II **9 Hours**

SUPERVISED LEARNING ALGORITHMS - REGRESSION

Introduction to regression, Types of regression, Simple Linear, Multilinear, Multivariate, Polynomial, Ridge, Lasso, Elastic Net, Support vector regression, Regression tree, Evaluating regression model performance, applications. Introduction to classification, Binary, Multiclass and multilabel classification, Linear and Non linear classification, K nearest neighbor, Logistic Regression- Decision tree, Random Forest, Naive Bayes Classifier, Support Vector Machine, SVM with kernel trick, Performance Evaluation of Classifiers, Applications

UNIT III **9 Hours**

UNSUPERVISED LEARNING ALGORITHMS -CLUSTER ANALYSIS AND DIMENSIONALITY REDUCTION TECHNIQUES

Introduction to Cluster Analysis, Types of Cluster Analysis, A Categorization of Major Clustering Methods, Partitioning Methods, Hierarchical Methods, Density Based Methods, Model Based Clustering Methods, Clustering High Dimensional Data, Constraint Based Cluster Analysis, Outlier Analysis, Applications Introduction to Dimensionality Reduction, Linear and Non Linear Dimensionality Reduction, Linear, Singular Value Decomposition ,Principal Component Analysis, Independent Component Analysis, Non Linear, Isomap, Kernel Principal Component Analysis.

UNIT IV **9 Hours**

ARTIFICAL NEURAL NETWORKS

Fundamentals, Biological Neuron, Artificial Neuron, Activation Function, Learning Rules, Perceptron Networks, Adaline, Madaline, Back Propogation Networks, Learning Factors, Linear Separability, Hopfield Network, Discrete Hopfield Networks, Associative Memories, Recurrent and Association Memory, Bidirectional associative memory, Boltzman machine

UNIT V **9 Hours**

APPLICATIONS OF MACHINE LEARNING

Design cycle of prediction and classification system for real time data-Boston house price prediction , stock market price prediction , traffic prediction in communication systems , neural network based image compression for multimedia communication system , neural network based phishing attack detection in communication systems , traffic classification in communication system based on parameters like packet sizes and interarrival times , clustering algorithms for grouping edge computing devices in an network

Total: 45 Hours

Reference(s)

1. Stephen Marsland, Machine Learning An Algorithmic Perspective, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014
2. Tom M Mitchell, Machine Learning, First Edition, McGraw Hill Education, 2013
3. Peter Flach, Machine Learning: The Art and Science of Algorithms that Make Sense of Data, First Edition, Cambridge University Press, 2012
4. Jason Bell, Machine learning Hands on for Developers and Technical Professionals, First Edition, Wiley, 2014
5. S.N. Sivanandam and S.N. Deepa, Principles of Soft Computing, Wiley India (P) Ltd., New Delhi, 2007
6. Laurene Fausett, Fundamentals of Neural Networks, Pearson Education India, New Delhi, 2004.

21CO65 COMPUTER VISION 3 0 0 3

Course Objectives

- Learn the image fundamentals and mathematical transforms necessary for image processing.
- Understand the image enhancement and restoration methods.
- Study the concepts of optics and lens systems

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.

Course Outcomes (COs)

1. Analyze the various image enhancement and segmentation methods.
2. Diagnose the different degrees of morphology and shape representations in images.
3. Identification of new developments in object recognition systems.
4. Describe the procedure for 3D vision tasks using cameras.
5. Analyze the various motion methods in processing of machine vision images.

UNIT I **9 Hours**

IMAGE SEGMENTATION

Thresholding , Edge based segmentation , Region based segmentation , Matching ,Evaluation issues in segmentation , Mean Shift segmentation , Active contour models , snakes , Geometric deformable models , level sets and geodesic active contours , Fuzzy Connectivity , Towards 3D graph,based image segmentation , Graph cut segmentation , Optimal single and multiple surface segmentation.

UNIT II **9 Hours**

MORPHOLOGY AND SHAPE REPRESENTATION

Basic morphological concepts , Four morphological principles , Binary dilation and erosion , Gray scale dilation and erosion , Skeletons and object marking , Granulometry , Morphological segmentation and watersheds. Region identification , Contour based shape representation and description , Region based shape representation and description , Shape classes.

UNIT III **9 Hours**

OBJECT RECOGNITION

Knowledge representation , Statistical pattern recognition , Neural nets -, Syntactic pattern recognition , Recognition as graph matching , Optimization techniques in recognition , Fuzzy systems , Boosting in pattern recognition.

UNIT IV **9 Hours**

3D VISION

3D vision tasks , Basics of projective geometry , A single perspective camera , Scene reconstruction from multiple views , Two cameras, stereopsis , Three cameras and trifocal tensor, 3D information from radiometric measurements.

UNIT V **9 Hours**

MOTION ANALYSIS

Differential motion analysis methods , Optical flow , Analysis based on correspondence of interest points , Detection of specific motion patterns , Video tracking , Motion models to aid tracking.

Total: 45 Hours

Reference(s)

1. Sonka, Hlavac, Boyle, Image Processing, Analysis and Machine Vision, CENGAGE Learning, 4th Edition, 2015.
2. Ramesh Jain, Rangachar Kasturi and Brian G. Schunck, Machine Vision, McGraw Hill International Edition, 2012.
3. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson India, 3rdEdition, 2013.
4. Gregory A Baxes, Digital Image Processing, John Wiley & Sons, 1994
5. W.K. Pratt, Digital Image Processing, John Wiley and Sons, 2001.

21CO66 UNDERWATER ACOUSTIC SIGNAL PROCESSING

3 0 0 3

Course Objectives

- To acquire an insight view and knowledge about characteristics of underwater acoustic environment and its channel impairments.
- Design the Optimization techniques in Echo cancellation, Beam forming and Noise reduction methods.
- Apply the concepts of SONAR systems in underwater communications.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Illustrate the characteristics of Underwater Acoustic Channel Environment.
2. Analyze and develop acoustic Echo Cancellation Algorithm and Beam forming Techniques.
3. Interpret the challenges in Noise reduction in underwater environment.
4. Analyze the Acoustic MIMO system design for underwater scenario.
5. Illustrate the principles and characteristics of SONAR systems.

UNIT I **9 Hours**

UNDERWATER ACOUSTICS

Speed of sound in seawater - Transmission Loss - Refraction - Deep sound channel and Reliable acoustic path - Surface Interference - Active and Passive UWSN - Noise and Bandwidth Considerations

UNIT II **9 Hours**

ECHO CANCELLATION AND BEAM FORMING TECHNIQUES

Acoustic echo cancellation (AEC) - Adaptive Beam Forming - Joint Acoustic echo cancellation and Adaptive Beam forming - Optimization Techniques: LCLSE, GSC, GSAEC, and RGSC Methods.

UNIT III **9 Hours**

NOISE REDUCTION

Weiner Filter and spectral subtraction - Optimum Filter design in digital domain - Weiner filter in frequency domain - Weiner filter realizations - Spectral subtraction: Principles and realizations

UNIT IV **9 Hours**

ACOUSTIC MIMO SYSTEMS

Acoustic environment distraction - Signal Models: SISO, SIMO, MISO, and MIMO - Characteristics: Reverberation Time - Channel Invertibility and Minimum phase filter - Multichannel diversity and Common Zero problem - Spare Impulse response.

UNIT V **9 Hours**

SONAR SYSTEMS

SONAR equations: Active and Passive, Underwater sound systems: Generic Active SONAR systems and Generic Passive SONAR systems, SONAR Transducers, Receivers, Receiving arrays and sonobuoys - Signal processing functions.

Total: 45 Hours

Reference(s)

1. L.Kinsler, et al., Fundamentals of Acoustics, Wiley Publications, (2000) - Fourth edition.
2. Jens Blauert, Ning Xiang-Acoustic MIMO Signal Processing-Springer (2006).
3. David Havelock, SonokoKuwano, Michael Vorlander-Handbook of Signal Processing in Acoustics (2 vol set) - Springer (2009).
4. E. Hansler, G. Shmidt -Topics in Acoustic Echo and Noise Control-Springer (2006)
5. Stergiopoulos, Stergios- Advanced signal processing handbook_theory and implementation for radar, sonar, and medical imaging real time systems-CR (2017)
6. Hanzo L., Somerville F.S., Woodard J.-Acoustic Signal Processing for Telecommunication, (2002).

21CO67 VLSI FOR WIRELESS COMMUNICATION 3 0 0 3

Course Objectives

- Infer the knowledge on recent developments in wireless communication systems.
- Analyze the Low Noise Amplifier, Analog to Digital Converters & Synthesizer and VLSI architecture for Wireless Systems.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Interpret the evolution of wireless communication technologies.
2. Infer the theory of Phase Locked Loop (PLL) with design examples.

3. Analyse the function of Low Noise Amplifier which includes wideband, narrow band for impedance matching and Core Amplifier.
4. Classify the different types of delta modulators of analog to digital converters and synthesizer
5. Implement the VLSI architecture for wireless system applications.

UNIT I **9 Hours**

OVERVIEW OF WIRELESS COMMUNICATION SYSTEMS

Introduction to wireless systems, Multiple antenna systems, Ad-hoc and wireless sensor networks, Satellite navigation systems, Ultrawideband (UWB) communications, Multicarrier systems and orthogonal frequency division multiplexing (OFDM), Cognitive radio and Software defined radio, Spread Spectrum Systems, WLAN(Wireless Local Area Network), WiMax, IoT(Internet of Things), ZigBee technology.

UNIT II **9 Hours**

PHASE LOCKED LOOP

Basic phase-locked loop architecture, voltage controlled oscillator, divider, phase detector, loop filer, the PLL in lock, Linearized small-signal analysis second-order PLL model, limitations of the second-order small-signal model, PLL design example, Jitter and phase noise period jitter, P-cycle jitter, adjacent period jitter, other spectral representations of jitter, probability density function of jitter, Electronic oscillators ring oscillators, LC oscillators, phase noise of oscillators, jitter and phase noise in PLLs input phase noise and divider phase noise, VCO phase noise, loop filter noise.

UNIT III **9 Hours**

ANALOG TO DIGITAL CONVERTERS

Demodulators, Delta Modulators, Low Pass Sigma Delta Modulators, High Order Modulators, One Bit DAC and ADC, Passive Low Pass Sigma Delta Modulator, Band pass Sigma Delta Modulators, Comparison, PLL based Frequency Synthesizer.

UNIT IV **9 Hours**

LOW NOISE AMPLIFIER

Low Noise Amplifier, Matching Networks, Matching for Noise and Stability, Matching for Power, Implementation, Comparison of Narrowband and Wideband LNA, Wideband LNA Design, Narrowband LNA, Impedance matching, Power matching, Salient features of LNA, Core Amplifier Design.

UNIT V **9 Hours**

VLSI ARCHITECTURE FOR WIRELESS SYSTEMS

Implementations: VLSI architecture for Multi-tier Wireless System - Hardware Design Issues for a Next generation CDMA System - Efficient VLSI Architecture for Base Band Signal processing.

Total: 45 Hours

Reference(s)

1. Bosco Leung, "VLSI for wireless Communication", Springer, 2nd Edition, 2011.
2. Andreas F.Molisch, "Wideband wireless Digital Communication", Prentice Hall PTR, 2001.
3. George.V.Tsoulous, "Adaptive Antennas for wireless Communication", IEEE Press, Willey Publications, 2001.
4. Xiaodong Wang and H.Vincent Poor, "Wireless Communication System ,Advanced Techniques forSignal Reception", Pearson Education. 2004.

21CO68 ASIC DESIGN 3 0 0 3

Course Objectives

- To aimed to provide an opportunity for the students to acquire technical business insight into some of the vital aspects of ASIC Design.
- To the students, the knowledge about ASICs chip design and construction.
- To provide to considers programmable ASICs analysis, front-end, back-end design and improvement algorithms

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.

Course Outcomes (COs)

1. Examine fundamentals of ASIC and its design methods.
2. Apply the knowledge on programmable architectures in real time applications.
3. Analyze the capabilities and limitations of CMOS logic.
4. Classify the different high performance algorithms and its applications in ASICs.
5. Analyze the Simulation and testing of systems.

UNIT I **9 Hours**

ASICS AND ITS DESIGN STRUCTURE

ASIC Types- Full Custom, Semi-Custom, Gate Array ASIC, Cell Based ASIC, ASIC Design Flow, Programmable ASIC- antifuse - Static RAM, EPROM & EEPROM Technology.

UNIT II **9 Hours**

PROGRAMMABLE ASICS INTERCONNECT

CMOS transistors, Design Rules, Combinational and sequential Logic, Data path Logic and I/O cells. Programmable ASIC Logic Cells, Xilinx LCA, MAX, Programmable ASIC I/O Cells, DC & AC inputs and outputs, Clock & Power inputs, Xilinx I/O blocks, Programmable ASIC Interconnect.

UNIT III **9 Hours**

ASIC CONSTRUCTION

Physical design, CAD Tools, Methods and Algorithms, System Partitioning, Estimating ASIC Size, Power Dissipation, Partitioning Methods-Connectivity Measurement, Constructive Partitioning, Iterative Partitioning Improvement, The K-L Algorithm, The Ratio-Cut Algorithm, The Look Ahead Algorithm, Simulated Annealing, Simple Partitioning Example.

UNIT IV **9 Hours**

FLOOR PLANNING AND PLACEMENT

Floor Planning, Goals and Objectives, Measurement of Delay, Tools, Channel Definition Placement Definitions, Goals and Objectives, Measurement of Placement, Goals, Placement Algorithms, Simple Placement Example, Physical Design Flow.

UNIT V **9 Hours**

ROUTING

Global routing, Global routing measurement, Detailed routing, Detailed routing measurement, Special routing, Detailed routing algorithm, Circuit Extraction, Layout design rules.

Total: 45 Hours

Reference(s)

1. Michael John Sebastian Smith, Applications Specific Integrated Circuits, Pearson Education, Ninth Indian reprint,13th edition, 2004.
2. Neil H.E.Weste, Eshraghian, Principles of CMOS VLSI Design Addison Wesley, 2001.
3. M.J Morant, Integrated Circuit Design & Technology, Chapman and Hall,1990.
4. Wayne Wolf, Modern VLSI Design-A System Approach, PTR Prentice Hall,1994.

21CO69 GLOBAL POSITIONING SYSTEMS AND NAVIGATIONAL AIDS

3 0 0 3

Course Objectives

- Understand the various GPS models and its applications.
- Understand the various coordinate systems.
- To learn the inter disciplinary applications of GPS.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.
b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Analyze the Hiran NNSS - GLONASS - GNSS, GPS Constellation Space segment.
2. Analyze the Geocentric coordinate system and Conventional terrestrial reference system.
3. Analyze the P-Code, Y-Code, L1,L2 Carrier frequencies.
4. Analyze the effects on GPS observations.
5. Apply the different types of inter disciplinary techniques in GPS.

UNIT I **9 Hours**

OVERVIEW OF GLOBAL POSITIONING SYTEM

History of GPS-BC 4System-Hiran NNSS - AVSTAR - GLONASS - GNSS, GPS Constellation - Space segment - control segment - User segment - single frequency - Dual frequency - point -relative GPS Differential GPS - Static and kinematic Positioning 2D and 3D Reporting - Anti spoofing(AS): Selective availability(SA) - DOP factors - GPS as path finder - inter disciplinary applications.

UNIT II **9 Hours**

COORDINATE SYSTEMS

Geocentric coordinate system-Conventional terrestrial reference system-Orbit description-Keplerian orbit-Kepler elements- satellite visibility-Topocentric Motion-Disturbed satellite Motion-Perturbed motion- disturbing accelerations-Perturbed orbit-time systems-astronomical system-Atomic time- GPS Time-Need for coordination-Link to earth rotation-time and Earth Motion Services.

UNIT III **9 Hours**

RANGE MODELS

C/A Code;P-Code; Y-Code; L1,L2 Carrier frequencies-Code pseudo ranges-carriers phases-Satellite signal signature-Navigation messages and formats-Undifferenced and differenced range models-Delta ranges-signal processing-Correlation techniques-Tracking networks-ephemeredes-data combination-Narrow lane, wide lane- OTF Ambiguity

UNIT IV **9 Hours**

EFFECTS ON GPS OBSERVATIONS

Propagation media-multipath effect-Antenna phase centre-Atmosphere in brief -Fundamentals of wave propagation-Ionospheric effects on GPS observations-Code delay- phase advances- integer Bias- Clock error-cycle slip-noise bias-Blunders- tropospheric effects- GPS observables-multipath effect- Antenna phase centre problems and corrections.

UNIT V **9 Hours**

INTER DISCIPLINARY APPLICATIONS

Crystal dynamics - gravity field mapping - atmospheric occulation - Surveying - Geophysics - air borne GPS - Ground transportation - space borne GPS - Metrological and Climate Research Using GPS.

Total: 45 Hours

Reference(s)

1. B.Hoffman-Wellenhof, H.Lichtenegger and J.Collins, GPS: Theory and Practice,4th revised edition, Springer, Wein, New york, 2001.
2. A.Leick, GPS Satellities Surveying, 2 nd edition, John Wiely&Sons, New york, 2015.
3. B.Parkinson, J.Spilker, Jr.(Eds),GPS: Theory and Applications,Vol.I&Vol.II,aiaa,370 LEnfant Promenade SW, Washington, DC, 20024,1996.
4. A.Kleusberg and P.Teunisen (Eds), GPS for Geodesy,Springer -Verlag,Berlin,1998.
5. L.Adams,The GPS-A Shared National Assest,Chair, National Academy Press, Washington DC, 1995.

21CO70 MIXED SIGNAL CIRCUIT DESIGN 3 0 0 3

Course Objectives

- To understand the types of filters.
- To understand the different techniques of ADC and DAC.
- To learn the basic concept of digital to analog and analog to digital converters.

Programme Outcomes (POs)

b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.

Course Outcomes (COs)

1. Analyze the characteristics of active filters.
2. Analyze the characteristics of digital filters.
3. Apply the concept of convertors such as digital to analog and analog to digital convertors.
4. Analyze the concept of theory of differential algebraic equations.
5. Apply the concept of Mixed Signal Interaction.

UNIT I **9 Hours**

ACTIVE FILTERS

Active RC Filters for monolithic filer design: First & Second-order filter realizations - universal active filter (KHN) -self tuned filter - programmable filters - Switched capacitor filters: Switched capacitor resistors - amplifiers -comparators - sample & hold circuits - Integrator- Biquad.

UNIT II **9 Hours**

CONTINUOUS TIME FILTERS

Introduction to Gm - C filters - bipolar trans conductors -CMOS Trans conductors using Triode transistors, active transistors - BiCMOS trans conductors - MOSFET C Filters - Tuning Circuitry - Dynamic range performance - Digital Filters: Sampling - decimation - interpolation - implementation of FIR and IIR filters.

UNIT III **9 Hours**

DIGITAL TO ANALOG AND ANALOG TO DIGITAL CONVERTERS

Non-idealities in the DAC - Types of DACs: Current switched, Resistive, Charge redistribution (capacitive), Hybrid, segmented DACs - Techniques for improving linearity - Analog to Digital Converters: quantization errors - non-idealities - types of ADCs: Flash, two step, pipelined, successive approximation, folding ADCs. SIGMA DELTA CONVERTERS: Over sampled converters - over sampling without noise & with noise - implementation imperfections - first order modulator - decimation filters - second order modulator - sigma delta DAC & ADCs

UNIT IV **9 Hours**

ANALOG AND MIXED SIGNAL EXTENSIONS TO VHDL

Introduction - Language design Course Objectives - Theory of differential algebraic equations - the 1076 .1 Language -Tolerance groups - Conservative systems - Time and the simulation cycle - A/D and D/A Interaction - Quiescent Point - Frequency domain modeling and examples.

UNIT V **9 Hours**

ANALOG EXTENSIONS TO VERILOG

Introduction - data types - Expressions-Signals-Analog Behavior-Hierarchical structures-Mixed Signal Interaction. Introduction - Equation construction - solution - waveform Filter functions - simulator - Control Analysis - Multi -disciplinary model.

Total: 45 Hours

Reference(s)

1. David A. Johns, Ken Martin, Analog Integrated Circuit Design John Wiley & Sons, 2012.
2. Rudy van de Plassche, Integrated Analog-to-Digital and Digital-to-Analog Converters, Kluwer 1999.
3. Antoniou, Digital Filters Analysis and Design, Tata McGraw Hill, 1998.
4. Phillip Allen and Douglas Holmberg, CMOS Analog Circuit Design, Oxford University. Press, 2007.
5. Benhard Razavi, Data Converters, Kluwer Publishers, 2000.
6. Jacob Baker, Harry W LI, and David E Boyce, CMOS, Circuit Design Layout and Simulation, Wiley- IEEE Press, 3rd Edition, 2010.

21CO71 ELECTRONIC DESIGN AUTOMATION TOOLS

3 0 0 3

Course Objectives

- To understand EDA tools and types of modeling using Verilog HDL.
- To obtain sound knowledge in programmable IC and ASIC technologies.
- To understand about layout design and fabrication techniques.

Programme Outcomes (POs)

a. Identify, formulate, review research literature, design and analyze complex engineering problems in signal processing, communication, VLSI and radiating systems that meet the specified needs with appropriate consideration for public health and safety.

b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.

c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.

f. Analyze the technologies behind recent wired and wireless communication standards in addressing the challenges for future communication needs.

Course Outcomes (COs)

1. Analyze the features of EDA tools.
2. Design a digital logics using Verilog HDL
3. Analyze the programmable IC technologies
4. Analyze the ASIC implementation process
5. Design a digital CMOS logic circuit and develop an optimum layout for IC fabrication

UNIT I **9 Hours**

DESIGN METHODOLOGIES

The VLSI Design Problem, Design Domains, Design Actions, VLSI Design Automation tools - An overview of the features of practical CAD tools - FPGA Technology & Tools-Xilinx ISE, ASIC Technology & Tools- Cadence.

UNIT II **9 Hours**

VERILOG HDL

Importance of HDL, Design Methodologies, Basic Concepts-Lexical Conventions-Data Types-Modules and Ports-Types of Modeling-Gate-Level Modeling, Dataflow Modeling, Behavioral Modeling - Design Examples using Combinational & Sequential Logic.

UNIT III **9 Hours**

DESIGN AND VERIFICATION OF VLSI CIRCUITS

PROM, PLA, PAL,CPLD Programmable IC Technologies -Introduction to FPGA - FPGA Implementation Process - FPGA EDA Tools - FPGA Internal Architectures - Logic Implementation using LUTs - Programmable Interconnections.

UNIT IV **9 Hours**

ASIC TECHNOLOGIES

ASIC Design Flow, Types of ASICs, Design Synthesis, Floor planning, Constructive and Iterative Partition and Placement Algorithm, Power planning, Clock Tree Synthesis - Lee Maze Routing Algorithm - Static Timing Analysis - Physical Verification - File Formats.

UNIT V **9 Hours**

LAYOUT DESIGN AND FABRICATION

Layout design rules- Lambda Design Rules Stick Diagrams-VLSI Layout Design -Full Custom and Semi-Custom Layout- Layout of Basic Structures - CMOS Logic Gates - Implementation of given logic function using CMOS - An overview of Silicon Semiconductor technology -NMOS fabrication - CMOS fabrication: n-well, pwell - Twin tub and SOI Process

Total: 45 Hours

Reference(s)

1. Sabih H Gerez, Algorithms for VLSI Design Automation, Wiley, 2006.
2. Ming -Bo Lin, Digital System Designs and Practices using Verilog HDL and FPGAs, Wiley, 2012.
3. Samir Palnitkar, Verilog HDL, Pearson Education, 2nd Edition, 2004.
4. M.J.S.Smith, Application Specific Integrated Circuits, Pearson Education, 2008.
5. J.Bhaskar, A Verilog Primer, Prentice Hall, 2005.

21CO72 SCRIPTING LANGUAGES FOR VLSI 3 0 0 3

Course Objectives

- To illustrate the various scripting languages in VLSI.
- To interpret the basic of Linux, PERL, TCL fundamentals and java script.
- To learn the applications of linux, PERL, TCL fundamentals and java script.

Programme Outcomes (POs)

b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
c. Use the techniques, skills and modern engineering tools necessary to evaluate and analyze the communication systems.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.

Course Outcomes (COs)

1. Apply the concept of linux in VHDL
2. Analyze the basic concept of PERL language in VHDL.
3. Apply the concept of PERL language in VHDL.
4. Apply the concept of TCL language in VHDL.
5. Apply the different types of digital video compression techniques in VHDL.

UNIT I **9 Hours**

LINUX CONCEPTS

Introduction to Linux, File System of the Linux, General usage of Linux kernel 7 basic commands, Linux users and group, Permissions for file, directory and users, Searching a file & directory, Zipping and unzipping concepts.

UNIT II **9 Hours**

SCRIPTS AND PERL LANGUAGE

Characteristics and uses of scripting languages, Introduction to PERL, Names and values, Variables and assignment, Scalar expressions, File handles, Operators, Control structures, Regular expressions, Built in data types, Statements and declarations- simple, Compound, Loop statements, Global and scoped declarations.

UNIT III **9 Hours**

PERL SCRIPTING

PERL built-in functions, Collections of Data, Working with arrays, Lists and hashes, Simple input and output, Strings, Patterns and regular expressions, Subroutines, Scripts with arguments

UNIT IV **9 Hours**

TCL FUNDAMENTALS

TCL Fundamentals, String and Pattern Matching, Structure, Syntax, Parser, Variables and data in TCL, Control flow, Data structures, Simple input/output, Procedures and Scope, Working with Strings, Patterns, Files and Pipes, Example code.

UNIT V **9 Hours**

OTHER LANGUAGES

JavaScript - Object models, Design Philosophy, Versions of JavaScript, The Java Script core language, Introduction to Python, Using the Python Interpreter, More Control Flow Tools, Data Structures, Modules, Input and Output, Errors and Exceptions, Classes, Brief Tour of the Standard Library.

Total: 45 Hours

Reference(s)

1. David Barron, The World of Scripting Languages, Wiley Student Edition, 2010.
2. Randal L, Schwartz Tom Phoenix, Learning PERL, Oreilly Publications, 3rd Edn., 2000.

AUDIT COURSES

21XE01 ENGLISH FOR RESEARCH PAPER WRITING 2 0 0 0

Course Objectives

- Illustrate that how to improve your writing skills and level of readability.
- Learn about what to write in each section.
- Recognize the skills needed when writing a Title.
- Ensure the good quality of paper at very first-time submission.

Programme Outcomes (POs)

d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.

e. Comprehend and write effective technical reports, design documentation, and make effective presentations.

Course Outcomes (COs)

1. Illustrate the research ideas and writing journal papers
2. Creating research paper writing

UNIT I **5 Hours**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

UNIT II **5 Hours**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III **5 Hours**

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT IV **5 Hours**

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

UNIT V **5 Hours**

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

UNIT VI **5 Hours**

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

Total: 30 Hours

Reference(s)

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)

2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highmans book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

21XE02 COST MANAGEMENT OF ENGINEERING PROJECTS

2 0 0 0

Course Objectives

- To understand the cost concepts and different stages of project execution and its activities.
- To understand cost behavior, management and its quantitative techniques.

Programme Outcomes (POs)

d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.

e. Comprehend and write effective technical reports, design documentation, and make effective presentations.

Course Outcomes (COs)

1. Apply the cost concepts in decision making.
2. Analyze the various stages of project execution and its activities.
3. Analyze the cost behavior and various types of costing.
4. Analyze the cost management and budget related decisions.
5. Analyze the quantitative techniques for cost management.

UNIT I **6 Hours**

COST CONCEPTS IN DECISION-MAKING

Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

UNIT II **6 Hours**

PROJECT

Meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.

UNIT III **6 Hours**

COST BEHAVIOR AND PROFIT PLANNING MARGINAL COSTING

Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies:

Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning.

UNIT IV **6 Hours**

TOTAL QUALITY MANAGEMENT AND THEORY OF CONSTRAINTS

Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT V **6 Hours**

QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Total: 30 Hours

Reference(s)

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

21XE03 STRESS MANAGEMENT 2 0 0 0

Course Objectives

- To achieve overall health of body and mind.
- To overcome stress by practicing yoga.

Programme Outcomes (POs)

d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.

Course Outcomes (COs)

1. Develop healthy mind in a healthy body thus improving social health also.
2. Improve Efficiency of the body by practicing breathing exercises and yoga.

UNIT I **10 Hours**

Definitions of Eight parts of yog. (Ashtanga)

UNIT II **10 Hours**

Yam and Niyam. Dos and Donts in life.i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan.

UNIT III **10 Hours**

Asan and Pranayam, i) Various yog poses and their benefits for mind & body ii)Regularization of breathing techniques and its effects-Types of pranayam.

Total: 30 Hours

Reference(s)

1. Yogic Asanas for Group Training-Part-I Janardan Swami Yogabhyasi Mandal, Nagpur. Model Curriculum of Engineering & Technology PG Courses [Volume-I][47].
2. Rajayoga or conquering the Internal Nature by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata.

21XE04 DISASTER MANAGEMENT 2 0 0 0

Course Objectives

- Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations
- Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Programme Outcomes (POs)

d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.

Course Outcomes (COs)

1. Illustrate the key concepts in disaster risk reduction and humanitarian response
2. Interpret the strengths and weaknesses of disaster management approaches, planning and programming

UNIT I **5 Hours**

INTRODUCTION

Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

UNIT II **5 Hours**

REPERCUSSIONS OF DISASTERS AND HAZARDS

Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms and Cyclones, Tsunamis and Floods, Droughts and Famines, Landslides and Avalanches Man-made disaster Nuclear Reactor Meltdown, Industrial Accidents and Oil Slicks and Spills Outbreaks of Disease and Epidemics War and Conflicts.

UNIT III **5 Hours**

DISASTER PRONE AREAS IN INDIA

Study of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

UNIT IV **5 Hours**

DISASTER PREPAREDNESS AND MANAGEMENT

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

UNIT V **5 Hours**

RISK ASSESSMENT

Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People"s Participation In Risk Assessment. Strategies for Survival.

UNIT VI **5 Hours**

DISASTER MITIGATION

Disaster Mitigation Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

Total: 30 Hours

Reference(s)

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies " , New Royal book Company.
2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi
3. Goel S. L. "Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.
4. Model Curriculum of Engineering & Technology PG Courses [Volume-I][42]

21XE05 VALUE EDUCATION 2 0 0 0

Course Objectives

- Interpret value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

Programme Outcomes (POs)

d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.

e. Comprehend and write effective technical reports, design documentation, and make effective presentations.

Course Outcomes (COs)

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

UNIT I **8 Hours**

Values and self-development- Social values and individual attitudes-Work ethics- Indian vision of humanism- Moral and non- moral valuation-Standards and principles-Value judgements.

UNIT II **7 Hours**

Importance of cultivation of values- Sense of duty Devotion- Self-reliance- Confidence-Concentration-Truthfulness- Cleanliness-Honesty- Humanity- Power of faith- National Unity- Patriotism- Love for nature-Discipline.

UNIT III **8 Hours**

Personality and Behavior Development - Soul and Scientific attitude- Positive Thinking- Integrity and discipline-Punctuality- Love and Kindness- Avoid fault Thinking- Free from anger- Dignity of labour-Universal brotherhood and religious tolerance-True friendship-Happiness Vs suffering- love for truth-Aware of self-destructive habits-Association and Cooperation-Doing best for saving nature.

UNIT IV **7 Hours**

Character and Competence -Holy books vs Blind faith, Self-management and Good health. Science of reincarnation, Equality, Nonviolence ,Humility, Role of Women. All religions and same message, Mind your Mind, Self-control. Honesty, Studying effectively.

Total: 30 Hours

Reference(s)

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi.

21XE06 PEDAGOGY STUDIES 2 0 0 0

Course Objectives

- Review existing evidence on the review topic to inform programmer design and policy making undertaken by the DfID, other agencies and researchers
- Identify critical evidence gaps to guide the development.

Programme Outcomes (POs)

d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.

e. Comprehend and write effective technical reports, design documentation, and make effective presentations.

Course Outcomes (COs)

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?

2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? verall personality

UNIT I **8 Hours**

INTRODUCTION AND METHODOLOGY

Aims and rationale- Policy background- Conceptual framework and terminology-Theories of learning-Curriculum- Teacher education-Conceptual framework- Research questions-Overview of methodology and Searching

UNIT II **7 Hours**

THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.

UNIT III **8 Hours**

EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES

Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school, curriculum and guidance materials best support effective pedagogy. Theory of change, Strength and nature of the body of evidence for effective pedagogical, practices, Pedagogic theory and pedagogical approaches, Teachers" attitudes and beliefs and Pedagogic strategies

UNIT IV **7 Hours**

PROFESSIONAL DEVELOPMENT

Alignment with classroom practices and follow up, Support Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes.

Total: 30 Hours

Reference(s)

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379
3. Akyeampong K (2003) Teacher training in Ghana - does it count. Multi-site teacher education research project (MUSTER) country report 1. London: DFID
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272-282
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, "learning to read" campaign.

21XE07 BUSINESS ANALYTICS 2 0 0 0

Course Objectives

- Illustrate the role of business analytics within an organization
- Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making
- To become familiar with processes needed to develop, report, and analyze business data
- Use decision-making tools/Operations research techniques and Manage business process using analytical and management tools

Programme Outcomes (POs)

b. Use research-based knowledge to interpret/investigate the problems, provide solutions and work towards the development of socially relevant products.
d. Apply ethical principles with commitment to professional ethics and responsibilities as per norms of the communication systems practice.
e. Comprehend and write effective technical reports, design documentation, and make effective presentations.

Course Outcomes (COs)

1. Implement the knowledge of data analytics
2. Apply the ability of think critically in making decisions based on data and deep analytics.
3. Analyze the ability to use technical skills in predicative and prescriptive modeling to support business decision-making
4. Determine the ability to translate data into clear, actionable insights
5. Analyze the decision problems in business analytics

UNIT I **6 Hours**

BUSINESS ANALYTICS AND STATISTICAL TOOLS

Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics-Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview

UNIT II **6 Hours**

TRENDINESS AND REGRESSION ANALYSIS

Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology

UNIT III **6 Hours**

ORGANIZATION STRUCTURES OF BUSINESS ANALYTICS

Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining

Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

UNIT IV **6 Hours**

FORECATING TECHNIQUES

Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models

UNIT V **6 Hours**

DECISION ANALYSIS

Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making

Total: 30 Hours

Reference(s)

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press
2. Business Analytics by James Evans, persons Education