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(Established as a University of Technology in the State of Maharashtra)
(Under Maharashtra Act No. XXIX of 2014)
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Course Structure and Detailed Syllabus

of

B. Tech Programme

for

Electronics and Telecommunication Engineering

from

Second to Final Year Engineering

In line with National Education Policy 2020

(Effective from Academic year 2024-25 for University campus only)

Department of Electronics and Telecommunication Engineering

Credit Framework under Four-Years UG Engineering Programme with Multiple Entry and Multiple Exit options:

- The Four-year Bachelor's Multidisciplinary Engineering Degree Programme allows the students to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per their choices and the feasibility of exploring learning from different institutions.
- The minimum and maximum credit structure for different levels under the Four-year Bachelor's Multidisciplinary Engineering UG Programme with multiple entry and multiple exit options are as given below:

Credit Framework

Levels	Qualification Title	Credit Requirements		Semester	Year
		Minimum	Maximum		
4.5	One Year UG Certificate in Engg./ Tech.	40	44	2	1
5.0	Two Years UG Diploma in Engg./ Tech.	80	88	4	2
5.5	Three Years Bachelor's Degree in Vocation (B. Voc.) or B. Sc. (Engg./ Tech.)	120	132	6	3
	4-Years Bachelor's degree				

Levels	Qualification Title	Credit Requirements		Semester	Year
		Minimum	Maximum		
6.0	(B.E./ B.Tech. or Equivalent) in Engg./ Tech. with Multidisciplinary Minor	160	176	8	4
6.0	4-Years Bachelor's degree (B.E./ B.Tech. or Equivalent) in Engg./ Tech.- Honors and Multidisciplinary Minor	180	194	8	4
6.0	4-Years Bachelor's degree (B.E./ B.Tech. or Equivalent) in Engg./ Tech.- Honors with Research and Multidisciplinary Minor	180	194	8	4
6.0	4-Years Bachelor's degree (B.E./ B.Tech. or Equivalent) in Engg./ Tech.- Major Engg. Discipline with Double Minors (Multidisciplinary and Specialization Minors)	180	194	8	4

- There are multiple exit options at each level. Student will be given a specific Qualification mentioned in the table depending on the level at which he/she decide to have an exit. Ex. If a student decides to exit after completion of two years (level 5.0) of the program, he will be given a Diploma in Engineering with specific exit condition mentioned in the syllabus of the specific branch. He/she can rejoin the program with the multiple entry option at the level next where he/she chose to exit previously. (Student can join at level 5.5 if successfully completed level 5.0 previously at the time of exit).
- Minimum credit requirements of each level are mentioned in the credit framework table.

- There are 4 distinct options available at level 6.0.
- First one is basic level 6.0 option where minimum 160-maximum 176 credits are mandatory which can be completed as per the Semester-wise Credit distribution structure mentioned in the table given below.

  Here, the Bachelor's Engineering Degree in chosen Engg./ Tech. Discipline with multidisciplinary minor (min.160-max.176 Credits) i.e. "**B. Tech in Electronics and Telecommunication Engineering with Computer Engineering**" (160-176 credits) enables students to take up five-six or required additional courses of 14 credits in the discipline other than Electronics and Telecommunication Engineering distributed over semesters III to VIII. Here in the case of "**B. Tech in Electronics and Telecommunication Engineering with Computer Engineering**" (160-176 credits) student is supposed to take up 50% or more courses to complete the 50% or more credits (from assigned 14 credits) from **Computer Engineering minor bucket**. The remaining courses to complete the assigned 14 credits can be covered from other discipline's minor buckets.
- Remaining three level 6.0 options are the advanced options where the student is given an opportunity to get extra qualification by earning some extra credits(18-20 extra credits). These three options are given below:
- Level 6.0: The **Bachelor's Engineering Degree with Honours** in chosen Major Engg./ Tech. Discipline i.e. in Electronics and Telecommunication Engineering with Honours with Multidisciplinary Minor (180-194 credits) enables students of Electronics and Telecommunication Engineering to take up five-six additional courses of 18 to 20 credits in the Electronics and Telecommunication Engineering discipline distributed over semesters III to VIII. The decision regarding the mechanism of distribution of these 18-20 credits over semesters III to VIII, which are over and above the min.160-max.176 Credits prescribed for the duration of four years will be taken by Academic Authorities of University. **Student must have CGPA equal to or greater than 7.5 at the end of second semester to go for this option**.
- Level 6.0: The **Bachelor's Engineering Degree with Research** in i.e. in Electronics and Telecommunication Engineering with Research with Multidisciplinary Minor (180-194 credits) enables students of Electronics and Telecommunication Engineering to take up a research project of 18 to 20 credits in the Electronics and Telecommunication Engineering discipline distributed over semesters VII to VIII. **Student must have CGPA equal to or greater than 7.5 at the end of sixth semester to go for this option**.
- Level 6.0: The **Bachelor's Engineering Degree in chosen Engg./ Tech. Discipline with Double Minor** (Multidisciplinary and Specialization Minor, 180-194 credits), i.e. "**B. Tech in Electronics and Telecommunication Engineering with *other selected discipline in* Engineering (as MDM) with Specialization Minor in Computer Engineering**" (180-194 credits) enables students to take up five-six additional courses of 14 credits in the discipline other than Electronics and Telecommunication Engineering(for completion of multidisciplinary minor) and 18 to 20 extra credits in the **Computer Engineering discipline** distributed over semesters III to VIII. Here, the ***other selected discipline* in Engineering should be different from Specialization Minor i.e. Computer Engineering**. This enables students to

take up five-six or required additional courses of 18 to 20 credits in the **Computer Engineering** discipline distributed over semesters III to VIII, which are over and above the min.160-max.176 Credits. The decision regarding the mechanism of distribution of these 18-20 credits over semesters III to VIII, prescribed for the duration of four years will be taken by Academic Authorities of University. **Student must have CGPA equal to or greater than 7.5 at the end of second semester to go for this option**.

Semester-wise Credit distribution structure for Four Year UG Engineering Program - One Major, One Minor

Semester		I	II	III	IV	V	VI	VII	VIII	Total Credits
Basic Science Course	BSC/ESC	06-08	08-10		--	--	--	--	--	14-18
Engineering Science Course		10-08	06-04		--	--	--	--	--	16-12
Programme Core Course (PCC)	Program Courses	--	02	08-10	08-10	10-12	08-10	04-06	04-06	44-56
Programme Elective Course (PEC)		--	--	--	--	04	08	02	06	20
Multidisciplinary Minor (MD M)	Multidisciplinary Courses		-	02	02	04	02	02	02	14
Open Elective (OE) Other than a particular program		--	--	04	02	02	--	--	--	08
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	02	02	--	02	--	02	--	--	08
Ability Enhancement Course (AEC -01, AEC-02)	Humanities Social Science and Management (HSSM)	02	--	--	02	--	--	--	--	04
Entrepreneurship/Economics/ Management Courses		--		02	02	--	--	--	--	04
Indian Knowledge System (IKS)			02		--	--	--	--	--	02
Value Education Course (VEC)		--	--	02	02	--	--	--	--	04
Research Methodology	Experiential Learning Courses	--	--	--	--	--	--		04	04
Comm. Engg. Project (CEP)/Field Project (FP)		--	--	02	--	--	--	-	-	02
Project		--	--	--	--	--	--		04	04
Internship/ OJT		--	---			--	--	12	-	12
Co-curricular Courses (CC)	Liberal Learning Courses	02	02		--	--	--	--	-	04
Total Credits (Major)		**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**160-176**

Student need to follow the Semester-wise Credit distribution structure for Four Year UG Engineering Program as prescribed in the table given above.

- There are seven vertical categories with specific credits distributed in specific semesters.
- Student can choose a Program Elective Course (PEC) in that specific semester from the given subjects.
- Multidisciplinary course(MDM) and Open Elective(OE) courses can be chosen from the MDM and OE Buckets depending on students choice. Completion of total credits given in the last column of the table for each vertical is mandatory.
- Students can complete 40% of the courses through online platforms like NPTEL/SWAYAM. The NPTEL SWAYAM course content should be at least 80% similar to the course content in the syllabus.

General Rules and Regulations

1. The normal duration of the course leading to B.Tech degree will be EIGHT semesters.

2. The normal duration of the course leading to M.Tech. degree will be FOUR semesters.

3. Each academic year shall be divided into 2 semesters, each of 20 weeks duration, including evaluation and grade finalization, etc. The Academic Session in each semester shall provide for at least 90 Teaching Days, with at least 40 hours of teaching contact periods in a five to six days session per week. The semester that is typically from Mid-July to November is called the ODD SEMESTER, and the one that is from January to Mid-May is called the EVEN SEMESTER. Academic Session may be scheduled for the Summer Session/Semester as well. For 1st year B. Tech and M. Tech the schedule will be decided as per the admission schedule declared by Government of Maharashtra.

4. The schedule of academic activities for a Semester, including the dates of registration, mid-semester examination, end-semester examination, inter-semester vacation, etc. shall be referred to as the Academic Calendar of the Semester, which shall be prepared by the Dean (Academic), and announced at least TWO weeks before the Closing Date of the previous Semester.

5. The Academic Calendar must be strictly adhered to, and all other activities including co-curricular and/or extra -curricular activities must be scheduled so as not to interfere with the Curricular Activities as stipulated in the Academic Calendar.

Registration:

1. Lower and Upper Limits for Course Credits Registered in a Semester, by a Full- Time Student of a UG/PG Programme:
   A full time student of a particular UG/PG programme shall register for the appropriate number of course credits in each semester/session that is within the minimum and

maximum limits specific to that UG/PG programme as stipulated in the specific Regulations pertaining to that UG/PG programme.

2. Mandatory Pre-Registration for higher semesters: In order to facilitate proper planning of the academic activities of a semester, it is essential for the every institute to inform to Dean (Academics) and COE regarding details of total no. of electives offered (Course-wise) along with the number of students opted for the same. This information should be submitted within two weeks from the date of commencement of the semester as per academic calendar.
3. PhD students can register for any of PG/PhD courses and the corresponding rules of evaluation will apply.
4. Under Graduate students may be permitted to register for a few selected Post Graduate courses, in exceptionally rare circumstances, only if the DUGC/DPGC is convinced of the level of the academic achievement and the potential in a student.

Course Pre-Requisites:

1. In order to register for some courses, it may be required either to have exposure in, or to have completed satisfactorily, or to have prior earned credits in, some specified courses.
2. Students who do not register on the day announced for the purpose may be permitted LATE REGISTRATION up to the notified day in academic calendar on payment of late fee.
3. REGISTRATION IN ABSENTIA will be allowed only in exceptional cases with the approval of the Dean (Academic) / Principal.
4. A student will be permitted to register in the next semester only if he fulfills the following conditions:
   i) Satisfied all the Academic Requirements to continue with the programme of Studies without termination
   ii) Cleared all Institute, Hostel and Library dues and fines (if any) of the previous semesters;
   iii) Paid all required advance payments of the Institute and hostel for the current semester;
   iv) Not been debarred from registering on any specific ground by the Institute.

Evaluation System:

1. Absolute grading system based on absolute marks as indicated below will be implemented from academic year 2023-24, from I year B. Tech.

Percentage of marks	Letter Grade	Grade Point
91-100	EX	10.0
86-90	AA	9.0

81-85	AB	8.5
76-80	BB	8.0
71-75	BC	7.5
66-70	CC	7.0
61-65	CD	6.5
56-60	DD	6.0
51-55	DE	5.5
40-50	EE	5.0
<40	EF	0.0

2. Class is awarded based on CGPA of all eighth semester of B.Tech Program.

CGPA for pass is minimum 5.0	
CGPA upto <5.50	Pass class
CGPA ≥ 5.50&<6.00	Second Class
CGPA ≥ 6.00&<7.5	First Class
CGPA >7.50	Distinction
[Percentage of Marks =CGPA*10.0]	

3. A total of 100 Marks for each theory course are distributed as follows:

Mid Semester Exam (MSE) Marks	20
Continuous Assessment Marks	20
End Semester Examination(ESE)Marks	60

4. A total of 100 Marks for each practical course are distributed as follows

1.	Continuous Assessment Marks	40
2.	End Semester Examination (ESE)Marks	60

- It is mandatory for every student of B. Tech to score a minimum of 40 marks out of 100, M. Tech to score a minimum of 45 marks out of 100 with a

minimum of 20 marks out of 60 marks in End Semester Examination for theory course.

- This will be implemented from the first year of B. Tech starting from Academic Year 2023-24

5. Description of Grades

EX Grade: An 'EX' grade stands for outstanding achievement.

EE Grade: The 'EE' grade stands for minimum passing grade.

The students may appear for the remedial examination for the subjects he/she failed for the current semester of admission only and his/her performance will be awarded with EE grade only.

If any of the students remain absent for the regular examination due to genuine reason and the same will be verified and tested by the Dean (Academics) or committee constituted by the University Authority.

FF Grade: The 'FF' grade denotes very poor performance, i.e. failure in a course due to poor performance .The students who have been awarded 'FF' grade in a course in any semester must repeat the subject in next semester.

6. Evaluation of Performance

a. Semester Grade Point Average (SGPA)

The performance of a student in a semester is indicated by Semester Grade Point Average (SGPA) which is a weighted average of the grade points obtained in all the courses taken by the student in the semester and scaled to a maximum of 10. (SGPI is to be calculated up to two decimal places). A Semester Grade Point Average (SGPA) will be computed for each semester as follows:

$$SGPA = \frac{[\sum_{i=1}^{n} c_i g_i]}{[\sum_{i=1}^{n} c_i]}$$

Where

'n' is the number of subjects for the semester,

'c_i' is the number of credits allotted to a particular subject, and

'g_i' is the grade-points awarded to the student for the subject based on his performance as per the above table.

SGPA will be rounded off to the second place of decimal and recorded as such.

b. Cumulative Grade Point Average (CGPA):

An up to date assessment of the overall performance of a student from the time he entered the Institute is obtained by calculating Cumulative Grade Point Average (CGPA) of a student. The CGPA is weighted average of the grade points obtained in all the courses registered by the student since s/he entered the Institute. CGPA is also calculated at the end of every semester (upto two decimal places).Starting from the first semester at the end of each semester (S), a Cumulative Grade Point Average (CGPA) will be computed as follows:

$$CGPA = \frac{[\sum_{i=1}^{m} c_i g_i]}{[\sum_{i=1}^{m} c_i]}$$

Where,

'm' is the total number of subjects from the first semester onwards up to and including the semester S,

'ci' is the number of credits allotted to a particular subject, and

'gi' is the grade-points awarded to the student for the subject based on his/her performance as per the above table.

CGPA will be rounded off to the second place of decimal and recorded as such.

7. Attendance Requirements:

a. All students must attend every lecture, tutorial and practical classes.

b. To account for approved leave of absence (eg. representing the Institute in sports, games or athletics; placement activities; NCC/NSS activities; etc.) and/or any other such contingencies like medical emergencies, etc., the attendance requirement shall be a minimum of 75% of the classes actually conducted. If the student failed to maintain 75% attendance, he/she will be detained for appearing the successive examination. The Dean (Academics)/ Principal is permitted to give 10% concession for the genuine reasons as such the case may be. In any case the student will not be permitted for appearing the examination if the attendance is less than 65%.

c. The course instructor handling a course must finalize the attendance 3 calendar days before the last day of classes in the current semester and communicate clearly to the students by displaying prominently in the department and also in report writing to the head of the department concerned.

d. The attendance records are to be maintained by the course instructor and he shall show it to the student, if and when required.

8. Transfer of Credits:

The courses credited elsewhere, in Indian or foreign University/Institutions/ Colleges/Swayam Courses by students during their study period at DBATU may count towards the credit requirements for the award of degree. The guidelines for such transfer of credits are as follows:

a. 20 % of the total credit will be considered for respective calculations.

b. Credits transferred will be considered for overall credits requirements of the programme.

c. Credits transfer can be considered only for the course at same level i.e UG, PG etc.

d. A student must provide all details (original or attested authentic copies) such as course contents, number of contact hours, course instructor /project guide and evaluation system for the course for which he is requesting a credits transfer. He shall also provide the approval or acceptance letter from the other side. These

details will be evaluated by the concerned Board of Studies before giving approval. The Board of Studies will then decide the number of equivalent credits the student will get for such course(s) in DBATU. The complete details will then be forwarded to Dean for approval.

e. A student has to get minimum passing grades/ marks for such courses for which the credits transfers are to be made.
f. Credits transfers availed by a student shall be properly recorded on academic record(s) of the student.
g. In exceptional cases, the students may opt for higher credits than the prescribed.

SECOND YEAR

	Course Code	Course Title	L	T	P	Cr	Categorisation
	2311372BS2000	Engineering Mathematics-III	3	0	0	3	BSC
SEM III	2311372PC201	Electronic Devices & Circuits	3	0	0	3	PCC
	2311372PC201L	Electronic Devices & Circuits Lab	0	0	2	1	PCC Lab
	2311372PC203	Digital Electronics	3	0	0	3	PCC
	2311372PC203L	Digital Electronics Lab	0	0	2	1	PCC Lab
	2311372MD201	**MDM Bucket***	2	0	0	2	MD Minor
	2311372OE201	**Open Elective Bucket****	2	0	0	2	OE
	2311372AE201	A. Employability and Skill Development B. Innovation and Entrepreneurship	2	0	0	2	Entrepreneurship
	2311372AE203	Universal Human Values II	3	0	0	3	VEC
	2311372AE205	Life of Chhatrapati Shivaji Maharaj	1	0	0	1	VEC
	2311372FP201	Community Engineering Project (CEP)	0	0	4	2	CEP/FP
			21	**1**	**8**		
					Total	**23**	

NOTE: * Refer to Multidisciplinary Minor Bucket

**** Refer to Open Elective Bucket**

	Course Code	Course Title	L	T	P	Cr	Categorisation
SEM IV	2311372PC202	Signals and Systems	3	0	0	3	PCC
	2311372PC202L	Signals and Systems Lab	0	0	2	1	PCC Lab
	2311372PC204	Microprocessors	3	0	0	3	PCC
	231137 2PC204L	Microprocessors Lab	0	0	2	1	PCC Lab
	2311372PC206	Network Theory	3	0	0	3	PCC
	2311372PC206L	Network Theory Lab	0	0	2	1	PCC Lab
	2311372MD202	**MDM Bucket***	2	0	0	2	MD Minor
	2311372OE202	**Open Elective Bucket****	3	0	0	3	OE
	2311372SE202	PCB Designing	0	0	4	2	VSEC
	2311372AE204	Marathi/Hindi/Sanskrit/Gujrati/Kannada/Pali	2	0	0	2	HSSM
	2311372AE206	Patents and IPR	2	0	0	2	Entrepreneurship
	2311372AE208	Constitution of India	2	0	0	AU	VEC
	2311372AE210	Life of Bharatratna Dr. Babasaheb Ambedkar	1	0	0	1	VEC
			20	**0**	**10**		
					Total	**24**	

NOTE: * Refer to Multidisciplinary Minor Bucket

**** Refer to Open Elective Bucket**

THIRD YEAR

	Course Code	Course Title	L	T	P	Cr	Categorisation
SEM V	2311372PC307	Digital Signal Processing	3	1	0	4	PCC
	2311372PC307L	Digital Signal Processing Lab	0	0	2	1	PCC Lab
	2311372PC309	Electromagnetic Wave Theory	3	1	0	4	PCC
	2311372PC311	Analog Communication	3	0	0	3	PCC
	2311372PC311L	Analog Communication Lab	0	0	2	1	PCC Lab
	2311372PE301	A. Fiber Optic Communication	3	0	0	3	PEC
		B. Control System					
		C. Advanced Mobile Communication					
	2311372MD303	**MDM Bucket***	4	0	0	4	MD Minor
	2311372OE303	**Open Elective Bucket****	3	0	0	3	OE
			17	**3**	**4**		
					Total	**23**	

NOTE: * Refer to Multidisciplinary Minor Bucket

**** Refer to Open Elective Bucket**

	Course Code	Course Title	L	T	P	Cr	Categorisation
	2311372PC308	Analog Circuits	3	0	0	3	PCC
	2311372PC308L	Analog Circuits Lab	0	0	2	1	PCC Lab
SEM VI	2311372PC310	Digital Communication	3	0	0	3	PCC
	2311372PC310L	Digital Communication Lab	0	0	2	1	PCC Lab
	2311372PE302	A. Digital Audio Processing	3	0	0	3	PEC
		B. Digital Image Processing					
		C. Introduction to Adaptive Signal Processing					
	2311372PE304	A. Microwave Theory & Techniques	3	0	0	3	PEC
		B. RF Circuit Design					
		C. Wireless Sensor Networks					
	2311372MD304	**MDM Bucket***	2	0	0	2	MD Minor
	2311372SE304	Basic Concepts of Film & Video Editing	3	0	0	3	VSEC
			17	**0**	**4**		
					Total	**19**	

NOTE: * Refer to Multidisciplinary Minor Bucket

FINAL YEAR

	Course Code	Course Title	L	T	P	Cr	Categorisation
	2311372PC313	Computer Networks	3	0	0	3	PCC
	2311372PC313L	Computer Networks Lab	0	0	2	1	PCC Lab
SEM VII	2311372PC315	Antenna and Wave Propagation	3	0	0	3	PCC
	2311372PE403	A. Biomedical Electronics	3	0	0	3	PEC
		B. Embedded System Design					
		C. Introduction to Information Theory					
	2311372PE405	A. Introduction to MEMS	3	0	0	3	PEC
		B. Satellite Communication					
		C. Introduction to Coding Theory					
	2311372MD405	**MDM Bucket***	2	0	0	2	MD Minor
	2311372RM401	Research Methodology	3	1	0	4	RM
	2311372PR401	Project	0	0	8	4	Project
			17	**1**	**10**		
					Total	**23**	

NOTE: * Refer to Multidisciplinary Minor Bucket

	Course Code	Course Title	L	T	P	Cr	Categorisation
SEM VIII	2311372PC312	VLSI Design	3	0	0	3	PCC
	2311372PE406	A. Data Structure & Algorithms Using Java Programming B. UAV in Engineering Applications C. Data Compression & Encryption	2	0	0	2	PEC
	2311372MD406	**MDM Bucket***	2	0	0	2	MD Minor
	2311372IT401	Internship	0	0	24	12	Internship
			7	**0**	**24**		
					Total	**19**	

NOTE: * Refer to Multidisciplinary Minor Bucket

Credit Distribution

SEM I	SEM II	SEM III	SEM IV	SEM V	SEM VI	SEM VII	SEM VIII	TOTAL
24	23	23	24	23	19	23	19	178

For Degree completion : Students must complete min 08 Credits of Open Elective, 20 Credits of Program Elective, 14 Credits of HSSM, 4 credits of co-curricular courses and 22 credits of Experiential learning courses from Open courses slots Institutes are free to manage the slots according to BoS inputs.

Note: Students can complete online courses of 40% of total credits through online platform NPTEL / SWAYAM/ Sector Skill council of India and other online platforms identified by the University time to time. At least 80% contents of the NPTEL / SWAYAM/ Sector Skill council of India course should match with syllabus contents of the subject prescribed by the university.

BSC/ESC	Program Courses (PCC & PEC)	Multidisciplinary Courses (MDM & OE)	Skill Courses (VSEC)	Humanities Social Science and Management (HSSM) (IKS, VEC,AEC)	Experiential Learning Courses (CEP & FP)	Liberal Learning Courses (CC)	TOTAL
36	**69**	**22**	**9**	**14**	**24**	**4**	**178**

SECOND YEAR

SEMESTER III

2311372PC2000	Engineering Mathematics-III	03 Credits

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Linear differential equations of higher order using analytical methods and numerical methods applicable to Control systems and Network analysis.
2. Transforms such as Fourier transform, Laplace transform and applications to Communication systems and Signal processing.
3. Vector differentiation and integration required in Electro-magnetics and Wave theory.
4. Complex functions, conformal mappings, contour integration applicable to Electrostatics, Digital filters, Signal and Image processing.

Course Outcomes:

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

CO1: Solve higher order linear differential equation using appropriate techniques for modelling and analyzing electrical circuits.
CO2: Solve problems related to Fourier transform, Laplace transform and applications to Communication systems and Signal processing.
CO3: Obtain Interpolating polynomials, numerically differentiate and integrate functions, numerical solutions of differential equations using single step and multi-step iterative methods used in modern scientific computing.
CO4: Perform vector differentiation and integration, analyze the vector fields and apply to Electromagnetic fields.
CO5: Analyze conformal mappings, transformations and perform contour integration of complex functions in the study of electrostatics and signal processing.

Unit 1: Laplace Transform 09 Hours

Definition – conditions for existence ; Transforms of elementary functions ; Properties of Laplace transforms - Linearity property, first shifting property, second shifting property, transforms of functions multiplied by t^n , scale change property, transforms of functions divided by t, transforms of integral of functions, transforms of derivatives ; Evaluation of integrals by using Laplace transform ; Transforms of some special functions- periodic function, Heaviside-unit step function, Dirac delta function.

Unit 2: Inverse Laplace Transform 09 Hours

Introductory remarks ; Inverse transforms of some elementary functions ; General methods of finding inverse transforms ; Partial fraction method and Convolution Theorem for finding inverse Laplace transforms ; Applications to find the solutions of linear differential equations

and simultaneous linear differential equations with constant coefficients.

Unit 3: Fourier Transform 09 Hours

Definitions – integral transforms ; Fourier integral theorem (without proof) ; Fourier sine and cosine integrals ; Complex form of Fourier integrals ; Fourier sine and cosine transforms ; Properties of Fourier transforms ; Parseval‟s identity for Fourier Transforms.

Unit 4: Partial Differential Equations and Their Applications 09 Hours

Formation of Partial differential equations by eliminating arbitrary constants and functions; Equations solvable by direct integration; Linear equations of first order (Lagrange‟s linear equations); Method of separation of variables – applications to find solutions of one dimensional heat flow equation (), and one dimensional wave equation.

Unit 5: Functions of Complex Variables 09 Hours

Analytic functions; Cauchy- Riemann equations in Cartesian and polar forms; Harmonic functionsinCartesianform;Cauchy‟sintegraltheorem;Cauchy‟sintegralformula;Residues; Cauchy‟s residue theorem (All theorems without proofs).

Text Books

1. Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers, NewDelhi.
2. Higher Engineering Mathematics by H. K. Das and Er. Rajnish Verma, S. Chand & CO. Pvt. Ltd., New Delhi.
3. A course in Engineering Mathematics (Vol III) by Dr. B. B. Singh, Synergy Knowledge ware, Mumbai.
4. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw-Hill Publications,
5. New Delhi.

Reference Books

1. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, NewYork.
2. A Text Book of Engineering Mathematics by PeterO‟Neil, Thomson Asia Pte Ltd., Singapore.
3. Advanced Engineering Mathematics by C. R. Wylie & L. C. Barrett, Tata Mcgraw-Hill Publishing Company Ltd., NewDelhi.
4. Integral Transforms and their Engineering Applications by Dr. B. B. Singh, Synergy Knowledge ware, Mumbai.
5. Integral Transforms by I. N. Sneddon, Tata McGraw-Hill , NewYork.

2311372PC201	Electronics Devices and Circuits	03 Credits

Course Objectives:

1. To brief about Semiconductor devices JFET & MOSFET, its characteristics, parameters and applications.

2. To discuss MOSFET DC and AC Configurations and it‟s analysis.
3. To explain various MOSFET Circuits
4. To introduce concepts of feedbacks in amplifiers & oscillators.
5. To impart skills to evaluate the performance of voltage regulator and SMPS Circuits

Course Outcomes:

CO1: Compare the characteristics and parameters of JFET towards its applications.
CO2: Compare the characteristics and parameters of MOSFET towards its DC circuits.
CO3: Explain various MOSFET circuits and their applications.
CO4: Explain MOSFET amplifiers with and without feedback & MOSFET oscillators, for given specifications.
CO5: Analyze the performance of linear and switching voltage regulators towards applications in regulated power supplies.

UNIT – 1 Bipolar Junction Transistor: (06 hrs.)

BJT: construction, working, characteristics, Transistor as switch, Transistor configurations, current gain equation, stability factor.

BJT Biasing and basic amplifier configurations: Need for biasing BJT, Transistor biasing methods, Transistor as amplifier, Analysis of Single Stage Amplifier, RC coupled Amplifiers, Effects of bypass and coupling capacitors, Frequency response of CE amplifier.

UNIT – 2 Junction Field Effect Transistor and MOSFET (06 hrs.)

JFET: JFET and its characteristics, Pinch off voltage, Drain saturation current, JFET amplifiers, CS,CD,CG amplifiers , Biasing the FET.

MOSFET: Overview of DMOSFET, EMOSFET, n-MOSFET, p-MOSFET and CMOS devices, MOSFET as an Amplifier and Switch, Biasing in MOSFET, Small signal operation and models, Single stage MOS amplifier, MOSFET capacitances.

CMOS Inverter, Comparison of FET with MOSFET and BJT w.r.t. to device and Circuit parameter.

UNIT III Power amplifiers: (06 hrs.)

Introduction, classification of power amplifiers -A, B, AB, C and D, transformer coupled class A amplifier, Class B push pull and complementary symmetry amplifier, calculation of efficiency of (transformer coupled class A amplifier, Class B push pull), calculation of power output, power dissipation.

UNIT IV- Feedback amplifiers & Oscillators (6 hrs.)

Feedback Amplifiers: Principle of Negative feedback in electronic circuits, Voltage series, Voltage shunt, Current series, Current shunt types of Negative feedback, Typical transistor circuit effects of Negative feedback on Input and Output impedance, Voltage and Current gains.

Oscillators: Principle of Positive feedback, Concept of Stability in electronics circuits, Barkhausen criteria for oscillation, Resonant frequency calculation of (General form of LC

oscillator, FET RC Phase Shift oscillator, Wein bridge oscillator, Hartley and Colpitts oscillators).

UNIT V- Voltage Regulator & Switched Mode Power Supply (SMPS) (6 hrs.)

Transistor application: Discrete transistor voltage Regulation, series voltage regulator, shunt voltage regulator.

IC Voltage Regulators: Three terminal voltage regulator, Variable voltage regulator.

Introduction to Switch Mode Power supply (SMPS), Block diagram of SMPS, Types of SMPS.

TEXT/REFERENCE BOOKS:

1. A. Neamen, Semiconductor Physics and Devices (IRWIN), Times Mirror High Education Group, Chicago)1997.
2. E.S. Yang, Microelectronic Devices, McGraw Hill, Singapore, 1988.
3. Brijesh Iyer, S. L. Nalbalwar, R. Dudhe, "Electronics Devices & Circuits", Synergy Knowledge ware Mumbai, 2017.ISBN:9789383352616
4. B.G. Streetman, Solid State Electronic Devices, Prentice Hall of India, New Delhi,1995.
5. J. Millman and A. Grabel, Microelectronics, McGraw Hill, International,1987.
6. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Saunder's College Publishing, 1991.
7. R.T. Howe and C.G. Sodini, Microelectronics: An integrated Approach, Prentice Hall International,1997.
8. V.K. Mehta, Rohit Mehta, Principles of Electronics, S. Chand and Company
9. Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 11th Edition.

2311372PC201L	Electronics and Device Circuits Lab	01 Credits

List of Experiments:

1) P-N junction diode characteristics.
2) Zener diode characteristics and Zener as voltage regulator.
3) Half -wave rectifier with and without filter.
4) Full - wave rectifier with and without filter.
5) Input and output characteristics of transistor CB configuration.
6) Input and output characteristics of transistor CE configuration.
7) FET characteristics.
8) H-parameters of CB configuration.
9) H-parameters of CE configuration.
10) Frequency response of CE amplifier.
11) Frequency response of CC amplifier.
12) Frequency response of common source FET amplifier.

2311372PC203	Digital Electronics	03 Credits

Course Objectives:

1. To acquaint the students with the fundamental principles of two-valued logic and Various devices used to implement logical operations on variables.
2. To lay the foundation for further studies in areas such as communication, VHDL, computer.

Course Outcomes:

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

CO1. Use the basic logic gates and various reduction techniques of digital logic circuit in detail.

CO2. Design combinational and sequential circuits.

CO3. Design and implement hardware circuit to test performance and application.

CO4. Understand the architecture and use of VHDL for basic operations and Simulate using simulation software.

UNIT 1: Combinational Logic Design:

Standard representations for logic functions, k map representation of logic functions (SOP and POS forms), minimization of logical functions for min-terms and max-terms (upto 4 variables), don't care conditions, Design Examples: Arithmetic Circuits, BCD - to – 7 segment decoder, Code converters. Adders and their use as subtractor, look ahead carry, ALU, Digital Comparator, Parity generators/checkers, Design of Multiplexers and Demultiplexers, Decoders.

UNIT 2: Sequential Logic Design

1 Bit Memory Cell, Clocked SR, JK, MS J-K flip flop, D and T flip-flops. Use of preset and clear terminals, Excitation Table for flip flops and Conversion of flip flops. Application of Flip- flops: Registers, Shift registers, Counters (ring counters, twisted ring counters), Sequence Generators, ripple counters, up/down counters, synchronous counters, definitions of lock out, Clock Skew, and Clock jitter.

UNIT 3: State Machines

Basic design steps- State diagram, State table, State reduction, State assignment, Mealy and Moore machines representation, Implementation, finite state machine implementation, Sequence detector.

UNIT 4:Digital Logic Families

Classification of logic families, Characteristics of digital ICs-Speed of operation, power dissipation, figure of merit, fan in, fan out, current and voltage parameters, noise immunity, operating temperatures and power supply requirements. TTL logic, Operation of TTL NAND gate, active pull up, wired AND, open collector output, unconnected inputs. Tri-State logic. CMOS logic – CMOS inverter, NAND, NOR gates, unconnected inputs, wired logic, open drain output. Interfacing CMOS and TTL, Comparison table of Characteristics of TTL, CMOS, ECL, RTL, I2 L and DCTL.

UNIT 5: VHDL

Programmable logic devices: Detail architecture, Study of PROM, PAL, PLA, Designing combinational circuits using PLDs. General Architecture of FPGA and CPLD Semiconductor memories: memory organization and operation, expanding memory size, Classification and characteristics of memories, RAM, ROM, EPROM, EEPROM, NVRAM, SRAM, DRAM. Introduction to VHDL: Behavioral – data flow, and algorithmic and structural description, lexical elements, data objects types, attributes, operators; VHDL coding examples, combinational circuit design examples in VHDL and simulation.

TEXT/REFERENCE BOOKS:

1. R.P. Jain, ―Modern digital electronics‖, 3rd edition, 12threprint Tata McGraw Hill Publication,2007.
2. M. Morris Mano, ―Digital Logic and Computer Design‖ 4th edition, Prentice Hall of India,2013.
3. Anand Kumar, ―Fundamentals of digital circuits‖ 1st edition, Prentice Hall of India, 2001.
4. Pedroni V.A., "Digital Circuit Design with VHDL", Prentice Hall India, 2nd 2001 Edition.

2311372PC203L	Digital Electronics Lab	01 Credits

List of Experiments:

1. Study of Logic gates and their ICs and universal gates.
2. Implement AND, OR, NOT, XOR, XNOR using NAND gates.
3. Implement AND, OR, NOT, XOR, XNOR using NOR gates.
4. Verifying De Morgan's laws. (Using Logic gates)
5. Implement the given Boolean expressions using minimum number of gates.
6. Design and implement Half adder and Full adder.
7. Design and implement 4:1 multiplexer.
8. Design and implement 1:4 Demultiplexer. Study of IC 74139
9. Design of 3-bit synchronous counter using 7473 and required gates.
10. Study of IC 7490, 7492, 7493 and designing mod-n counters using these.
11. Design and implement a 2-bit by 2-bit multiplier.
12. Design and implement a 2-bit comparator.

2311372AE201	Employability and Skill Development	02 Credits

Course Objectives:

1. To develop analytical abilities.
2. To develop communication skills.

3. To introduce the students to skills necessary for getting, keeping and being successful in a profession.
4. To expose the students to leadership and team-building skills.

Course Outcomes:

On completion of the course, student will be able to:

CO1. Have skills and preparedness for aptitude tests.

CO 2. Be equipped with essential communication skills (writing, verbal and non-verbal)

CO 3. Master the presentation skill and be ready for facing interviews.

CO 4. Build team and lead it for problem solving.

Unit 1: Soft Skills & Communication basics

Soft skills vs. hard skills, Skills to master, Interdisciplinary relevance, Global and national perspectives on soft skills, Resume, Curriculum vitae, How to develop an impressive resume, Different formats of resume – Chronological, Functional, Hybrid, Job application or cover letter, Professional presentation- planning, preparing and delivering presentation.

Unit 2: Interpersonal Skills

Critical Thinking, Assertiveness, Decision Making, Problem Solving, Negotiation, Building Confidence, Time Management, Personal Presentation, Assertiveness, negotiation, avoiding Stress. Commercial Awareness: Professional etiquettes and manners.

Unit 3: Grammar and Comprehension:

English sentences and phrases, Technical writing, Paragraph writing, Story writing, Reproduction of a story, Letter writing and e-mail writing.

Unit 4: Skills for interviews:

Interviews- types of interviews, preparatory steps for job interviews, interview skill tips, Group discussion- importance of group discussion, types of group discussion, difference between group discussion, panel discussion and debate, tips for successful participation in group discussion, Listening skills: virtues of listening, fundamentals of good listening.

Unit 5: Problem Solving Techniques

Problem solving model: 1. Define the problem, 2. Gather information, 3. Identify various solution, 4. Evaluate alternatives, 5. Take actions, 6. Evaluate the actions. Problem solving skills: 1. Communicate. 2. Brain storming, 3. Learn from mistakes.

TEXT/REFERENCE BOOKS:

1. R. Gajendra Singh Chauhan, Sangeeta Sharma, “Soft Skills- An integrated approach to maximize personality”, ISBN: 987-81-265-5639-7, First Edition 2016, WileyWren and Martin, "English grammar and Composition", S. Chandpublications.

2. R. S. Aggarwal, "A modern approach to verbal reasoning", S. Chandpublications.
3. Philip Carter, "The Complete Book of Intelligence Test", John Willey & SonsLtd.
4. Philip Carter, Ken Russell, "Succeed at IQ test", KoganPage.
5. Eugene Ehrlich, Daniel Murphy, "Schaum‟s Outline of English Grammar", McGraw Hills.
6. David F. Beer, David A. McMurrey, “A Guide to Writing as an Engineer”, ISBN: 978-1-118-30027-5 4th Edition, 2014, Wiley.

2311372AE201 Innovation and Entrepreneurship 02 Credits

Course Objectives:

1. To build inspiration, aspiration, knowledge, skills, networks, practical experience, and confidence to Start-up a new Venture.

Course Outcomes:

Students will be able to:

CO1: Develop entrepreneurial mind-set and attributes;

CO2: Apply process of problem-opportunity identification and feasibility assessment through developing a macro perspective of the real market, industries, domains and customers

CO3: Analyse Customer and Market segmentation, estimate Market size.

CO4: Initiate Solution design, Prototype for Proof of Concept. Understand MVP development and validation techniques to determine Product-Market fit.

CO5: Craft initial Business and Revenue models, financial planning and pricing strategy for profitability and financial feasibility of a venture.

CO6: Understand and apply story telling skills in presenting a persuasive and defensible Venture Pitch.

Unit 1: Entrepreneurship Fundamentals & Context

Meaning and concept, attributes and mindset of entrepreneurial and intrapreneurial leadership, role models in each and their role in economic development. Gamified role play based exploration aligned to one’s short term career aspiration and ambition. An understanding of how to build entrepreneurial mindset, skillsets, attributes and networks while on campus.

Core Teaching Tool: Simulation, Game, Industry Case Studies (Personalized for students – 16 industries to choose from), Venture Activity

Unit 2: Problem & Customer Identification

Understanding and analysing the macro Problem and Industry perspective, technological, socio-economic and urbanization trends and their implication on new opportunities. Identifying passion, identifying and defining problem using Design thinking principles.

Analysing problem and validating with the potential customer. Iterating problem-customer fit. Understanding customer segmentation, creating and validating customer personas. Competition and Industry trends mapping and assessing initial opportunity.
Core Teaching Tool: Several types of activities including: Class, game, Gen AI, 'Get out of the Building' and Venture Activity.

Unit 3: Solution design & Prototyping
Understanding Customer Jobs-to-be-done and crafting innovative solution design to map to customer's needs and create a strong value proposition. Developing Problem-solution fit in an iterative manner. Understanding prototyping and MVP. Developing a feasibility prototype with differentiating value, features and benefits. Initial testing for proof-of-concept and iterate on the prototype.
Core Teaching Tool: Venture Activity, nocode Innovation tools, Class activity

Unit 4: Opportunity Assessment and Sizing
Assess relative market position via competition analysis, sizing the market and assess scope and potential scale of the opportunity.
Core Teaching Tool: Class and Venture Activity

Unit 5: Business & Financial Model, Go-to-Market Plan
Introduction to Business model and types, Lean approach, 9 block lean canvas model, riskiest assumptions to Business models. Importance of Build - Measure – Lean approach Business planning: components of Business plan- Sales plan, People plan and financial plan, Financial Planning: Types of costs, preparing a financial plan for profitability using financial template, understanding basics of Unit economics and analysing financial performance. Introduction to Marketing and Sales, Selecting the Right Channel, creating digital presence, building customer acquisition strategy. Choosing a form of business organization specific to your venture, identifying sources of funds: Debt & Equity, Map the Start-up Lifecycle to Funding Options.
Core Teaching Tool: Founder Case Studies – Sama and Securely Share; Class activity and discussions; Venture Activities.

Reference Books

1. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020). Entrepreneurship, McGrawHill, 11th Edition.
2. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business.
3. Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons
4. Chowdhry Ajay, (2023) Just Aspire: Notes on Technology, Entrepreneurship and the Future.
5. Simon Sinek (2011) Start With Why, Penguin Books limited
6. Brown Tim (2019) Change by Design Revised & Updated: How Design Thinking Transforms Organizations and Inspires Innovation, Harper Business

7. Namita Thapar (2022) The Dolphin and the Shark: Stories on Entrepreneurship, Penguin
   Books Limited
8. Collins Jim, Porras Jerry, (2004) Built to Last: Successful Habits of Visionary Companies
9. Burlington Bo, (2016) Small Giants: Companies That Choose to Be Great Instead of Big
10. Saras D. Sarasvathy, (2008) Effectuation: Elements of Entrepreneurial Expertise, Elgar
    Publishing Ltd

Web Resources

Learning resource- IgniteX Course Wadhwani platform (Includes 200+ components of custom created modular content + 500+ components of the most relevant curated content)

2311372AE203	Universal Human Values II	03 Credits

Course Objectives:

1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.

Course Outcomes:

By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

This is only an introductory foundational input. It would be desirable to follow it up by
a) Faculty-student or mentor-mentee programs throughout their time with the institution

b) Higher level courses on human values in every aspect of living.

Module 1 Introduction to Value Education
-Understanding Value Education
- Self-exploration as the Process for Value Education
- Continuous Happiness and Prosperity the Basic Human Aspirations
- Right Understanding, Relationship and Physical Facility
- Happiness and Prosperity Current Scenario
- Method to Fulfill the Basic Human Aspirations

Module 2 Harmony in the Human Being
- Understanding Human being as the Co-existence of the Self and the Body
- Distinguishing between the Needs of the Self and the Body
- The Body as an Instrument of the Self
- Understanding Harmony in the Self
- Harmony of the Self with the Body
- Programme to ensure self-regulation and Health

Module 3 Harmony in the Family and Society
- Harmony in the Family the Basic Unit of Human Interaction
- Values in Human-to-Human Relationship
- 'Trust' the Foundational Value in Relationship
- 'Respect' as the Right Evaluation
- Understanding Harmony in the Society
- Vision for the Universal Human Order

Module 4 Harmony in the Nature/Existence Lecture 19: Understanding Harmony in the Nature
- Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature
- Realizing Existence as Co-existence at All Levels
- The Holistic Perception of Harmony in Existence

Module 5 Implications of the Holistic Understanding a Look at Professional Ethics
- Natural Acceptance of Human Values
- Definitiveness of (Ethical) Human Conduct
- A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order
- Competence in Professional Ethics
- Holistic Technologies, Production Systems and Management Models-Typical Case Studies
- Strategies for Transition towards Value-based Life and Profession

3. READINGS:
Text Book and Teachers Manual
a. The Textbook

A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1

b. The Teacher's Manual

Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

SEMESTER IV

2311372PC202	Signals and Systems	03 Credits

Course Objectives:

1. To understand the mathematical description of continuous and discrete time signals and systems.
2. To classify signals into different categories.
3. To analyse Linear Time Invariant (LTI) systems in time and transform domains.
4. To build basics for understanding of courses such as signal processing, control system and communication.

Course Outcomes:

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

CO1: Understand mathematical description and representation of continuous and discrete time signals and systems.

CO2: Develop input output relationship for linear shift invariant system and understand the convolution operator for continuous and discrete time system.

CO3: Understand and resolve the signals in frequency domain using Fourier series and Fourier transforms.

CO4: Understand the limitations of Fourier transform and need for Laplace transform and develop the ability to analyze the system in s-domain.

UNIT 1: Introduction to Signals and Systems

Introduction and Classification of signals: Definition of signal and systems, Continuous time and discrete time signal, Classification of signals as even, odd, periodic and non-periodic, deterministic and non-deterministic, energy and power, elementary signals used for testing: exponential, sine, impulse, step and its properties, ramp, rectangular, triangular, signum, sinc Operations on signals: Amplitude scaling, addition, multiplication, differentiation, integration (Accumulator for DT), time scaling, time shifting and time folding, Sampling Theorem and reconstruction of sampled signal, Concept of aliasing, examples on under sampled and over sampled signals. Systems: Definition, Classification: linear and non-linear, time variant and invariant, causal and non-causal, static and dynamic, stable and unstable, invertible.

UNIT 2 Time domain representation of LTI System

System modeling: Input-output relation, definition of impulse response, convolution sum, convolution integral, computation of convolution integral using graphical method, Computation of convolution sum. Properties of convolution, properties of the system based on impulse response, step response in terms of impulse response.

UNIT 3 Fourier Series

Fourier series (FS) representation of periodic Continuous Time (CT) signals, Dirichlet condition for existence of Fourier series, FS representation of CT signals using exponential Fourier series, Fourier spectrum representation, properties of Fourier series, Gibbs phenomenon, Discrete Time Fourier Series and its properties.

UNIT 4 Fourier Transform

Fourier Transform (FT) representation of aperiodic CT signals, Dirichlet condition for existence of Fourier transform, evaluation of magnitude and phase response, FT of standard, CT signals, FT of standard periodic CT signals, Introduction to Fourier Transform of DT signals, Properties of CTFT and DTFT, Fourier Transform of periodic signals. Concept of sampling and reconstruction in frequency domain, sampling of band-pass signals.

UNIT 5 Laplace and Z-Transform

Definition of Laplace Transform (LT), Limitations of Fourier transform and need of Laplace transform, ROC and its properties, properties of Laplace transform, Laplace transform evaluation using properties, Inverse Laplace transform based on partial fraction expansion, Application of Laplace transforms to the LTI system analysis. Introduction to Z-transform, and its properties, Inverse Z-transform, different methods of inverse Z-transform, Z-transform for discrete time system LTI analysis.

TEXT/REFERENCE BOOKS:

1. Alan V. Oppenheim. Alan S. Willsky and S. Hamid Nawab, “Signals and Systems”,PHI
2. Dr. S. L. Nalbalwar, A.M. Kulkarni and S.P. Sheth, “Signals and Systems”, 2nd Edition, Synergy Knowledgeware,2017
3. Simon Haykins and Barry Van Veen, “Signals and Systems”, 2nd Edition, WileyIndia.
4. ShailaApte, “Signals and Systems-principles and applications”, Cambridge University press,2016.
5. Mrinal Mandal and Amir Asif, Continuous and Discrete Time Signals and Systems, Cambridge University Press,2007.
6. Peyton Peebles, “Probability, Random Variable, Random Processes”, 4th Edition, Tata McGraw Hill.
7. A. NagoorKanni “Signals and Systems”, 2nd edition, McGrawHill.
8. NPTEL video lectures on Signals and Systems.
9. Roberts, M.J., “Fundamentals of Signals & Systems”, Tata McGraw Hill.2007.
10. Ziemer, R.E., Tranter, W.H. and Fannin, D.R., “Signals and Systems: Continuous and Discrete”, 4th 2001 Ed., Pearson Education.

2311372PC202L	Signals and Systems Lab	01 Credit

List of Experiments:

1. MATLAB code to generate standard signals
2. MATLAB code to perform basic operations on signals
3. MATLAB code to verify Properties of system
4. MATLAB code to perform convolution
5. MATLAB code to Verify properties of Fourier Transform
6. MATLAB program to find one sided Z-transform of Standard causal signals
7. MATLAB code to find residues and poles of Z-domain signal
8. MATLAB code to find Laplace transform of Standard causal signal
9. MATLAB code for convolution using Fourier transform
10. MATLAB code for convolution using Laplace transform
11. MATLAB code for convolution using Z-transform

2311372PC204	Microprocessors	03 Credits

Course objectives:

1. Familiarize basic architecture of 8085 microprocessor
2. Program 8085 Microprocessor using Assembly Level Language
3. Handling interrupts in 8085.
4. Understand interfacing of 16 bit microprocessor with memory and peripheral chips involving system design
5. Understand the architecture of 8086.

Course Outcomes:

CO1: Students get ability to conduct experiments based on interfacing of devices to or interfacing to real world applications.

CO2: Students get ability to interface mechanical system to function in multidisciplinary system like in robotics, Automobiles.
CO3: Students can identify and formulate control and monitoring systems using microprocessors.
CO4: Learn use of hardware and software tools.
CO5: Develop interfacing to real world devices.
CO6: Graduates will be able to design real time controllers using microcontroller-based system.
CO7: Learn importance of microcontroller in designing embedded application.

Unit 1: Fundamentals of Microprocessor
Basic 8085 microprocessor architecture and its functional blocks, 8085 microprocessor IC pin outs and signals.

Unit 2: Programming with 8085
Assembly Language Programming Basics, Addressing Modes, Instruction set of microprocessor, Instruction timing diagram. Writing, Assembling & Executing Assembly Language Programs.

Unit 3: Interrupts
Interrupt structure of 8085 microprocessor, processing of vectored and non-vectored interrupts, latency time and response time; Handling multiple interrupts.

Unit 4: Interfacing Memory Interfacing
Interfacing with 8255 Programmable Peripheral Interface, 8254 Programmable Interval Timer, 8279 Display controller, Interrupt controller 8259.

Unit 5: Introduction of 8086 Microprocessor Detail Architecture of 8086, Addressing Modes, Assembler directives, Co-Processor.

TEXT/REFERENCE BOOKS:

1. Douglas V. Hall, Microprocessors & Interfacing, McGraw Hill International Edition, 1992.
2. Microprocessor-Architecture, programming and application with 8085, gaonkar, penram international.
3. M. A. Mazidi, The 8085 microcontroller & embedded system, using assembly and C, 2nd edi, pearsonedu.
4. Jonathan W Valvano, Embedded Microcomputer Systems: Real Time Interfacing, Cengage Learning, Jan2011.
5. David Calcutt, 8051 microcontrollers: Applications based introduction, Elsevier.
6. Udayashankara V., MallikarjunaSwamy, 8051 microcontroller,TMH.
7. K. J. Ayala, 8051 microcontroller, Cenage (Thomson).

2311372PC204L	Microprocessors Lab	01 Credit

List of Experiments:

1. 8-bit Addition, Subtraction, Multiplication and Division
2. 16-bit Addition, Subtraction, Multiplication and Division
3. Largest number in a data array
4. Smallest number in a data array
5. BCD to Hexadecimal and vice-versa
6. BCD to Binary Conversion and vice-versa
7. Move a data block without overlap
8. Counters and Time Delay

2311372PC206	Network Theory	03 Credit

Course Objectives:

1. To learn about the basic laws of electric circuits as well as the key fundamentals of the communication channels, namely transmission lines.
2. To understand the need of simplification techniques of complicated circuits To learn about the comprehensive insight into the principle techniques available for characterizing circuits, networks and their implementation in practice.
3. To learn about the use of mathematics, need of different transforms and usefulness of differential equations for analysis of networks.
4. To train the students for handling analog filter design through theory of NA along with practical, this is basic requirement of signal processing field.

Course Outcomes:

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

CO1: Apply knowledge of mathematics to solve numerical based on network simplification and it will be used to analyze the same.

CO2: Design passive filters and attenuators theoretically and practically.

CO3: To apply knowledge for design of active filters as well as digital filters and even extend this to advance adaptive filters.

CO4: Identify issues related to transmission of signals, analyze different RLC networks.

CO5: Find technology recognition for the benefit of the society.

Module 1- Network Theorems

Basic nodal and mesh analysis, linearity, superposition and source transformation, Thevinin‟s, Norton‟s and maximum power transfer theorem and useful circuit analysis techniques, network topology, introduction to SPICE in circuit analysis.

Module 2 Transient Analysis and Frequency Domain Analysis:

Transient Analysis: Source free RL and RC circuits, unit step forcing function, source free parallel and series RLC circuit, complete response of the RLC circuit, lossless LC circuit. Frequency Domain Analysis: The phasor concept, sinusoidal steady state analysis; AC circuit power analysis.

Module 3 Laplace transform and its circuit applications
Laplace transform, initial and final value theorem, circuit analysis in s domain, frequency esponse.

Module 4 Two Port Networks:
Two Port Networks: Z, Y, h and ABCD parameters, analysis of interconnected (magnetically coupled) two port, three terminal networks.

Module 5 State Variable Analysis and RL & RC Network Synthesis:
State Variable Analysis: State variables and normal-form equations, matrix-based solution of the circuit equations. RL & RC Network Synthesis: Synthesis of one-port networks, transfer function synthesis, basics of filter design.

TEXT/REFERENCE BOOKS:

1. Hayt, Kemmerley and Durbin, "Engineering Circuit Analysis", 8th 2012 Ed., Tata McGraw-Hill
2. DeCarlo, R.A. and Lin, P.M., "Linear Circuit Analysis: Time Domain, Phasor and Laplace Transform Approaches", Oxford University Press.2003.
3. M.E. Van Valkenburg, "Network Analysis", 3rd ed., Pearson2006.
4. M.E. Van Valkenburg, "Network Synthesis," PHI2007.
5. Kuo, F.F., "Network Analysis and Synthesis", 2nd Ed., Wiley India.2008.
6. D Roy Choudary, "Network and Systems" 1st edition, New Age International,1988
7. Boylestead, "Introductory Circuit Analysis", 4th edition, Charles & Merrill,1982.
8. Royal Signal Handbook on Line Communication.
9.

2311372PC206L	Network Theory Lab	03 Credits

1. Thevenin's, Norton's and Maximum Power Transfer Theorems
2. Superposition Theorem and RMS value of complex wave
3. Reciprocity and Millmann's Theorems
4. Locus Diagrams of RL and RC Series Circuits
5. Series and Parallel Resonance
6. Z and Y Parameters
7. Transmission and hybrid parameters
8. Measurement of Active Power for Star and Delta connected balanced loads
9. Measurement of Reactive Power for Star and Delta connected balanced loads
10. Simulation of DC Circuits
11. Mesh Analysis
12. Nodal Analysis
13. DC Transient response

2311372SE202	PCB Designing	02 Credits

Course Objectives:

1. To develop skills in starting projects, using design tools, and creating net lists.
2. To understand and implement PCB manufacturing techniques.
3 To find the faults and understand PCB assembly.
4. To understand Soldering Techniques and Quality Control
5. Learn to build accurate library parts for effective PCB layouts.

Course Outcomes:

Students will be able to develop projects using design tools and creating net lists.

CO1: Students will be able to find faults in the designs.
CO2: Students will be able to understand PCB assembly.
CO3: Students will be able to implement PCB manufacturing techniques.
CO4: Student will be able to build accurate library parts for effective PCB layouts.

Unit 1: Printed circuit Board Design:

Various types of Printed Circuit Boards: Single Sided Boards, Double Sided Plated through Hole Boards, multilayer Boards, and Process of PCB design and product development flow.

Schematic Design: Starting a project, Working with schematic design tools, Schematic drawing from circuit, Rules for PCB Design, Standards for PCB Design, Placing, editing, and connecting parts and electrical symbols, Creating a net list, Exporting and importing schematic data, Basic Circuit simulation using EDA tool.

Unit 2: PCB Layout Design

Study of technical terms in layout design, Board outline Design, components placement, Details of layers, Routing methods, Copper Pour, Adding reference texts, Build library parts (footprints, schematic symbols), Manufacturing Output files generation.

Unit 3: PCB Manufacturing Techniques

Film Master Generation method: Study of photographic Film, Properties of material used in Manufacturing of PCBs. Cleaning Method of base materials. PCB Manufacturing Methods: Method of Screen Printing for pattern transfer. Method of Wet film and Dry film for single and Double Sided Board Manufacturing. Plating, etching, punching, drilling, milling and routing.

Unit 4: **Study of-Fault Finding methods of PCBs**

Repairing techniques, De-soldering techniques, PCB Assembly Techniques: Components Preparation Method, Lead identification of components. Component mounting techniques, Lead Forming methods. Leaded through hole assembly and Surface Mount Assembly. Mixed Assembly Techniques of through hole and SMDs. Manual Assembly method, Semiautomatic and automatic Assembly method.

Unit 5: Soldering Techniques:

Materials used in Soldering Process. Types of soldering techniques. Soldering Methods – Manual and Mass soldering Techniques. Tools for soldering and de-soldering. Study of

soldering defect and rectification. Testing for quality control. Introduction to SMD soldering methods, placing methods of SMDs, study of material for SMD soldering. Rework and Repairing methods.

TEXT/REFERENCE BOOKS:

1. Printed Circuit Board Designer's Reference: Basics, by Christopher T. Robertson
2. Complete PCB Design Using OrCAD Capture and PCB Editor 2nd Edition, Kindle Edition, by Kraig Mitzner (Author), Bob Doe (Author), Alexander Akulin (Author), Anton Suponin (Author), Dirk Müller (Author).
3. PCB Design for Real-World EMI Control By: Bruce R. Archambeault (Author) , James Drewniak (Author) , Bruce R Archambeault (Author) | Publisher: Springer, 2002.

2311372AE204	Marathi/Hindi/Sanskrit/Gujarati/Kannada	02

2311372AE206	Patents and IPR	02 Credits

Course objectives

1. To explore the historical development and significance of patents in fostering innovation.
2. To familiarize students with the legal frameworks governing patents.
3. To Identify and evaluate the criteria for patentability, including novelty, non-obviousness, and industrial applicability.
4. To understand the role of prior art in the patent examination process.
5. To understand the challenges and opportunities associated with filing patents globally.

Course outcomes:

Students will be able to

CO1: Demonstrate proficiency in patent categorization and practical patent procedures.

CO2: Utilize patent databases effectively.

CO3: Grasp the significance of IPR and its historical context.

CO4: Stay updated on the latest IPR developments, especially in biological systems and computer software.

CO5: Apply acquired knowledge and problem-solving skills to real-world cases related to patents and IPR.

UNIT 1: Patents

Designs, Trade and Copyright, Classification of patents in India, Categories of Patent, Special Patents, Patent document, Granting of patent, Rights of a patent, Patent Searching, Patent Drafting, filing of a patent, different layers of the international patent system, Utility models.

UNIT 2: Patent Rights

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

UNIT 3: Overview of Intellectual Property

Introduction of IPR, Need for intellectual property right (IPR), IPR in India – Genesis and Development IPR in abroad.

UNIT 4: New Developments in IPR

Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge, Case Studies.

UNIT 5: Case studies:

Case studies related to patents and IPR

TEXT/REFERENCE BOOKS:

1. Feroz Ali, The Law of Patents, LexisNexis
2. Ronald D. Slusky, Invention Analysis and Claiming – A Patent Lawyer's Guide, Second Edition, American Bar Association, 2012.
3. Feroz Ali, The Touchstone Effect – The Impact of Pre-grant Opposition on Patents, LexisNexis, 2009.

2311372AE208	Constitution of India	02 Credits

Mandatory Courses (non-credit)

Universal declaration of Human Rights and Provisions of India, Constitution and Law, National Human Rights Commission and State Human Rights Commission.

Course Objectives:

1. To acquaint the students with legacies of constitutional development in India and help them to understand the most diversified legal document of India and philosophy behind it.
2. To make students aware of the theoretical and functional aspects of the Indian Parliamentary System.
3. To channelize students' thinking towards basic understanding of the legal concepts and its implications for engineers.
4. To acquaint students with latest intellectual property rights and innovation environment with related regulatory framework.
5. To make students learn about role of engineering in business organizations and e-governance.

Course Outcomes:

At the end of the course the students will

CO1: Identify and explore the basic features and modalities about Indian constitution.

CO2: Differentiate and relate the functioning of Indian parliamentary system at the center and state level.

CO3: Differentiate different aspects of Indian Legal System and its related bodies.

CO4: Discover and apply different laws and regulations related to engineering practices.
CO5: Correlate role of engineers with different organizations and governance models.

Constitution of India – Basic features and fundamental principles

The Constitution of India is the supreme law of India. Parliament of India can not make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. The Parliament of India has been empowered to amend the Constitution under Article 368, however, it cannot use this power to change the "basic structure" of the constitution, which has been ruled and explained by the Supreme Court of India in its historical judgments. The Constitution of India reflects the idea of "Constitutionalism" – a modern and progressive concept historically developed by the thinkers of "liberalism" – an ideology which has been recognized as one of the most popular political ideology and result of historical struggles against arbitrary use of sovereign power by state. The AICTE Model Curriculum for Mandatory Courses & Activities (Non-Credit) for Undergraduate Degree in Engineering & Technology 116 | Page historic revolutions in France, England, America and particularly European Renaissance and Reformation movement have resulted into progressive legal reforms in the form of "constitutionalism" in many countries. The Constitution of India was made by borrowing models and principles from many countries including United Kingdom and America. The Constitution of India is not only a legal document but it also reflects social, political and economic perspectives of the Indian Society. It reflects India's legacy of "diversity". It has been said that Indian constitution reflects ideals of its freedom movement, however, few critics have argued that it does not truly incorporate our own ancient legal heritage and cultural values. No law can be "static" and therefore the Constitution of India has also been amended more than one hundred times. These amendments reflect political, social and economic developments since the year 1950. The Indian judiciary and particularly the Supreme Court of India has played an historic role as the guardian of people. It has been protecting not only basic ideals of the Constitution but also strengthened the same through progressive interpretations of the text of the Constitution. The judicial activism of the Supreme Court of India and its historic contributions has been recognized throughout the world and it gradually made it "as one of the strongest court in the world".

Course Content :

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

13. Scheme of the Fundamental Right to Equality
14. Scheme of the Fundamental Right to certain Freedom under Article 19
15. Scope of the Right to Life and Personal Liberty under Article 21.

Suggested Readings:

1. Brij Kishore Sharma: Introduction to the Indian Constitution, PHI, New Delhi, latest edition.
2. Granville Austin: The Indian Constitution: Cornerstone of a Nation. 1966, Oxford Clarendon Press.
3. Subhash C. Kashyap: Our Constitution: An Introduction to India's Constitution and constitutional Law, NBT, 2018.
4. PM Bakshi: The Constitution of India, Latest Edition, Universal Law Publishing.
5. V.K. Ahuja: Law Relating to Intellectual Property Rights (2007)
6. Suresh T. Viswanathan: The Indian Cyber Laws, Bharat Law House, New Delhi-88
7. P. Narayan: Intellectual Property Law, Eastern Law House, New Delhi
8. Prabudh Ganguli: Gearing up for Patents: The Indian Scenario, Orient Longman.
9. BL Wadehra: Patents, Trademarks, Designs and Geological Indications.Universal Law Publishing - LexisNexis.
10. Intellectual Property Rights: Law and Practice, Module III by ICSI (only relevant sections)
11. Executive programme study material Company Law, Module II, by ICSI (The Institute of Companies Secretaries of India) (Only relevant sections i.e., Study 1, 4 and 36). https://www.icsi.edu/media/webmodules/publications/Company%20Law.pdf
12. Handbook on e-Governance Project Lifecycle, Department of Electronics & Information Technology, Government of India, https://www.meity.gov.in/writereaddata/files/eGovernance_Project_Lifecycle_Participant_Handbook-5Day_CourseV1_20412.pdf
13. Companies Act, 2013 Key highlights and analysis by PWC. https://www.pwc.in/assets/pdfs/publications/2013/companies-act-2013-key-highlights-and-analysis.pdf

Referred Case Studies:

- Keshavanand Bharati V. State of Kerala, AIR 1973 SC 1461.
- Maneka Gandhi V. Union of India AIR, 1978 SC 597.
- S.R. Bammai V. Union of India, AIR 1994 SC 1918.
- Kuldip Nayyar V. Union of India, AIR 2006 SC312.
- A.D.M. Jabalpur V. ShivkantShakla, AIR 1976 SC1207.
- Remshwar Prasad V. Union of India, AIR 2006 SC980.
- Keshav Singh in re, AIR 1965 SC 745.
- Union of India V. Talsiram, AIR 1985 SC 1416.
- Atiabari Tea Estate Co.V. State of Assam, AIR 1961SC232.
- SBP & Co. Vs. Patel Engg. Ltd. 2005 (8) SCC 618.
- Krishna Bhagya Jala Nigam Ltd. Vs. G. Arischandra Reddy (2007) 2 SCC 720.
- Oil & Natural Gas Corporation Vs. Saw Pipes Ltd. 2003 (4) SCALE 92 – 185.

**(Other relevant case studies can be consulted by the teacher as per the topic).

Prescribed Legislations:

1. Information Technology Act, 2000 with latest amendments.
2. RTI Act 2005 with latest amendments.
3. Information Technology Rules, 2000
4. Cyber Regulation Appellate Tribunal Rules, 2000

Suggested aid for Students and Pedagogic purpose

- RSTV debates on corporate law, IPR and patent issues
- NPTEL lectures on IPR and patent rights

Episodes of 10 -part mini TV series "Samvidhan: The Making of Constitution of India" by RSTV.

SEMESTER V

2311372PC307	Digital Signal Processing	04 Credit

Course Objectives:

1. To introduce students with transforms for analysis of discrete time signals and systems.
2. To understand the digital signal processing, sampling and aliasing.
3. To use and understand implementation of digital filters.
4. To understand concept of sampling rate conversion and DSP processor architecture.

Course Outcomes:

After successfully completing the course students will be able to

1. Understand use of different transforms and analyze the discrete time signals and systems.
2. Realize the use of LTI filters for filtering different real-world signals.
3. Capable of calibrating and resolving different frequencies existing in any signal.
4. Design and implement multistage sampling rate converter.
5. Design of different types of digital filters for various applications.

Module 1:

DSP Preliminaries: 07 Hours

Discrete time signals: Sequences; representation of signals on orthogonal basis; Sampling and reconstruction of signals, Basic elements of DSP and its requirements, advantages of Digital over Analog signal processing.

Module 2

Discrete Fourier Transform: 07 Hours

DTFT, Definition, Frequency domain sampling, DFT, Properties of DFT, circular convolution, linear convolution, Computation of linear convolution using circular convolution, FFT, decimation in time and decimation in frequency using Radix-2 FFT algorithm.

Module 3

Z transform: 07 Hours

Need for transform, relation between Laplace transform and Z transform, between Fourier Transform and Z transform, Properties of ROC and properties of Z transform, Relation between pole locations and time domain behaviour, causality and stability considerations for LTI systems, Inverse Z transform, Power series method, partial fraction expansion method, Solution of difference equations.

Module 4

IIR Filter Design: 07 Hours

Concept of analog filter design (required for digital filter design), Design of IIR filters from analog filters, IIR filter design by impulse invariance method, Bilinear transformation method. Characteristics of Butterworth filters, Chebyshev filters, Butterworth filter design, IIR filter realization using direct form, cascade form and parallel form, Lowpass, High pass,

Bandpass and Bandstop filters design using spectral transformation (Design of all filters using Low pass filter).

Module 5:

FIR Filter Design and introduction to MDSP: 07 Hours

Ideal filter requirements, Gibbs phenomenon, windowing techniques, characteristics and omparison of different window functions, Design of linear phase FIR filter using windows and frequency sampling method. FIR filters realization using direct form, cascade form and lattice form. Introduction to Multirate signal processing: Concept of Multirate DSP, Introduction to Up sampler, Down sampler and two channel filter banks, Application of Multirate signal processing in communication, Music processing, Image processing and Radar signal processing.

TEXT/REFERENCE BOOKS:

1. S. K. Mitra, Digital Signal Processing: A computer-based approach, TMH
2. A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall, 1989.
3. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Prentice Hall,1997.
4. L. R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, Prentice Hall,1992.
5. J. R. Johnson, Introduction to Digital Signal Processing, Prentice Hall, 1992.
6. J. DeFatta, J. G. Lucas and W. S. Hodgkiss, Digital Signal Processing, John Wiley & Sons, 1988.

2311372PC307L	Digital Signal Processing Lab	01 Credit

List of Experiments:

1. To find DFT / IDFT of given DT signal
2. Program to obtain Linear Convolution of two finite length sequences
3. Program for Computing auto correlation
4. To find frequency response of a given system(transfer function/ difference equation)
5. Implementation of FFT of given sequence
6. Determination of Power Spectrum of a given signal.
7. Implementation of LP FIR filter for a given sequence
8. Implementation of HP FIR filter for a given sequence
9. Implementation of LP IIR filter for a given sequence
10. Implementation of HP IIR filter for a given sequence
11. Generation of Sinusoidal signal through filtering
12. Generation of DTMF signals
13. Implementation of Decimation Process
14. Implementation of Interpolation Process
15. Implementation of I/D sampling rate converters
16. Impulse Response of First Order and Second Order Systems

2311372PC309	Electromagnetic Wave Theory	04 Credit

Course objectives:

1. To provide a foundational understanding of electromagnetic (EM) waves and various techniques of communication, preparing students for advanced study in communication
2. To introduce students to the basic laws of electromagnetics, vector calculus, and the formulation and application of Maxwell's equations in various media systems.
3. To impart knowledge on the propagation of uniform plane waves, including wave polarization, phase velocity, power flow, and the Poynting vector.
4. To familiarize students with practical applications of transmission lines, including the use of Smith charts for impedance matching and analysis.

Course outcomes:

CO1: Explain fundamental EM wave concepts and communication techniques.
CO2: Derive and solve transmission line equations; calculate propagation constant and characteristic impedance.
CO3: Understand and apply Maxwell's equations and boundary conditions.
CO4: Analyze uniform plane waves, wave polarization, phase velocity, and power flow.
CO1: Predict wave behavior at media interfaces, including reflection, refraction, and polarization.
CO5: Use Smith charts for impedance matching and transmission line analysis.

Module 1 Introduction and Transmission line: 7 hours

Introduction to EM waves and various techniques of communication, Equations of Voltage and Current on TX line, Equations of Voltage and Current on TX line, Propagation constant, Characteristic impedance and reflection coefficient, Impedance Transformation, Loss-less and Low loss Transmission line and VSWR, Power transfer on TX line, Smith Chart, Admittance Smith Chart, Applications of transmission lines.

Module 2 Maxwell's Equation: 7 hours

Basics of Vectors, Vector calculus, Basic laws of Electromagnetics, Maxwell's Equations, Boundary conditions at Media Interface.

Module 3 Uniform plane Wave: 7 hours

Uniform plane wave, Propagation of wave, Wave polarization, Pioncere 's Sphere, Wave propagation in conducting medium, Wave propagation and phase velocity, Power flow and Pointing vector, Surface current and power loss in a conductor.

Module 4 Plane wave at Media interface: 7 hours

Plane wave in arbitary direction, Plane wave at dielectric interface, Reflection and refraction at media interface, Total internal reflection, Polarization at media interface, Reflection from a conducting boundary.

REFERENCE BOOKS:

1. David K. Cheng, "Field and Wave Electromagnetics", 2nd Edition, Pearson Education India, 1989.
2. William H. Hayt, Jr. and John A. Buck, "Engineering Electromagnetics", 8th Edition.
3. David M. Pozar, "Microwave Engineering", 4th Edition, Wiley, 2011. McGraw-Hill Education, 2011.
4. Matthew N.O. Sadiku, "Elements of Electromagnetics", 6th Edition, Oxford University Press, 2014.

2311372PC311	Analog Communication	03 Credits

Course Objectives:

1. The fundamental principles of analog communication systems, including modulation techniques, signal transmission, and reception.
2. To analyze various analog modulation techniques such as amplitude modulation (AM), frequency modulation (FM), and phase modulation (PM), understanding their advantages, disadvantages, and applications.
3. To understand the process of signal transmission through analog communication channels, including the effects of noise, attenuation, and distortion, and methods to mitigate these effects.
4. To study the different demodulation techniques for extracting the original message signal from modulated carrier waves, such as envelope detection, synchronous detection, and coherent detection.
5. To comprehend the sources of noise and distortion in analog communication systems, such as thermal noise, intermodulation distortion, and phase noise, and strategies to minimize their effects.
6. To explore real-world applications of analog communication systems, including radio broadcasting, television transmission, and voice communication, understanding their technological evolution and current trends.

Course Outcomes:

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

CO1: To demonstrate a thorough understanding of analog modulation techniques, including amplitude modulation (AM), frequency modulation (FM), and phase modulation (PM), and their applications in communication systems.CO2: Choose specific modulation technique as per system requirement.

CO2: To analyze analog signals in both time and frequency domains, including their spectra, bandwidth, and modulation index, using mathematical tools and simulation software.

CO3: To acquire knowledge of demodulation techniques used to recover the original message signal from modulated carrier waves, such as envelope detection, synchronous detection, and coherent detection.

CO4: To understand the effects of noise and distortion on analog communication systems, including thermal noise, intermodulation distortion, and phase noise, and methods to mitigate these effects.

CO5: To enhance the critical thinking and problem-solving skills by analyzing trade-offs between different modulation techniques, channel bandwidth requirements, and system complexity, and proposing solutions to optimize system performance.

CO6: To enhance their critical thinking and problem-solving skills by analyzing trade-offs between different modulation techniques, channel bandwidth requirements, and system complexity, and proposing solutions to optimize system performance.

UNIT – 1 Introduction to Communication System **07 Hours**

Block schematic of communication system, Simplex and duplex systems, Modes of communication: Broadcast and point to point communication, Necessity of modulation, Classification of modulation, sampling theorem and pulse analog modulation, multiplexing: TDM, FDM.

UNIT – 2 Amplitude Modulation **07 Hours**

Introduction, Mathematical analysis and expression for AM, Modulation index, Frequency spectrum and bandwidth of AM, Power calculations, Generation of AM using nonlinear property, Low and high level modulation, Balance Modulator.

Types of AM: DSB-FC, DSB-SC, SSB-SC, ISB and VSB, their generation methods and comparison.

UNIT – 3 Angle Modulation **07 Hours**

Introduction, Mathematical analysis of FM and PM, Modulation index for FM and PM, Frequency spectrum and bandwidth of FM, Narrow band and wide band FM, Direct and indirect methods of FM generation, Pre emphasis and de-emphasis, Comparison of AM, FM and PM.

UNIT – 4 Radio Receivers and Demodulators **07 Hours**

Introduction, Performances characteristic of receivers: Sensitivity, Selectivity, Fidelity, Image frequency and IFRR, Tracking and Double spotting, TRF, Super heterodyne receivers, RF amplifier, Local oscillator and mixer, IF amplifier, AGC.

UNIT – 5 AM and FM Detectors and noise **07 Hours**

AM Detectors: Envelop detector and practical diode detector.

FM Detectors: Slope detector, phase discriminator and ratio detector.

Noise: Introduction, Sources of noise, Classification of noise, Noise calculations (thermal noise), SNR, Noise figure, Noise Factor, Noise Temperature.

TEXT/REFERENCE BOOKS:

1. Kennedy, "Electronics Communications Systems", McGraw-Hill New Delhi-1997, 4th Edition.
2. Anokh Singh, "Principles of communication engineering"S.Chand
3. Roddy&Coolen, "Electronic communication"PHI
4. Taub & Schilling "Principles of communication systems" Tata Mc GrawHill
5. Beasley & Miller, "Modern Electronic Communication", Prentice-Hall India-2006, 8th Edition.

6. Wayne Tomasi, "Electronic Communication Systems", Pearson Education-2005, 5th Edition.
7. R. G. Gupta, "Audio & Video Systems" Tata McGraw-Hill NewDelhi-2008.

2311372PC311L	Analog Communication Lab	03 Credits

1. Amplitude modulation and demodulation.
2. DSB-SC Modulator & Detector
3. SSB-SC Modulator & Detector (Phase Shift Method)
4. Frequency modulation and demodulation.
5. Spectrum analyzer and analysis of AM and FM signals
6. Pre-emphasis & de-emphasis.
7. Time Division Multiplexing & De multiplexing
8. Frequency Division Multiplexing & De multiplexing
9. Verification of Sampling Theorem
10. Pulse Amplitude Modulation & Demodulation

2311372PE301A	Fiber Optic Communication	03 Credits

Course Objectives:

1. To learn the basic elements of optical fiber transmission link, fiber modes configurations and structures.
2. To understand the different kind of losses, signal distortion in optical wave guides and other signal degradation factors.
3. To learn the various optical source materials, LED structures, quantum efficiency, Laser diodes
4. Understand the functionality of each of the components that comprise a fiber-optic communication system: transmitter, fiber, amplifier, and receiver.
5. Understand the properties of optical fiber that affect the performance of a communication link.
6. Understand basic optical amplifier operation and its effect on signal power and noise in the system.
7. Apply concepts listed above to the design of a basic communication link.

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

CO1: Understand the principles fiber-optic communication, the components and the bandwidth advantages.
CO2: Understand the properties of the optical fibers and optical components.
CO3: Understand operation of lasers, LEDs, and detectors.
CO4: Analyze system performance of optical communication systems.
CO5: Design optical networks and understand non-linear effects in optical fibers.

Module 1

Introduction:
Introduction to vector nature of light, propagation of light, propagation of light in a cylindrical dielectric rod, Ray model, wave model.

Module 2
Types of optical fibers:
Different types of optical fibers, Modal analysis of a step index fiber, Signal degradation on optical fiber due to dispersion and attenuation. Fabrication of fibers and measurement techniques like OTDR.

Module 3
Optical sources:
LEDs and Lasers, Photo-detectors - pin-diodes, APDs, detector responsively, noise, optical receivers. Optical link design - BER calculation, quantum limit, power penalties

Module 4
Optical switches and Optical amplifiers:
Coupled mode analysis of directional couplers, electro-optic switches. Optical amplifiers: EDFA, Raman amplifier, WDM and DWDM systems, Principles of WDM networks.

Module 5
Nonlinear effects in fiber optic links
Nonlinear effects in fiber optic links, Concept of self-phase modulation, group velocity dispersion and solition based communication.

TEXT/REFERENCE BOOKS:

1. J. Keiser, Fibre Optic communication, McGraw-Hill, 5th Ed. 2013 (Indian Edition).
2. T. Tamir, Integrated optics, (Topics in Applied Physics Vol.7), Springer-Verlag,1975.
3. J. Gowar, Optical communication systems, Prentice Hall India,1987.
4. S.E. Miller and A.G. Chynoweth, eds., Optical fibres telecommunications, Academic Press,1979.
5. G. Agrawal, Nonlinear fibre optics, Academic Press, 2nd Ed.1994.
6. G. Agrawal, Fiber optic Communication Systems, John Wiley and sons, New York,1997
7. F.C. Allard, Fiber Optics Handbook for engineers and scientists, McGraw Hill, New York (1990).

2311372PE301B	Control System	03 Credits

Course Objectives:
1. To introduce the elements of control system and their modeling using various Techniques.
2. To introduce methods for analyzing the time response, the frequency response and the stability of systems.

3. To introduce the concept of root locus, Bode plots, Nyquist plots.
4. To introduce the state variable analysis method.
5. To introduce concepts of PID controllers and digital and control systems.
6. To introduce concepts programmable logic controller.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

CO1: Understand the modeling of linear-time-invariant systems using transfer function and state-space representations.

CO2: Understand the concept of stability and its assessment for linear-time invariant systems.

CO3: Design simple feedback controllers.

Module 1

Introduction to control problem:

Industrial Control examples, Mathematical models of physical systems, Control hardware and their models, Transfer function models of linear time-invariant systems.

Feedback Control: Open-Loop and Closed-loop systems. Benefits of Feedback, Block diagram reduction techniques, Signal flow graph analysis.

Module 2

Time Response Analysis and Stability Analysis

Standard test signals, Time response of first and second order systems for standard test inputs. Application of initial and final value theorem, Design specifications for second-order systems based on the time-response.Concept of Stability, Routh-Hurwitz Criteria, Relative Stability analysis, Root-Locus technique. Construction of Root-loci, Dominant Poles, Application of Root Locus Diagram.

Module 3

Frequency-response analysis:

Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion, Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.

Module 4

Introduction to Controller Design:

Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems, Application of Proportional, Integral and Derivative Controllers, Designing of Lag and Lead Compensator using Root Locus and BodePlot.

Module 5

State variable Analysis:

Concepts of state variables, State space model. Diagonalization of State Matrix, Solution of state equations, Eigen values and Stability Analysis, Concept of controllability and observability, Pole-placement by state feedback, Discrete-time systems, Difference

Equations, State-space models of linear discrete-time systems. Stability of linear discretetime systems.

TEXT/REFERENCE BOOKS:

1. N. J. Nagrath and M. Gopal, "Control System Engineering", New Age International
2. Publishers, 5th Edition,2009.
3. Benjamin C. Kuo, "Automatic control systems", Prentice Hall of India, 7thEdition,1995.
4. M. Gopal, "Control System – Principles and Design", Tata McGraw Hill, 4th Edition, 2012.
5. Schaum"sOutlineSeries,"FeedbackandControlSystems"TataMcGraw-Hill,2007.
6. John J. D"Azzo& Constantine H. Houpis, "Linear Control System Analysis andDesign", Tata McGraw-Hill, Inc.,1995.
7. Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", Addison – Wesley, 1999.

2311372PE301C	Advanced Mobile Communication	03 Credits

Course objectives:

1. Introduce students to the principles of wireless communications and channel modeling.
2. Cover multiple access technologies, cellular processes such as call setup and handover, and teletraffic theory.
3. Discuss multicarrier modulation, cyclic prefix, and issues related to OFDM such as PAPR and frequency/timing offsets.
4. Introduce students to MIMO technology, including channel capacity, SVD, eigenmodes, spatial multiplexing, and diversity techniques like BLAST and Alamouti.
5. Familiarize students with the standards and technologies of 3G and 4G wireless communication systems including GSM, GPRS, WCDMA, LTE, and WiMAX.

Course outcomes:

CO1: Students will be able to model fast fading wireless channels using Rayleigh and Ricean models.

CO2: Students will be proficient in WSSUS channel modeling, calculating RMS delay spread, and understanding Doppler fading using Jakes model.

CO3: Students will be able to design and analyze CDMA systems using Walsh codes, PN sequences, and RAKE receivers.

CO4: Students will comprehend MIMO channel capacity, SVD, eigenmodes, and techniques like BLAST and Alamouti for spatial multiplexing and diversity.

CO5: Students will be familiar with the architecture, technologies, and standards of 3G and 4G wireless systems including GSM, GPRS, WCDMA, LTE, and WiMAX.

Module 1:

Wireless Communications and Diversity

Fast Fading Wireless Channel Modeling, Rayleigh/Ricean Fading Channels, BER Performance in Fading Channels, Diversity modeling for Wireless Communications, BER Performance Improvement with diversity, Types of Diversity – Frequency, Time, Space.

Module 2: Broadband Wireless Channel Modeling

WSSUS Channel Modeling, RMS Delay Spread, Doppler Fading, Jakes Model, Autocorrelation, Jakes Spectrum, Impact of Doppler Fading, Cellular Communications, Frequency reuse, Multiple Access Technologies, Cellular Processes - Call Setup, Handover etc., Teletraffic Theory.

Module 3: CDMA and OFDM

CDMA, Walsh codes, Variable tree OVSF, PN Sequences, Multipath diversity, RAKE Receiver, CDMA Receiver Synchronization, OFDM, Multicarrier Modulation and Cyclic Prefix, Channel model and SNR performance, OFDM Issues – PAPR, Frequency and Timing Offset Issues.

Module 4: MIMO and UWB

MIMO, MIMO Channel Capacity, SVD and Eigenmodes of the MIMO Channel, MIMO Spatial Multiplexing – BLAST, MIMO Diversity -Alamouti, OSTBC, MRT, MIMO - OFDM, UWB (Ultrawide Band), UWB Definition and Features, UWB Wireless Channels, UWB Data Modulation, Uniform Pulse Train, Bit-Error Rate Performance of UWB.

Module 5: 3G and 4G Wireless Standards

GSM, GPRS, WCDMA, LTE, WiMAX.

REFERENCE BOOKS:

1. Wireless Communications: Principles and Practice,Theodore S. Rappaport,Publisher: Pearson Education, ISBN: 978-0130422323
2. Fundamentals of Wireless Communication, David Tse and Pramod Viswanath, Publisher: Cambridge University Press, ISBN: 978-0521845274
3. Mobile Communications, Jochen Schiller, Publisher: Addison-Wesley, ISBN: 978 0321123817
4. Digital Communication over Fading Channels, Marvin K. Simon and Mohamed-Slim Alouini, Publisher: Wiley-Interscience, ISBN: 978-0471649533.

SEMESTER VI

2311372PC308	Analog Circuits	03 Credits

Course Objectives:

1. To understand characteristics of IC and Op-Amp and identify the internal structure.
2. To introduce various manufacturing techniques.
3. To study various op-amp parameters and their significance for Op-Amp.
4. To learn frequency response, transient response and frequency compensation technique for Op-Amp.
5. To analyze and identify linear and nonlinear applications of Op-Amp.

Course Outcomes:

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

CO1: Understand the characteristics of IC and Op-Amp and identify the internal structure.
CO2: Understand and identify various manufacturing techniques.
CO3: Derive and determine various performances-based parameters and their significance For Op-Amp.
CO4: Verify parameters after exciting IC by any stated method.
CO5: Analyze and identify the closed loop stability considerations and I/O limitations
CO6: Analyze and identify linear and nonlinear applications of Op-Amp.
CO7: Understand and verify results (levels of V & I) with hardware implementation.
CO8: Implement hardwired circuit to test performance and application for what it is being designed.

UNIT 1: Introduction to operational Amplifiers

Introduction to operational amplifiers: The difference amplifier and the ideal operational amplifier models, concept of negative feedback and virtual short; Analysis of simple operational amplifier circuits; Frequency response of amplifiers, Bode plots. Feedback: Feedback topologies and analysis for discrete transistor amplifiers; stability of feedback circuits using Barkhausen criteria.

UNIT 2: Linear applications of operational amplifiers:

Linear applications of operational amplifiers: Inverting and non-inverting amplifier configurations, voltage follower, summing, averaging scaling amplifier, difference amplifier, integrator, differentiator, instrumentation amplifiers, and Active filters.

UNIT 3: Non-linear applications of operational amplifiers:

Non-linear applications of operational amplifiers: Comparators, clippers and clampers; Linearization amplifiers; Precision rectifiers; Logarithmic amplifiers, multifunction circuits and true rms convertors.

UNIT 4: Oscillators

Waveform Generation: sinusoidal feedback oscillators; Relaxation oscillators, square triangle oscillators.

UNIT 5: Analog and Digital interface circuits:
Analog and Digital interface circuits: Analog-to-digital converters (ADC): Single slope, dual slope, successive approximation, flash type, Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, resistor string etc., V-F, I-V and V-I converter.

TEXT/REFERENCE BOOKS:

1. J. V. Wait, L. P. Huelsman and GA Korn, Introduction to Operational Amplifier theory and applications, 2nd edition, McGraw Hill, New York,1992.
2. J. Millman and A. Grabel, Microelectronics, 2nd edition, McGraw Hill,1988.P.
3. Horowitz and W. Hill, The Art of Electronics, 2nd edition, Cambridge University Press,1989.
4. A. S. Sedra and K.C. Smith, Microelectronic Circuits, Saunder's College Publishing, Edition IV.
5. Paul R. Gray & Robert G. Meyer, Analysis and Design of Analog Integrated Circuits, Wiley, 3 rdEdition.
6. Ramakant A. Gaikwad, "Op Amps and Linear Integrated Circuits", Pearson Education 2000.
7. Salivahanan and Kanchana Bhaskaran, "Linear Integrated Circuits", Tata McGraw Hill, India2008.
8. George Clayton and Steve Winder, "Operational Amplifiers", 5th EditionNewnes.
9. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", Tata McGrawHill.
10. Bali, "Linear Integrated Circuits", McGraw Hill 2008.Gray, Hurst, Lewise, Meyer,
11. "Analysis & Design of Analog Integrated Circuits", Wiley Publications on Education.

2311372PC308L	Analog Circuits Lab	01 Credit

List of Experiments:

1) Implement Single stage R-C coupled CE Amplifier and Plot its Frequency Response.
2) Determine frequency of oscillation of RC phase shift Oscillator.
3) Determine frequency of oscillation of Wien Bridge Oscillator.
4) Implement Inverting and Non-Inverting amplifier using Op-Amp 741/LM324 IC and determine the gain.
5) Implement Integrator and Differentiator using Op-Amp 741/LM324 IC and observe output waveform.
6) Implement Comparator using OpAmp 741/LM324 IC and observe output waveform.
7) Implement Schmitt Trigger using Op-Amp 741/LM351 IC and observe output waveform.
8) Implement Low Pass Filter (LPF) using Op-Amp 741/LM351 IC and plot frequency response curve.

9) Implement High Pass Filter (HPF) using Op-Amp 741/LM351 IC and plot frequency response curve.
10) Design Astable multivibrator using IC 555 timer and determine its frequency of operation.

2311372PC310	Digital Communication	03 Credits

Course Objectives:

1. To understand the building blocks of digital communication system.
2. To prepare mathematical background for communication signal analysis.
3. To understand and analyze the signal flow in a digital communication system.
4. To analyze error performance of a digital communication system in presence of noise and other interferences.
5. To understand concept of spread spectrum communication system.

Course Outcomes:

CO1: Analyze the performance of a baseband and pass band digital communication system in terms of error rate and spectral efficiency.

CO2: Perform the time and frequency domain analysis of the signals in a digital communication system.

CO3: Select the blocks in a design of digital communication system. 4. Analyze Performance of spread spectrum communication system.

Unit 1:

Digital Transmission of Analog Signal:

Introduction to Digital Communication System: Why Digital?, Block Diagram and transformations, Basic Digital Communication Nomenclature. Digital Versus Analog Performance Criteria, Sampling Process, PCM Generation and Reconstruction, Quantization Noise, Non-uniform Quantization and Companding, PCM with noise: Decoding noise, Error threshold, Delta Modulation, Adaptive Delta Modulation, Delta Sigma Modulation, Differential Pulse Code Modulation, LPC speechsynthesis.

Unit 2:

Baseband Digital Transmissions:

Digital Multiplexing: Multiplexers and hierarchies, Data Multiplexers. Data formats and their spectra, synchronization: Bit Synchronization, Scramblers, Frame Synchronization. Inter-symbol interference, Equalization.

Unit 3:

Random Processes:

Introduction, Mathematical definition of a random process, Stationary processes, Mean, Correlation & Covariance function, Ergodic processes, Transmission of a random process through a LTI filter, Power spectral density, Gaussian process, noise, Narrow band noise, Representation of narrowband noise in terms of in phase & quadrature components.

Unit 4:

Baseband Receivers:

Conversion of continuous AWGN channel to vector channel, Likelihood functions, Coherent Detection of binary signals in presence of noise, Optimum Filter, Matched Filter, Probability of Error of Matched Filter, Correlation receiver.

Unit 5:

Passband Digital Transmission & Spread Spectrum Techniques:

Pass band transmission model, Signal space diagram, Generation and detection, Error Probability derivation and Power spectra of coherent BPSK, BFSK and QPSK. Geometric representation, Generation and detection of - M-ary PSK, M-ary QAM and their error probability, Generation and detection of -Minimum Shift Keying,

Spread Spectrum Techniques: Introduction, Pseudo noise sequences, A notion of spread spectrum, Direct sequence spread spectrum with coherent BPSK, Signal space dimensionality & processing gain, Probability of error, Concept of jamming, Frequency hop spread spectrum.

TEXT/REFERENCE BOOKS:

1. Simon Haykin, "Digital Communication Systems", John Wiley & Sons, Fourth Edition.
2. A.B Carlson, P B Crully, J C Rutledge, "Communication Systems", Fourth Edition, McGraw Hill Publication.
3. Ha Nguyen, Ed Shwedyk, "A First Course in Digital Communication", Cambridge University Press.
4. B P Lathi, Zhi Ding "Modern Analog and Digital Communication System", Oxford University Press, Fourth Edition.
5. Bernard Sklar, Prabitra Kumar Ray, "Digital Communications Fundamentals and Applications" Second Edition, Pearson Education
6. Taub, Schilling, "Principles of Communication System", Fourth Edition, McGrawHill.
7. P Ramkrishna Rao, Digital Communication, Mc Graw Hill Publication.

2311372PC310L	Digital Communication Lab	01 Credits

List of Experiments:

1. Verification of Sampling Theorem.
2. Study of generation of Unipolar NRZ, Polar NRZ, Unipolar RZ and Polar RZ line code.
3. Study of generation and detection of Pulse Code Modulation (PCM).
4. Study of generation and detection of Delta Modulation.
5. Study of generation and detection of Amplitude Shift Keying (ASK).
6. Study of generation and detection of Phase Shift Keying (PSK).
7. Study of generation and detection of Frequency Shift Keying (FSK).
8. Analysis of the process of Time Division Multiplexing and demultiplexing

2311372PE302A	Digital Audio Processing	03 Credits

Course Objectives:

This course aims to provide students with a comprehensive understanding of audio and speech signal processing, equipping them with the knowledge and skills necessary to analyze, design, and implement various audio and speech processing systems and applications.

Course Outcomes:

At the end of this course, the students should be able to

CO1: Understand different characteristics of Audio signals.

CO2: Analyze different speech analysis and synthesis systems.

CO3: Write an algorithm for automatic speech recognition system

CO4: Design models and algorithms for audio and speech processing applications.

Unit 1:

Audio Signal Characteristics, Production model, Hearing and Auditory model, Acoustic characteristic of speech, Speech production models, Linear Separable equivalent circuit model, Vocal Tract and Vocal Cord Model

Unit 2:

Audio signal acquisition, Representation and Modelling, Enhancement of audio signals: Spectral Subtraction, Weiner based filtering, Neural nets

Unit 3:

Audio/ Speech Analysis and Synthesis Systems: Digitization, Sampling, Quantization and coding, Spectral Analysis, Spectral structure of speech, Autocorrelation and Short Time Fourier transform, Window function, Sound Spectrogram, Mel frequency Cepstral Coefficients, Filter bank and Zero Crossing Analysis, Analysis –by-Synthesis, Pitch Extraction., Linear Predictive Coding Analysis.

Unit 4:

Psychoacoustics, Multi-microphone audio processing: Room acoustics, Array beamforming. Acoustic sound source localization and tracking

Unit 5: Applications:

Principles of Automatic Speech Recognition (ASR),Theory and implementation of Hidden Markov Model (HMM) for ASR, Speaker Recognition, Evolution of Speech APIs, Natural Language Processing, Sound source separation models.

Text/References:

1. Sen, Soumya, Dutta, Anjan Dey, Nilanjan, Audio Processing and Speech Recognition,1st edition, 2019, Springer
2. Gold, B.; Morgan, N.; Ellis, D. Speech and audio signal processing: processing and perception of speech and music. 2nd rev. ed. Wiley-Blackwell, 2011.
3. Bali & Bali, Audio Video Systems, Khanna Book Publishing.
4. Sadaoki Furui, “Digital Speech Processing, Synthesis and Recognition” 2/e.

5. Rabiner and Schafer, “Digital Processing of Speech Signals”, Pearson Education

2311372PE302B	Digital Image Processing	03 Credits

Course Objectives:
An ability to use current techniques, skills, and tools necessary for computing practice with an understanding of the limitations

Course Outcomes: After completion of this course students will be able to
CO1: Review the fundamental concepts of digital image processing system
CO2: Analyze images in the frequency domain using various transforms.
CO3: Categories various compression techniques. 4. Interpret image segmentation and representation techniques.

Unit 1: Introduction:
Introduction to Digital Image Processing & Applications, Image Digitalization, Sampling, Quantization, Signal Reconstruction from Samples: Convolution Concept, Signal Reconstruction from Image using convolution, Basic Relationship Between Pixels: Relationship of Adjacency and Connected Components Labeling, Basic Transform: Translation, Rotation, Scaling, Image Formation

Unit 2: Image Transformation:
Image Geometry, Stereo Imaging Model, Interpolation and Resampling, Interpolation Techniques, Separable Transformation, Basis Images, Fourier transformation, Properties of FT, Rotation Invariance Property, DCT and Walsh Transform, Hadamard Transformation, KL-transform

Unit 3: Image Enhancement and morphological image processing:
Dilation, Erosion, Opening, Closing, Hit-miss transformation, Thinning, Thickening, Point Processing Techniques, Contrast Stretching Operation, Histogram Equalization, Histogram Implementation, Mask Processing Techniques: Linear smoothing filter, median filter, sharpening filter, Unsharp masking, High boost filter, first order derivative operator, Frequency Domain Processing Techniques: Smoothening (Ideal low pass filter, Butterworth LPF), Sharpening filters: (Ideal high pass filter, Butterworth HPF), Laplacian mask

Unit 4: Image Restoration and colour image processing:
Image restoration techniques: Inverse filtering, minimum mean square error (wiener) filtering, constrained least square filter, difference between image enhancement and image restoration, Image formation process, Estimation of degradation Model: by observation, by experimentation, Mathematical modeling, Primary and Secondary colours, colour characteristics, chromaticity diagram, RGB colour model, HIS colour model, conversion from one model to another, Pseudo color image processing

Unit 5: Image Segmentation and Object Recognition

Different approaches for image segmentation: discontinuity based (point, line and edge detection) and region based, global thresholding, local thresholding, Adaptive thresholding, Edge detection: Roberts operator, prewitt operator, sobel operator, Laplacian operator, linking of edge points: local processing and global processing (Hough transform), region based segmentation: region growing technique, region merging and splitting technique, object recognition.

TEXT/REFERENCE BOOKS:

1. Rafael C. Gonzalez and Woods, "Digital Image Processing", Addison Wesley,1998
2. A. K. Jain, "Digital Image Processing", PHI, New Delhi, 1997
3. Pratt W.K., "Digital Image Processing", 2nd Edition, John Wiley, New York,2001
4. Edward R. Dougherty, "Random Processes for Image and Signal Processing",PHI-2001.

2311372PE302C	Introduction to Adaptive Signal Processing	03 Credits

Course Objectives:

1. Provide a foundational understanding of adaptive filters and their significance in various real-world applications.
2. Develop the necessary mathematical concepts within the course to ensure students with minimal prerequisites can follow and understand the material.
3. Illustrate the close relationship between adaptive filters, neural networks, and machine learning.
4. Prepare students for advanced studies in adaptive filters and related fields by equipping them with the essential knowledge and skills.

Course Outcomes:

By the end of this course, students will be able to:

CO1: Understand Basic Principles of Adaptive Filters: Explain the core concepts of adaptive filters and their importance in signal processing and related fields.

CO2: Identify Real-World Applications: Recognize and describe various applications of adaptive filters in areas such as radar, sonar, wireless communications, speech and audio processing, instrumentation, and exploration geophysics.

CO3: Develop Necessary Mathematical Skills: Apply basic concepts from linear algebra, probability, and random variables as they relate to adaptive filters, developed within the context of the course.

CO4: Explore Connections to Neural Networks and Machine Learning: Describe the relationship between adaptive filters, neural networks, and machine learning, and understand how these fields intersect.

CO5: Prepare for Advanced Studies: Demonstrate readiness for further study in adaptive filters and related subjects, having gained a solid introductory understanding and foundational skills.

Unit 1: Basic principle of adaptive filtering and estimation; probability, random variables, conditional and joint probability densities, statistical independence, correlation and covariance.

Unit 2: Complex random variables, random vectors, correlation and covariance matrices, properties of Hermitian matrices (e.g., correlation / covariance matrices), positive definite forms, multivariate Gaussian density

Unit 3: Concepts of random processes, wide sense stationary (WSS) processes and their correlation structures, power spectral density, parametric modeling of WSS processes – AR, MA and ARMA processes. Optimal FIR filters, real and complex valued optimal filters, method of steepest descent

Unit 4: Least mean square (LMS) algorithm; convergence of LMS algorithm; normalized LMS, affine projection. Examples of adaptive filters : channel equalization, echo cancellation, interference cancellation, line enhancement, beamforming etc.

Unit 5: Limitations of LMS algorithm, formulation of recursive least squares (RLS) based adaptive filters, Moore-Penrose pseudo inverse, matrix inversion lemma. Development of the RLS transversal adaptive filter, properties, variants of the RLS family.

Books and references

1. "Adaptive Filters", S. Haykin, Prentice-Hall India
2. "Adaptive Filters", A. H. Sayed, Wiley-Interscience, New York, USA
3. "Adaptive Filters : Theory and Applications", B. Farhang-Boroujeny, Wiley, New York, USA

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course	Name Instructor	Host Institute
1.	Introduction To Adaptive Signal Processing	Prof. Mrityunjoy Chakraborty	IIT Kharagpur

2311372PE304A Microwave Theory & Techniques 03 Credits

Course Objectives:

1. To lay the foundation for microwave engineering
2. To understand the applications of microwave engineering
3. Carryout the microwave network analysis.

Course Outcomes: After successfully completing the course students will be able to

CO1: Formulate the wave equation in wave guide for analysis.
CO2: Identify the use of microwave components and devices in microwave applications.
CO3: Understand the working principles of all the microwave tubes
CO4: Understand the working principles of all the solid state
CO5: Choose a suitable microwave tube and solid state device for a particular application
CO6: Carry out the microwave network analysis
CO7: Choose a suitable microwave measurement instruments and carry out the required measurements.

Unit 1: Transmission Lines and Waveguides

Introduction to Microwaves engineering: History of Microwaves, Microwave Frequency bands, Applications of Microwave, General solution for TEM, TE and TM waves, Parallel plate waveguide, and rectangular waveguide, Wave guide parameters, Introduction to coaxial line, Rectangular waveguide cavity resonators, Circular waveguide cavity resonators.

Unit 2: Microwave Components

Multi-port junctions: Construction and operation of E-plane, H-plane, Magic Tee and Directional couplers. Ferrites components: - Ferrite Composition and characteristics, Faraday rotation, Construction and operation of Gyrator, Isolator and Circulator. Striplines: Structural details and applications of Striplines, Microstrip line, Parallel Strip line, Coplanar Strip line, Shielded Strip Line.

Unit 3: Microwave Network Analysis

Introduction and applications of Impedance and Equivalent voltages and currents, Impedance and Admittance matrices, The Transmission (ABCD) matrix Scattering Matrix:-Significance, formulation and properties. S-Matrix calculations for-2 port network junction, E plane, H-plane and E-H (Magic Tee) Tees, Directional coupler, Isolator and Circulator, Related problems.

Unit 4: Microwave Tubes

Limitations of conventional tubes, O and M type classification of microwave tubes, reentrant cavity, velocity modulation, O **type tubes, Two cavity Klystron:** Construction and principle of operation, velocity modulation and bunching process Applegate diagram, **Reflex Klystron:** Construction and principle of operation, velocity modulation and bunching process, Applegate diagram, Oscillating modes, o/p characteristics, efficiency, electronic & mechanical tuning, **M-type tubes, Magnetron:** Construction and Principle of operation of 8 cavity cylindrical travelling wave magnetron, hull cutoff condition, modes of resonance, PI mode operation, o/p characteristics, Applications. **Slow wave devices**, **Advantages of slow wave devices, Helix TWT:** Construction and principle of operation, Applications.

Unit 5: Microwave Solid State Devices

Microwave bipolar transistor, FET, MESFET, Varactor Diode, PIN Diode, Shottky Barrier Diode, Tunnel Diode, TEDs, Gunn Diodes, IMPATT diode and TRAPATT diode. Structural details, Principle of operation, various modes, specifications, and applications of all these devices.

Unit 6: Microwave Measurements

Measurement devices: Slotted line, Tunable detector, VSWR meter, Power Meter, Sparameter measurement, frequency measurements, Power measurement, Attenuation measurement, Phase shift measurement, VSWR measurement, Impedance measurement, Q of cavity resonator measurement.

TEXT/REFERENCE BOOKS:

1. Samuel Y. Liao, “Microwave Devices and Circuits”, 3rd edition, Pearson
2. David M. Pozar, “Microwave Engineering", Fourth edition, Wiley.
3. M. Kulkarni, “Microwave and Radar engineering”, 3rd edition, Umesh Publications
4. M L Sisodia & G S Raghuvamshi, “Microwave Circuits and Passive Devices” Wiley, 1987
5. M L Sisodia & G S Raghuvanshi, “Basic Microwave Techniques and Laboratory
6. Manual”, New Age International (P) Limited, Publishers.

2311372PE304B	RF Circuit Design	03 Credits

Course Objectives:

1. To study RF issues related to active and passive components.
2. To study circuit design aspects at RF
3. To learn design and modeling of circuits at RF.

Course Outcomes: After successfully completion of the course students will be able to

CO1: Understand behavior of passive components at high frequency and modeling of HF circuit.

CO2: Design HF amplifiers with gain bandwidth parameters.

CO3: Understand Mixer types and characteristics.

CO4: Gain the knowledge about PLLs and Oscillators with respect to their circuit topologies.

Unit 1: RF Behaviour of Passive Components

HF Resistors, HF Capacitors, HF Inductors, Chip Components. Circuit Board Considerations: Chip Resistors, Chip Capacitors, Surface Mounted Inductors.

Unit 2: Bandwidth Estimation

Open Circuit Time Constant Method: Observations & Interpretations, Accuracy of OC τs, Considerations, and Design examples. Short Circuit Time Constant Method: Background, Observations & Interpretations, Accuracy of SC τs, Considerations. Delay of a system in cascade, Rise time of systems in cascade, Relation between Rise Time and Bandwidth.

Unit 3: High Frequency Amplifier Design

Shunt Peaked Amplifier, Shunt Series peak Amplifier, Two port bandwidth enhancement, Design example. Bandwidth enhancement techniques. Tuned Amplifier: Common Source Amplifier with Single Tuned Load, Analysis of Tuned Amplifier. Neutralization and uni lateralization. Characteristics of RF amplifier. Amplifier power relations. Stability considerations. Stabilization methods.

Unit 4: Low Noise Amplifier Design

MOSFET two port noise parameters, LNA topologies, Power-constrained noise optimization. Design examples: Single ended LNA, Differential LNA. Linearity and large signal performance. Spurious free dynamic range.

Unit 5: Oscillators

Problem with Purely Linear Oscillators, Describing Functions, Describing Function for MOS. Colpitts Oscillator: Describing Function Model and Start-up Model of Colpitts Oscillator. Resonators: Quarter-Wave Resonators, Quartz Crystals. Tuned Oscillators: Basic LC Feedback Oscillators, Crystal Oscillator. Negative Resistance Oscillator.

Unit 6: Mixers

Mixer Fundamentals. Significant Characteristics of Mixer: Conversion Gain, Noise Figure, Linearity and Isolation, Spurs. Non Linear Systems as Linear Mixers. Multiplier Based Mixers: Single Balanced Mixer, Linearization techniques of Mixer, Active Double Balanced Mixer. Passive Double Balanced Mixer, Diode Ring Mixers.

TEXT/REFERENCE BOOKS:

1. Reinhold Ludwig, Pavel Bretchko, "RF Circuit Design Theory and Applications", Pearson Education.
2. Thomas H. Lee, "The Design of CMOS Radio-Frequency Integrated Circuits", Second Edition, Cambridge Publications.
3. T. Yettrdal, Yunhg Cheng, "Devices modeling for analog and RF COMS circuits design", John Wiley publication.
4. Calvin Plett, "Radio frequency Integrated Circuits Design", Artech house.

2311372PE304C	Wireless Sensor Networks	03 Credits

Course Objectives:

1. To introduce the emerging research areas in the field of wireless sensor networks
2. To understand different protocols and there uses in WSN.
3.

Course Outcomes: At the end of the course the students will be able to

CO1: Design wireless sensor networks for a given application
CO2: Understand emerging research areas in the field of sensor networks
CO3: Understand MAC protocols used for different communication standards used in WSN
CO4: Explore new protocols for WSN.

Unit 1: Introduction:

Introduction to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks, Types of wireless sensor networks.

Unit 2: Networks:
Mobile Ad-hoc Networks (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks. Issues and challenges in wireless sensor networks.

Unit 3: Protocols:
Routing protocols, MAC protocols: Classification of MAC Protocols, S-MAC Protocol, B- MAC protocol, IEEE 802.15.4 standard and ZigBee.

Unit 4: Dissemination protocol:
Dissemination protocol for large sensor network, Data dissemination, data gathering, and data fusion; Quality of a sensor network; Real-time traffic support and security protocols.

Unit 5: Design Principles for WSNs:
Design Principles for WSNs, Gateway Concepts Need for gateway, WSN to Internet Communication, and Internet to WSN Communication. Single-node architecture, Hardware components & design constraints, Operating systems and execution environments.

TEXT/REFERENCE BOOKS:

1. WaltenegusDargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks Theory and Practice", By John Wiley & Sons Publications,2011.
2. SabrieSoloman, "Sensors Handbook" by McGraw Hill publication.2009
3. Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks", ElsevierPublications,2004
4. KazemSohrby, Daniel Minoli, "Wireless Sensor Networks": Technology, Protocols and Applications, Wiley-Interscience
5. Philip Levis, And David Gay "Tiny OS Programming" by Cambridge University Press 2009.

2311372SE304	Basic Concepts of Film & Video Editing	03 Credits

Course Objectives:

1. Provide an overview of the history and evolution of film editing, including its invention and significant milestones.
2. Explore the impact of editing on the language of cinema and how it shapes narrative and emotional engagement.
3. Teach the fundamental technical skills required for effective film editing, including the basic joining of shots.
4. Introduce students to advanced concepts in editing, such as complex narrative structures and the psychological effects of editing choices.
5. Enable students to apply these concepts and techniques practically, culminating in the ability to edit their own simple narrative film.

Course Outcomes:

By the end of this course, students will be able to:

CO1: Understand the Historical Context of Film Editing: Articulate the historical development of film editing and its role in the evolution of cinema.

CO2: Recognize the Impact of Editing on Storytelling: Analyze how different editing techniques influence the narrative flow and emotional impact of a film.

CO3: Demonstrate Technical Proficiency: Apply technical knowledge to perform basic editing tasks, including cutting and joining shots.

CO4: Construct Complex Narratives: Utilize editing techniques to build and understand complex narrative structures in film.

CO5: Produce a Simple Narrative Film: Independently edit a simple narrative film, showcasing an understanding of both technical skills and creative storytelling.

Unit 1:

Basic Concepts of Editing, Creative Role of the Editor.

Unit 2:

Basic Aspects of Film Editing, Techniques of Joining Two Shots, Match Cut, Invisible Cut etc, Imaginary Line, 30 Degree Rule etc, Methods and techniques.

Unit 3:

Narrativisation, Digital Editing Software and Equipment, Editing Basics.

Unit 4:

FCP Introduction, Interface, Capturing and Transferring Video, Basic editing Functions, Image Sizes, Settings and Motion Tab.

Unit 5:

Manipulations, Audio, Key Framing and Text, Colour Correction & Chroma Keying, Short Cuts and Exports.

Books and references

1. Walter Murch; “In the blink of an Eye”.
2. Ken Dancyger; “The Technique of Film and Video Editing”.
3. Edward Dmytryk; “On Film Editing”; ‘An introduction to the Art of Film Construction’.
4. Sergei Eisenstein; “Film Form”; ‘Essays in Film Theory and the Film Sense’.
5. Vincent LoBrutto; “Selected Takes”; ‘Film Editors on Editing’.
6. David Mamet; “On Directing Film”.
7. Richard d. Pepperman; “The Eye is Quicker”.
8. Bobbie O’Steen; “The Invisible Cut”.
9. Karel Reisz, Gavin Millar; “The Technique of Film Editing”.
10. Roger Critttenden; “Fine Cuts”.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course	Name Instructor	Host Institute
2.	Basic Concepts of Film & Video Editing	Saikat Sekhareswar Ray	Satyajit Ray Film & Television Institute

FINAL YEAR
SEMESTER VII

2311372PC313	Computer Networks	03 Credits

Course Objectives:

1. To develop an understanding of modern network architectures from a design and performance perspective.
2. To introduce the student to the major concepts involved in wide-area networks (WANs), local area networks (LANs) and Wireless LANs (WLANs).
3. To provide an opportunity to do network programming
4. To provide a WLAN measurement idea.

Course Outcomes:

CO1: To master the terminology and concepts of the OSI reference model and the TCP-IP reference model.
CO2: To master the concepts of protocols, network interfaces, and design/performance issue s in local area networks and wide area networks.
CO3: To be familiar with wireless networking concepts.
CO4: To be familiar with contemporary issues in networking technologies.
CO5: To be familiar with network tools and network programming.
CO6: For a given requirement (small scale) of wide-area networks (WANs), local area networks (LANs) and Wireless LANs (WLANs) design it based on the market available component.
CO7: For a given problem related TCP/IP protocol developed the network programming.
CO8: Configure DNS DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls using open source available software and tools.

Unit 1:
Physical Layer:
Data Communications, Networks, Network types, Protocol layering, OSI model, Layers in OSI model, TCP / IP protocol suite, Addressing, Guided and Unguided Transmission media. Switching: Circuit switched networks, Packet Switching, Structure of a switch.

Unit 2:
Data Link Layer:
Introduction to Data Link Layer, DLC Services, DLL protocols, HDLC, PPP, Media Access Control: Random Access, Controlled Access, Channelization. Wired LAN: Ethernet Protocol, Standard Ethernet, Fast Ethernet, Giagabit Ethernet, 10 Gigabit Ethernet.

Unit 3:
Wireless LANS & Virtual Circuit Networks and Network Layer:

Introduction, Wireless LANS: IEEE 802.11 project, Bluetooth, Zigbee, connecting devices and Virtual LANS: Connecting devices, Virtual LANS. Network Layer: Switching, Logical addressing – IPV4, IPV6; Address mapping – ARP, RARP, BOOTP and DHCP–Delivery, Forwarding and Unicast Routing protocols.

Unit 4:

Transport Layer:

Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), SCTP Congestion Control; Quality of Service, QoS improving techniques: Leaky Bucket and Token Bucket algorithm.

Unit 5:

Application Layer:

Domain Name Space (DNS), DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls, Basic concepts of Cryptography.

TEXT/REFERENCE BOOKS:

1. Data Communication and Networking, 4th Edition, Behrouz A. Forouzan,McGraw-Hill.
2. TCP/IP Protocol Suite, 4th Edition, Behrouz A. Forouzan, TataMcGraw-Hill.
3. Data and Computer Communication, 8th Edition, William Stallings, Pearson Prentice HallIndia.
4. Computer Networks, 8th Edition, Andrew S. Tanenbaum, Pearson New International Edition.
5. Internetworking with TCP/IP, Volume 1, 6th Edition Douglas Comer, Prentice Hall of India.
6. TCP/IP Illustrated, Volume 1, W. Richard Stevens, Addison-Wesley, United States of America.

2311372PC313L	Computer Networks Lab	01 Credits

List of Experiments: (Perform any 9 – 10 Experiments)

1. Study of different types of Network cables and Practically implement the cross-wired cable and straight through cable using clamping tool.
2. Study of Network Devices in Detail.
3. Study of network IP.
4. Connect the computers in Local Area Network.
5. Study of basic network command and Network configuration commands.
6. Performing an Initial Switch
7. Configuration Performing an Initial Router Configuration
8. Configuring and Troubleshooting a Switched Network
9. Connecting a Switch
10. Configuring WEP on a Wireless Router
11. Using the Cisco IOS Show Commands

12. Examining WAN Connections
13. Interpreting Ping and Traceroute Output
14. Demonstrating Distribution Layer Functions
15. Placing ACLs
16. Exploring Different LAN Switch Options
17. Implementing an IP Addressing Scheme
18. Examining Network Address Translation (NAT)
19. Observing Static and Dynamic Routing
20. Configuring Ethernet and Serial Interfaces
21. Configuring a Default Route
22. Configuring Static and Default Routes
23. Configuring RIP
24. Planning Network-based Firewalls
25. Configuring a Cisco Router as a DHCP Server
26.

2311372PC313	Antennas and Wave Propagation	03 Credits

Course Objectives:

1. To understand the applications of electromagnetic engineering.
2. To formulate and solve the Helmholtz wave equation and solve it for Uniform Plane Wave.
3. To analyze and understand the Uniform plane wave propagation in various media.
4. To solve the electric field and magnetic fields for a given wire antenna.

Course Outcomes:

After successfully completing the course students will be able to

CO1: Formulate the wave equation and solve it for uniform plane wave.
CO2: Analyze the given wire antenna and its radiation characteristics.
CO3: Identify the suitable antenna for a given communication system.

UNIT 1: Wave Propagation

Fundamental equations for free space propagation, Friis Transmission equation, Attenuation over reflecting surface, Effect of earth‟s curvature. Ground, sky & space wave propagations. Structure of atmosphere. Characteristics of ionized regions. Effects of earth‟s magneticfield. Virtual height, MUF, Skip distance. Ionospheric abnormalities. Multi-hop propagation. Space link geometry. Characteristics of Wireless Channel: Fading, Multipath delay spread, Coherence Bandwidth, and CoherenceTime.

UNIT 2: Antenna Fundamentals and Wire Antennas

Introduction, Types of Antenna, Radiation Mechanism, Antenna Terminology: Radiation pattern, radiation power density, radiation intensity, directivity, gain, antenna efficiency, half

power beam width, bandwidth, antenna polarization, input impedance, antenna radiation efficiency, effective length, effective area, reciprocity. Radiation Integrals: Vector potentials A, J, F, M, Electric and magnetic fields electric and magnetic current sources, solution of inhomogeneous vector potential wave equation, far field radiation.

Wire Antennas: Analysis of Linear and Loop antennas: Infinitesimal dipole, small dipole, and finite length dipole half wave length dipole, small circular loop antenna. Complete Analytical treatment of all these elements.

UNIT 3: Antenna Arrays

Two element array, pattern multiplication N-element linear array, uniform amplitude and spacing, broad side and end-fire array, N-element array: Uniform spacing, non-uniform amplitude, array factor, binomial and DolphTchebyshev array. Planar Array, Circular Array, Log Periodic Antenna, Yagi Uda Antenna Array.

UNIT 4: Concepts of Smart Antennas

Introduction, Smart Antenna Analogy, Cellular Radio System Evolution, benefits and drawbacks of smart antennas, fixed weight beam forming basics, Antenna beamforming.

UNIT 5: Antennas and Applications

Structural details, dimensions, radiation pattern, specifications, features and applications of following Antennas: Hertz & Marconi antennas, V- Antenna, Rhombic antenna. TW antennas. Loop antenna, Whip antenna, Biconical, Helical, Horn, Slot, Microstrip, Turnstile, Super turnstile & Lens antennas. Antennas with parabolic reflectors.

Text /Reference Books:

1. Shevgaonkar, R. K., "Electromagnetic waves", Tata McGraw-Hill Education, 2006.
2. Balanis, Constantine A., "Antenna theory: analysis and design", John wiley& sons,2016.
3. Mathew N O Sadiku, "Elements of Electromagnetics" 3rd edition, Oxford University Press.
4. John D Kraus, Ronald J Marhefka, Ahmad S Khan, Antennas for All Applications, 3rd Edition, the McGraw Hill Companies.
5. K. D. Prasad, "Antenna & Wave Propagation", SatyaPrakashan, NewDelhi.
6. John D Kraus, "Antenna& Wave Propagation", 4th Edition, McGraw Hill,2010.
7. Vijay K Garg, Wireless Communications and Networking, Morgan Kaufmann Publishers, An Imprint of Elsevier, 2008.

2311372PE403A	Biomedical Electronics	03 Credits

Course Objectives:

PEO I	1	Have a basic understanding of medical terminology, relevant for biomedical instrumentation.
PEO II	1	Explain and describe different diagnostic measurement methods for different

human variables and their necessary instrumentation.

2 Explain and describe different therapeutic methods of treatment where electrical medical equipment is a vital part of the method and their necessary instrumentation.

3 Explain and describe different diagnostic measurement methods for identification of humane bio-potentials and their necessary instrumentation.

4 Understand and describe the physical and medical principles used as a basis for biomedical instrumentation.

PEO V 1 Understand the elements of risk for different instrumentation methods and basic electrical safety.

2 Understand the position of biomedical instrumentation in modern hospital care.

CourseOutcomes:

After successfully completing the course students will be able to

CO1: Build an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

CO2: Develop an understanding of biology and physiology.

CO3: Enhance the capability to apply advanced mathematics (including differential equations and statistics), science, and engineering to solve problems at the interface of engineering and biology CO4: Discuss about the latest developments in medical imaging systems.

CO4: Build an ability to make measurements on and interpret data from living systems.

CO5: Develop an ability to address problems associated with the interaction between living and non-living materials and systems.

CO6: Analyze and evaluate the effect of different diagnostic and therapeutic methods, their risk potential, physical principles, opportunities and possibilities for different medical procedures

CO7: Explain the different medical imaging systems, compare advantages and disadvantages, understand the limitations and find the best suitable method for different pathological diagnoses.

UNIT 1:

Introduction to Electrophysiology and Cell Structure

Bioelectric signals: EEG, ECG, EMG, EOG, Muscle cell and nerve cell actions, resting potentials

UNIT 2:

Central Nervous and Cardio-Vascular System

Receptors, Motor systems, Neural and neuromuscular measurements, Evoked response of EEG, Structure of Heart, Rhythmicity, Pacemaker cells, ECG theory, Electrocardiograph, Measurement of blood pressure and blood flow, ECG electrodes, Life saving devices: Pacemaker, Defibrillators.

UNIT 3:

Bio-signal Amplifiers and Signal Processing

Electrodes and transducers for biomedical applications, Basic requirements of op-Amp circuits and instrumentation amplifiers in biomedical applications, ECG data acquisition and biomedical signal processing.

UNIT 4:

Intensive Care Instrumentation and Patient Safety

Bedside and central station monitoring systems, Introduction to bio-medical telemetry, Surgical Diathermy, Physiological effects of electricity, Macroshock and Microshock hazards, Basic approaches to protection against shock.

UNIT 5:

Imaging and Display System

X-ray machine, CT-scanners, Ultrasound scanner, Nuclear methods, Recorders and displays: Inkjet, Thermal array, Fiber optic face plate CRT, Non fade CRO

UNIT 6:

Clinical Laboratory Equipment

Calorimeter, Spectro- photometers, Auto analyzers, Blood cell counter, Blood gas analyzers

REFERENCE BOOKS:

1. Leslie Cromwell, Fred Weibell and Erich A Pfeiffer, "Biomedical Instrumentation and Measurement", PHI
2. R. S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill
3. Jacobson and Webster, "Medicine and Clinical Engineering", PHI
4. Carr and Brown, "Introduction to Biomedical Equipment Design", John Wiley.

2311372PE403B	Embedded System Design	03 Credits

Course Objectives:

1. Understand Embedded Systems
2. Embedded C Programming
3. Interfacing Techniques
4. Communication Protocols
5. Real-Time Operating Systems (RTOS)

Course Outcomes:

CO1: System Classification: Students will be able to classify and differentiate embedded systems from general computing systems

CO2: Efficient Programming: Students will write efficient and optimized Embedded C programs tailored for specific hardware.

CO3: Protocol Implementation: Students will implement and troubleshoot communication protocols in embedded applications

CO4: RTOS Integration: Students will integrate and manage real-time operating systems in embedded solutions, handling tasks, resources, and events efficiently.

Unit I: Introduction to Embedded systems

Introduction to Embedded Systems, Architecture of Embedded System, Classification of Embedded system, Core of Embedded system, RISC vs CISC controllers, Harvard vs VanNeumen architecture.

Unit II: Embedded C Programming

Introduction to Embedded C, Data Types and Variables, Complex Data Types, Data Type Modifiers, Storage Class Modifiers, C Statements, Structures, and Operations, Libraries, Optimizing and Testing Embedded C Programs.

Unit III: Interfacing Sensors and peripherals using Embedded C

Sensors and Signal Conditioning Circuits amplifiers/attenuators/filters /comparators/ADC and DAC), Interfacing with GLCD/TFT display, Relays and Drivers for interfacing Motors (DC and stepper), Interfacing with BLDC motors and drivers, USB/HDMI camera interfacing.

Unit IV: Communication Protocols

Use of communication protocols in embedded systems, Serial communication basics, synchronous/asynchronous interfaces, UART Protocol, I2C protocol, USB Protocol, SPI protocol, Bluetooth, Zig-Bee, Wireless sensor network.

Unit V: Real Time Operating Systems (RTOS)

RTOS fundamentals, Multitasking in small embedded systems, Memory management, Task management, Queue management, software timer management, interrupt management, resource management, event, Task notification.

TEXT BOOKS:

1. Steve Furber, “ARM System-on-Chip Architecture”, Second Edition, Pearson EducationPublication
2. James K. Peckol, “Embedded Systems: A Contemporary Design Tool”, WILEY Student EditionPublication
3. Andrew N. Sloss, “ARM system developer's guide”, Morgan Kaufmannelsevier.com
4. Tammy Noergaard, “Embedded Systems Architecture”, ElsevierPublication
5. **Wayne Wolf,** *"Embedded Systems: Architecture, Programming, and Design,"* Second Edition, **Pearson Education Publication.**
6. **David Russell,** *"Introduction to Embedded Systems: Using ANSI C and the Arduino Development Environment,"* **Morgan Kaufmann Publishers.**
7. “Real -Time System Design and analysis -Tools for the practioner ” By Phillip A Laplante (WileyPublication)

REFERENCE BOOKS:

1. Mastering the Free RTOS Real time Kernel A hands on tutoral guide by Richard

Barry

2. The Free RTOS Reference manual API functions and configuration options.

2311372PE403C	Introduction to Information Theory	03 Credits

Course Objectives:

1. To provide in-depth understanding of principles and applications of information theory.
2. To provide in-depth understanding of how information is measured in terms of probability and entropy and how these are used to calculate the capacity of a communication channel.
3. To provide in-depth understanding of different coding techniques for error detection and correction.

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

CO1: Understand the concept of information and entropy.

CO2: Understand Shannon‟s theorem for coding.

CO3: Calculation of channel capacity.

CO4: Apply coding techniques.

UNIT 1:

Introduction: Entropy, Relative Entropy, Mutual Information;Information Inequalities. Block to variable length coding-I: Prefix-free code, Block to variable length coding-II: Bounds on optimal code length; Block to variable length coding-III: Huffman coding.

UNIT 2:

Block to variable length coding-I: Prefix-free code,

Block to variable length coding-II: Bounds on optimal codelength;

Block to variable length coding-III: Huffman coding.

Variable to block length coding, The asymptotic equipartition property, Block to block coding of DMS.

UNIT 3:

Universal Source Coding-I: Lempel-Ziv Algorithm-LZ77

Universal source coding-II: Lempel-Ziv Welch Algorithm (LZW)

UNIT 4:

Coding for sources with memory, Channel capacity of discrete memoryless channels. Joint typical sequences, Noisy channel coding theorem; Differential entropy;

UNIT 5:

Gaussian Channel; Parallel Gaussian Channel.

Rate Distortion Theory; Blahut-Arimoto Algorithm for computation of channel capacity and rate- distortion function.

TEXT/REFERENCE BOOKS:

1. R.P.Singh, S.D. Sapre; Communication systems: Analog and Digital;TMH.
2. N. Abramson, Information and Coding, McGraw Hill,1963
3. M. Mansurpur, Introduction to Information Theory, McGraw Hill, 1987
4. B. P. Lathi; Modern Digital and Analog Communication Systems; OxfordPublication.
5. Das, Mullick, Chaterjee; Principles of Digital Communication; New AgeInternational.
6. Taub, Schilling, Principles of CommunicationEngineering(2 Edition), TMH.
7. Thomas M. Cover, Joy A. Thomas, Elements of Information Theory, Wiley Interscience.

S. No.	NPTEL Course	Name Instructor	Host Institute
1.	An Introduction To Information Theory	Prof. Adrish Banerjee	IIT Kanpur

2311372PE405A Introduction to MEMS 03 Credits

Course Objectives:

1. The objective of this course is to make students to gain basic knowledge on overview of MEMS (Micro electro Mechanical System) and various fabrication techniques.
2. This enables them to design, analysis, fabrication and testing the MEMS based components and to introduce the students various opportunities in the emerging field of MEMS.
3. This will enable student to study applications of micro-sensors and micro-actuators, various MEMS fabrication technologies, MEMS-specific design issues and constraints, Dynamics and modeling of microsystems, getting access to fabrication and testing in academia and industry.

Course Outcomes:

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

CO1: Appreciate the underlying working principles of MEMS and NEMS devices.

CO2: Design and model MEMS devices.

UNIT 1: Introduction to MEMS: 07 Hours

Introduction, History, Concepts of MEMS: Principles, application and design, Scaling Properties/Issues, Micromachining Processes: Substrates, lithography, wet/dry etching processes, deposition processes, film stress, exotic processes. Mechanical Transducers: transduction methods, accelerometers, gyroscopes, pressure sensors, MEMS microphones, mechanical structures, actuators.

UNIT 2: Control and Materials of MEMS: 07 Hours

Controls of MEMS: Analog control of MEMS, Sliding mode control of MEMS, Digital control of MEMS, Materials for MEMS: Substrate and wafers, Active substrate material,

silicon, Silicon compound, Silicon pezoresisters, Gallium arsenide, Quartz, piezoelectric crystals,Polymers.

UNIT 3: Review of Basic MEMS fabrication modules: 07 Hours

MEMS fabrication modules, Oxidation, Deposition Techniques, Lithography (LIGA), and Etching.

UNIT 4: Micromachining: 07 Hours

Micromachining, Surface Micromachining, sacrificial layer processes, Stiction; Bulk Micromachining, Isotropic Etching and Anisotropic Etching, Wafer Bonding.

UNIT 5: Mechanics of solids in MEMS/NEMS: 07 Hours

Mechanics of solids in MEMS/NEMS: Stresses, Strain, Hookes‟s law, Poisson effect,Linear Thermal Expansion, Bending, Energy methods. Overview of Finite Element Method, Modeling of Coupled Electro-mechanical Systems.

2311372PE405B	Satellite Communication	03 Credits

Course Objectives:

1. Understand the basic principle of satellite orbits and trajectories.
2. Study of electronic systems associated with a satellite and the earth station.
3. Understand the various technologies associated with the satellite communication.
4. Focus on a communication satellite and the national satellite system.
5. Study of satellite applications focusing various domains services such as remote sensing, weather forecasting and navigation.

Course Outcomes:

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

CO1: Describe the satellite orbits and its trajectories with the definitions of parameters associated with it.
CO2: Describe the electronic hardware systems associated with the satellite subsystem and earth station.
CO3: Describe the communication satellites with the focus on national satellite system.
CO4: Compute the satellite link parameters under various propagation conditions with the illustration of multiple access techniques.
CO5: Describe the satellites used for applications in remote sensing, weather forecasting and navigation.

UNIT 1:

Satellite Orbits and Trajectories: Definition, Basic Principles, Orbital parameters, Injection velocity and satellite trajectory, Types of Satellite orbits, Orbital perturbations, Satellite stabilization, Orbital effects on satellite’s performance, Eclipses, Look angles: Azimuth angle, Elevation angle.

UNIT 2:

Satellite subsystem: Power supply subsystem, Attitude and Orbit control, Tracking, Telemetry and command subsystem, Payload.

Earth Station: Types of earth station, Architecture, Design considerations, Testing, Earth station Hardware, Satellite tracking.

UNIT 3:

Multiple Access Techniques: Introduction, FDMA (No derivation), SCPC Systems, MCPC Systems, TDMA, CDMA, SDMA.

Satellite Link Design Fundamentals: Transmission Equation, Satellite Link Parameters, Propagation Considerations.

UNIT 4:

Communication Satellites: Introduction, Related Applications, Frequency Bands, Payloads, Satellite Vs. Terrestrial Networks, Satellite Telephony, Satellite Television, Satellite radio, Regional satellite Systems, National Satellite Systems.

UNIT 5:

Remote Sensing Satellites: Classification of remote sensing systems, orbits, Payloads, Types of images: Image Classification, Interpretation, Applications.

Weather Forecasting Satellites: Fundamentals, Images, Orbits, Payloads, Applications.

Navigation Satellites: Development of Satellite Navigation Systems, GPS system, Applications.

Text Book:

1. Anil K. Maini, Varsha Agrawal, Satellite Communications, Wiley India Pvt. Ltd., 2015, ISBN: 978-81-265-2071-8.

Reference Books :

1. Dennis Roddy, Satellite Communications, 4th Edition, McGraw- Hill International edition, 2006.
2. Timothy Pratt, Charles Bostian, Jeremy Allnutt, Satellite Communications, 2nd Edition, Wiley India Pvt. Ltd , 2017, ISBN: 978-81-265-0833-4.
3. M. O. Kolawole, Satellite Communication Engineering, Marcel Dekker, Inc.NY.
4. Robert Gagliardi, "Satellite Communication" , CBS Publication.

2311372PE405C	Introduction to Coding Theory	03 Credits

Course Objectives:

1. To define and explain fundamental concepts in coding theory, including error detection and correction, code distance, and code rate.
2. To analyze and compare different types of block codes, such as Hamming codes and Reed-Solomon codes, in terms of their error correction capabilities, code rate, and complexity.

3. Knowledge of convolutional codes, their encoder and decoder structures, and their application in communication systems.
4. Understand cyclic codes, their generator polynomial representation, and their properties, including the cyclic redundancy check (CRC) codes commonly used in data communication.
5. To design basic error detection and correction codes for specific applications, considering factors such as error probability, code rate, and decoding complexity.

Course Outcomes:

CO1: Students will gain a comprehensive understanding of the fundamental concepts in coding theory, including error detection and correction codes, block codes, convolutional codes, and cyclic codes.

CO2: Students will develop the ability to design basic error detection and correction codes, such as Hamming codes and Reed-Solomon codes, and understand their properties and limitations.

CO3: Students will learn how to analyze the performance of codes in terms of error detection/correction capabilities, code rate, and complexity, and understand the trade-offs involved in code design.

CO4: Students will explore the application of coding theory in various communication systems, including telecommunications, data storage, and digital transmission, and understand how coding techniques improve reliability and efficiency.

CO5: Students will build a strong foundation in the mathematical principles underlying coding theory, including linear algebra, finite fields, and algebraic structures, and apply these principles to code construction and analysis.

UNIT 1:

Introduction to error control coding, Introduction to linear block codes, generator matrix and parity check matrix

Properties of linear block codes: Syndrome, error detection

Decoding of linear block codes, Distance properties of linear block codes

UNIT 2:

Some simple linear block codes: Repetition codes, Single parity check codes, Hamming codes, Reed Muller codes

Bounds on size of codes: Hamming bound, Singleton bound, Plotkin bound, Gilbert-Varshamov bound

UNIT 3:

Introduction to convolutional codes-I: Encoding, state diagram, trellis diagram

Introduction to convolutional codes-II: Classification, realization, distance properties

Decoding of convolutional codes-I: Viterbi algorithm

UNIT 4:
Decoding of convolutional codes-II: BCJR algorithm
Performance bounds for convolutional codes
Low density parity check codes

UNIT 5:
Turbo codes, Turbo decoding, Distance properties of turbo codes, Applications of linear codes

TEXT/REFERENCE BOOKS:

1. "Error Control Coding", by Shu Lin and Daniel J. Costello, Jr., second edition, Prentice Hall, 2004.
2. Todd K. Moon, "Error Correction Coding", 1st Edition, Wiley-Interscience, 2006.
3. J. MacWilliams, N. J. A. Sloane, "The Theory of Error-Correcting Codes", North-Holland, Amsterdam, 1977
4. R. E. Blahut, "Algebraic Codes for Data Transmission", 1st Edition, Cambridge University Press 2003.
5. Cary W. Huffman, Vera Pless, "Fundamentals of Error-Correcting Codes", 1st Edition, Cambridge University Press, 2003.
6. Rolf Johannesson and Kamil Sh. Zigangirov, ``Fundamentals of Convolutional Coding'', IEEE Press, 1999.

S. No.	NPTEL Course	Name Instructor	Host Institute
1.	An Introduction To Coding Theory	Prof. Adrish Banerjee	IIT Kanpur

2311372RM401 Research Methodology 04 Credits

Course Objectives:
1. To develop a research orientation among the scholars and to acquaint them with fundamentals of research methods.
2. To develop understanding of the basic framework of research process.
3. To identify various sources of information for literature review and data collection.
4. To understand the components of scholarly writing and evaluate its quality.

Course Outcomes:
CO1: Learner will learn the meaning, objective, motivation and type of research.
CO2: Learner will be able to formulate their research work with the help of literature review.
CO3: Learner will be able to develop an understanding of various research design and techniques.
CO4: Learner will have an overview knowledge of modeling and simulation of research work.

CO5: Learner will be able to collect the statistical data with different methods related to research work.

CO6: Learner will be able to write their own research work with ethics and non-plagiarized way.

UNIT I

Introduction: Defining research, Motivation in Research, Meaning of Research, Types of research

Research Formulation: Formulating the research Problem, Literature Review, Development of Working Hypothesis.

UNIT II

Research Design: Important Concept in Research Design, Research Life Cycle, Developing Research Plan.

UNIT III

Overview of Modeling and Simulation: Classification of models, Development of Models, Experimentation, Simulation.

UNIT IV

Statistical Aspects: Methods of Data Collection, Sampling Methods, Statistical analysis, Hypothesis testing.

UNIT V

Research Report: Research Ethics, Plagiarism, Research Proposal, Report Writing and Writing Research Papers.

TEXTBOOKS / REFERENCES:

1. C.R. Kothari, Research Methodology, Methods & Techniques
2. J.P. Holman., Experimental Methods for Engineers

SEMESTER VIII

2311372PC312	VLSI Design	03 Credits

Course Objectives:

1. To study HDL based design approach.
2. To learn digital CMOS logic design.
3. To nurture students with CMOS analog circuit designs.
4. To realize importance of testability in logic circuit design.
5. To overview SoC issues and understand PLD architectures with advanced features.

Course Outcomes: After successfully completing the course, students will be able to

CO1: Model digital circuit with HDL, simulate, synthesis and prototype in PLDs.

CO2: Understand chip level issues and need of testability.

CO3: Design analog & digital CMOS circuits for specifconstitutionied applications

UNIT 1:

VHDL Modeling:

Data objects, Data types, Entity, Architecture & types of modeling, Sequential statements, Concurrent statements, Packages, Sub programs, Attributes, VHDL Test bench, Test benches using text files. VHDL modeling of Combinational, Sequential logics & FSM,Meta-stability.

UNIT 2:

PLD Architectures:

PROM, PLA, PAL: Architectures and applications. Software Design Flow, CPLD Architecture, Features, Specifications, Applications, FPGA Architecture, Features, Specifications, Applications.

UNIT 3:

SoC & Interconnect:

Clock skew, Clock distribution techniques, clock jitter, Supply and ground bounce, power distribution techniques. Power optimization, Interconnect routing techniques; wire parasitic, Signal integrity issues, I/O architecture, pad design, Architectures for low power.

UNIT 4:

Digital CMOS Circuits:

MOS Capacitor, MOS Transistor theory, C-V characteristics, Non ideal I-V effects, Technology Scaling. CMOS inverters, DC transfer characteristics, Power components, Power delay product, Transmission gate. CMOS combo logic design, Delays: RC delay model, Effective resistance, Gate and diffusion capacitance, Equivalent RC circuits; Linear delay model, Logical effort, Parasitic delay, Delay in a logic gate, Path logical efforts.

UNIT 5:

Analog CMOS Design and Testability:

Current sink and source, Current mirror, Active load, Current source and Push-pull inverters, Common source, Common drain, Common gate amplifiers. Cascade amplifier, Differential amplifier and Operational amplifier. Testability: Types of fault, Need of Design for Testability (DFT), Testability, Fault models, Path sensitizing, Sequential circuit test, BIST, Test pattern generation, JTAG & Boundary scan, TAP Controller.

TEXT/REFERENCE BOOKS:

1. Charles H. Roth, "Digital systems design using VHDL",PWS.
2. Wyane Wolf, "Modern VLSI Design (System on Chip)", PHI Publication.
3. Allen Holberg, "Analog CMOS Design", Oxford University Press.
4. NeilH. E. Weste, David Money Harris, "CMOS VLSI Design: A Circuit & System Perspective", Pearson Publication.

2311372PE406 Data Structure & Algorithms Using Java Programming 02 Credits

Course Objectives:

1. To assess how the choice of data structures and algorithm design methods impacts the performance of programs.
2. To choose the appropriate data structure and algorithm design method for a specified application.
3. To study the systematic way of solving problems, various methods of organizing large amounts of data.
4. To solve problems using data structures such as linear lists, stacks, queues, binary trees, binary search trees, and graphs and writing programs for these solutions.
5. To employ the different data structures to find the solutions for specific problems.

Course Outcomes:

On completion of the course, student will be able to:

CO1: To impart the basic concepts of data structures and algorithms.

CO2: To understand concepts about searching and sorting techniques

CO3: Describe how arrays, records, linked structures are represented in memory and use them in algorithms.

CO4: To understand basic concepts about stacks, queues, lists trees and graphs.

CO5: To enable them to write algorithms for solving problems with the help of fundamental data structures.

UNIT –1

Introduction:

Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade

off. Searching: Linear Search and Binary Search Techniques and their complexity analysis

UNIT – 2 Stacks and Queues:
ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each type of Queues: Algorithms and their analysis.

UNIT – 3 Linked Lists:
Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis.

UNIT –4 Trees:
Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees, B Tree, B+ Tree: definitions, algorithms and analysis.

UNIT – 5 Sorting and Hashing:
Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing. Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexityanalysis.

TEXT/REFERENCE BOOKS:

1. Algorithms, Data Structures, and Problem Solving with C++", Illustrated Edition by Mark Allen Weiss, Addison-Wesley PublishingCompany
2. "How to Solve it by Computer", 2nd Impression by R. G. Dromey, PearsonEducation.
3. Ellis Horowitz, SartajSahni, "Fundamentals of Data Structures", Galgotia Books Source. ISBN 10:0716782928.
4. Richard F. Gilberg&Behrouz A. Forouzan, Data Structures: A Pseudocode Approach with C, Cengage Learning, second edition. ISBN-10:0534390803.
5. Seymour Lipschutz, Data Structure with C, Schaum‟s Outlines, Tata Mc Graw Hill. ISBN-10:1259029964.
6. E Balgurusamy - Programming in ANSI C, Tata McGraw-Hill, Third Edition. ISBN-10: 1259004619.
7. YedidyahLangsam, Moshe J Augenstein, Aaron M Tenenbaum – Data structures using C and C++ - PHI Publications, Second Edition). ISBN 10:8120311779.

2311372PE406	UAV in Engineering Applications	02 Credits

Course Objectives:

1. Introduce students to the basic principles and components of UAV systems, including aerodynamics, propulsion, control systems, and sensors.
2. Develop practical skills in designing, building, and operating UAVs through hands-on projects and simulations.
3. Educate students on safety protocols, regulations, and ethical considerations associated with UAV operations, including airspace regulations and privacy concerns.
4. Explore the diverse range of engineering applications for UAV technology, including but not limited to aerial mapping, surveillance, agriculture, disaster management, and infrastructure inspection.
5. Foster critical thinking and problem-solving abilities in students by challenging them to address real-world engineering challenges using UAV technology.

Course Outcomes:

1. Students will be able to design UAVs tailored to specific engineering applications, considering factors such as payload capacity, endurance, and environmental conditions.
2. Students will have practical experience in assembling, programming, and testing UAV systems, including flight control algorithms and sensor integration.
3. Students will understand and adhere to legal and ethical guidelines governing UAV operations, ensuring safe and responsible use of the technology.
4. Graduates will be proficient in applying UAV technology to solve engineering problems across various industries, demonstrating competence in tasks such as aerial surveying, environmental monitoring, and infrastructure inspection.
5. Students will demonstrate creativity and innovation in developing novel UAV applications and solutions to address emerging engineering challenges.

Unit 1: Introduction, Classifications, Applications and Payloads of UAV

Motivation - Types of UAV – Characteristics – Fixed Wing – Rotary Wing – Flapping Wing – Basic Parts of UAV – Specifications – Applications – Pay loads of UAV

Aerodynamics and Computational Fluid Dynamic Analysis of UAV

Basics of Aerodynamics - Lift and Drag – Bernoulli Theories and Equations – Angle of Attack - Peculiarities of Multicopters – Wing Tip Vortices and Wake Turbulence - Stability – Turning Flight – Stall - Introduction to CFD – Fluid Governing Equations - Turbulence Models - External and Internal Flow -Modeling and Aerodynamic Analysis - Computational and Numerical Tools.

Unit 2: Design, Assembly, Integration and Testing of Quadcopter

Design of Quadcopter – Selection of Sub Systems - Airframe Assembly – Integration of Electronic Systems – Firmware Loading and Parameter Set up - Calibration of Sensors – Tuning - Introduction to Ground Control Station – Flight Simulation – Autonomous Flight Path Planning – Testing of Quadcopter – Demonstration Videos.

Industrial and Engineering Applications of UAVs

Need of UAVs for Industrial Applications - Development of UAVs for Powerline Inspection - Telecom Structure Inspection and Radiation Measurement – Bridge and Heritage Structure Inspection – Collection of Sea Weeds using UAV.

Unit 3: Case study 1 : Development of Amphibious UAV for water quality monitoring

Conceptual Designs of Amphibious UAV - Design Parameters – CFD and FEA Analysis – Subsystems of Amphibious UAV - Selection of Components – Fabrication - Testing of Sub Systems – Integration of Sub Systems – Real Time Testing of Developed Amphibious UAV – Water Quality Sensors – Collection of Water Quality Data using IoT Platform.

Unit 4: Case study 2: SWARM of UAVs for 3D Mapping using Stereo vision system

Stereo Vision Camera – Working Principle – Capturing of Point Cloud Data: Indoor and Outdoor Environment – Image Stitching – 3D Mapping. Path Planning Algorithms – Simulation Studies – Implementation of Developed Algorithm in UAV – Testing – Obstacle Avoidance. SWARM of UAVs : Simulation Studies – Line and Triangle Formation of UAVs : Demonstration Videos with UAV – Theoretical an Experimental Comparison – Discussion.

Unit 5: Case study 3: Development of Flapping Wing Vehicle (FWV) and Image Based Control of Flocking of Birds

Flapping Wing Vehicle – Introduction – Lift and Drag Forces – Birds Motion – Angle of Attack – Measurement of Lift and Thrust Forces – Mechanism Design of FWV – Manufacturing of Micro Mechanism Components: Injection Moulding, Wire Cut EDM, 3D Printing – Selection and Assembly of FWV Components – Testing – Image Based Control of Group of FWVs – Demonstration Videos with FWV.

DGCA Rules, Regulation and Future Engineering Application of UAVs

Drone Categories Based on All-up weight – Type Certification of UAVs - DGCA Rules for UAV Registration, Certification and Pilot Licensing - Remote Pilot Training Organization (RPTO) – Flying Zones – Future Engineering Applications of UAVs.

Books and References:

1. Austin, R. (2011). Unmanned aircraft systems: UAVS design, development and deployment. John Wiley & Sons.
2. Fahlstrom P, Gleason T (2012) Introduction to UAV systems, 4th edn. Wiley, UK
3. Norris D (2014) Build your own quadcopter. McGraw-Hill Education, New York
4. Büchi R (2014) Radio control with 2.4 GHz. BoD–Books on Demand
5. Valavanis K. P.; Vachtsevanos, G. J., eds (2015): Handbook of unmanned aerial vehicles, Springer reference
6. Yang, L. J., & Esakki, B. (2021). Flapping Wing Vehicles: Numerical and Experimental Approach. CRC Press.
7. Sebbane, Y. B. (2022). A first course in aerial robots and drones. CRC Press.

S. No.	NPTEL Course	Name Instructor	Host Institute
1.	UAV in Engineering Applications	Dr. E. Balasubramanian	National Institute of Technical Teachers Training and Research, Chennai.

2311372PE406 Data Compression & Encryption 02 Credits

Course Objectives:

1. The concept of security, types of attack experienced.
2. Encryption and authentication for deal with attacks, what is data compression, need and techniques of data compression.

Course Outcomes:

At the end of this course

CO1: The student will have the knowledge of Plaintext, cipher text, RSA and other cryptographic algorithm.

CO2: The student will have the knowledge of Key Distribution, Communication Model, Various models for data compression.

UNIT – 1

Data Compression and Encryption:

Need for data compression, Lossy /lossless compression, symmetrical compression and compression ratio, run length encoding for text and image compression, scalar and quantization.

UNIT – 2

Statistical Methods:

Statistical Methods: Statistical modeling of information source, coding redundancy, variable size codes, prefix codes, Shannon- Fano coding, Huffman coding, adaptive Huffman coding, arithmetic coding and adaptive arithmetic coding.

UNIT – 3

Dictionary Methods:

String compression, sliding window compression, LZ77, LZ78 and LZW algorithms and applications in text comp ression.

UNIT – 4

Image and Audio Compression: Lossless techniques of image compression, JPEG and JPEG-LS compression standards, pulse code modulation and differential pulse code modulation methods of image compression. Digital audio, lossy sound compression, DPCM and ADPCM audio compression, MPEG audio standard.

UNIT – 5

Conventional Encryption:

Security of information, security attacks, classical techniques, caeser Cipher, block cipher principles, data encryption standard, key generation for DES, block cipher principle, design and modes of operation, triple DES with two three keys, key distribution.

TEXT/REFERENCE BOOKS:

1. Data compression- David Solomon Springer Verlagpublication.
2. Cryptography and network security- William Stallings Pearson Education Asia Publication.
3. Introduction to data compression-Khalid Sayood Morgan kaufmannpublication.
4. The data compression book- Mark Nelson BPBpublication.
5. Applied cryptography-Bruce schnecer, John Wiley and sons Inc.,publications.